Real-Time Water Quality Report

Canada Fluorspar (NL) Inc, Real-Time Water Quality Stations

Deployment Period
August 15 2018 to September 26 2018

Newfoundland Labrador

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

Prepared by:

Tara Clinton
Environmental Scientist
Water Resources Management Division
Department of Municipal Affairs & Environment
4th Floor, Confederation Building, West Block
PO Box 8700, St. John's NL A1B 4J6
Ph. No.: (709) 729 - 5925
Fax No.: (709) 729 - 0320
taraclinton@gov.nl.ca

General

The Water Resources Management Division (WRMD), in partnership with Water Survey of Canada (WSC) -Environment and Climate Change Canada (ECCC), maintain real-time water quality and water quantity monitoring stations on Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond, brooks that are within the site of Canada Fluorspar (NL) Inc, St. Lawrence, Newfoundland & Labrador.

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

Outflow of Grebes Nest Pond

The Outflow of Grebes Nest Pond station is established downstream of the pit dewatering effluent outfall and upstream of John Fitzpatrick Pond. The stream is approximately 1.0 to 2.0 meters wide and sustains a sufficient pool for the instrumentation to be placed in (Figure 2). The pool depth is approximately 0.5 to 1.0 metres. The GPS coordinates for this site are as follows**: N46° 54’ 35.9” W055° 27’ 45.6”**.

The station hut was placed on the north bank looking downstream approximately 5 metres from the stream. This station will provide real-time water quality and quantity data to ensure emerging issues associated with the open pit (from both the construction and operational phases)are detected, to allow the appropriate mitigation measures to be implemented in a timely manner, thus reducing any adverse effect on the downstream systems.

Outflow of Unnamed Pond south of Long Pond

The Outflow of Unnamed Pond south of Long Pond is established downstream of the Tailings Management Facility (TMF). This station will provide near real-time water quality and quantity data to ensure emerging issues associated with the TMF are detected, to allow the appropriate mitigation measures to be implemented in a timely manner, thus reducing any adverse effect on the downstream systems. The location of Outflow of Unnamed Pond south of Long Pond was selected due to accessibility to the brook and the sufficient pool available to place the water quality and quantity instruments (See Figure 3). The stream initiates from a small unnamed pond and meanders through a marsh environment alongside the TMF. The stream is approximately 1.0 to 2.0 meters wide. Where the instrument is deployed, there is a depth of approximately 1.0 to 1.5 meters. The GPS coordinates for this site are as follows: **N46° 54’ 14.1” W055° 26’ 37.5”**. The station hut was placed on the right bank looking downstream approximately 8 meters from the stream (Figure 3).

Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest Pond.

Figure 3: Real-Time Water Quality and Quantity Station at Outflow of Unnamed Pond south of Long Pond.

Quality Assurance and Quality Control

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

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

WRMD staff (Municipal Affairs and Environment (MAE) are responsible for maintenance of the real-time water quality monitoring equipment, as well as recording and managing the water quality data. Tara Clinton, is MAE's main contact for the real-time water quality monitoring operation at Canada Fluorspar (NL) Inc, and is responsible for maintaining and calibrating the water quality instrument, as well as grooming, analyzing and reporting on water quality data recorded at the station.

WSC staff have an essential role in the data logging/communication aspect of the network and the maintenance of the water quantity monitoring equipment. WSC staff visit the site regularly to ensure the data logging and data transmitting equipment are working properly. WSC is responsible for handling stage and streamflow issues. The quantity data is raw data that is transmitted via satellite and published online along with the water quality data on the Real-Time Stations website. Quantity data has not been corrected or groomed when published online or used in the monthly reports for the stations. WSC is responsible for QA/QC of water quantity data. Corrected stage and streamflow data can be obtained upon request to WSC.

Table 1: Instrument Performance Ranking classifications for deployment and removal

	Rank				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be divided into subgroups of: temperature dependent temperature compensated and temperature independent. Due to the temperature sensor's location on the sonde, the entire sonde must be at a constant temperature before the temperature sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

Table 2: Instrument performance rankings

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Grebes Nest Pond	August 15	Deployment	Good	Excellent	Good	Excellent	Excellent
	September 26	Removal	Good	Good	Fair	Excellent	Excellent
Unnamed Pond	August 15	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	September 26	Removal	Excellent	Good	Good	Good	Excellent

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, pH, specific conductivity, dissolved oxygen and turbidity data ranked 'Good' or 'Excellent' against the QA values.

During removal of the instrument, the ranking for water temperature, pH, dissolved oxygen and Turbidity ranked 'Excellent' or 'Good' against the QA data. Conductivity data ranked as 'Fair' at removal. At removal it was noted that there was a lot of silt and sediment on the instrument which likely interfered with the conductivity data at this time.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond the data ranked as 'Excellent' or 'Good' for all parameters

At the end of the deployment, all water quality parameters ranked as 'Good' or 'Excellent'.

Concerns or Issues during the Deployment Period

Please note that the stage data in this document 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.

Due to issues with communication at Outflow of Grebes Nest Pond there is no stage data for this deployment.

Due to transmission issues with Outflow to Unnamed Pond south of Long Pond station during this deployment, there is no hourly stage data to compare against the hourly water quality parameters. However, daily averaged stage levels were provided with each graph for a general overview of the deployment.

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from 7.77°C to 22.58°C during the deployment period (Figure 4). The water temperature has a larger range than the previous deployment and there was more fluctuation. The average water temperature for this deployment is 14.86°C. The water temperature data was compared against the Mean Air Temperatures from the St. Lawrence Weather Station.

Water temperature data for this deployment illustrates the warm August temperatures decreasing into Fall near the end of the deployment.

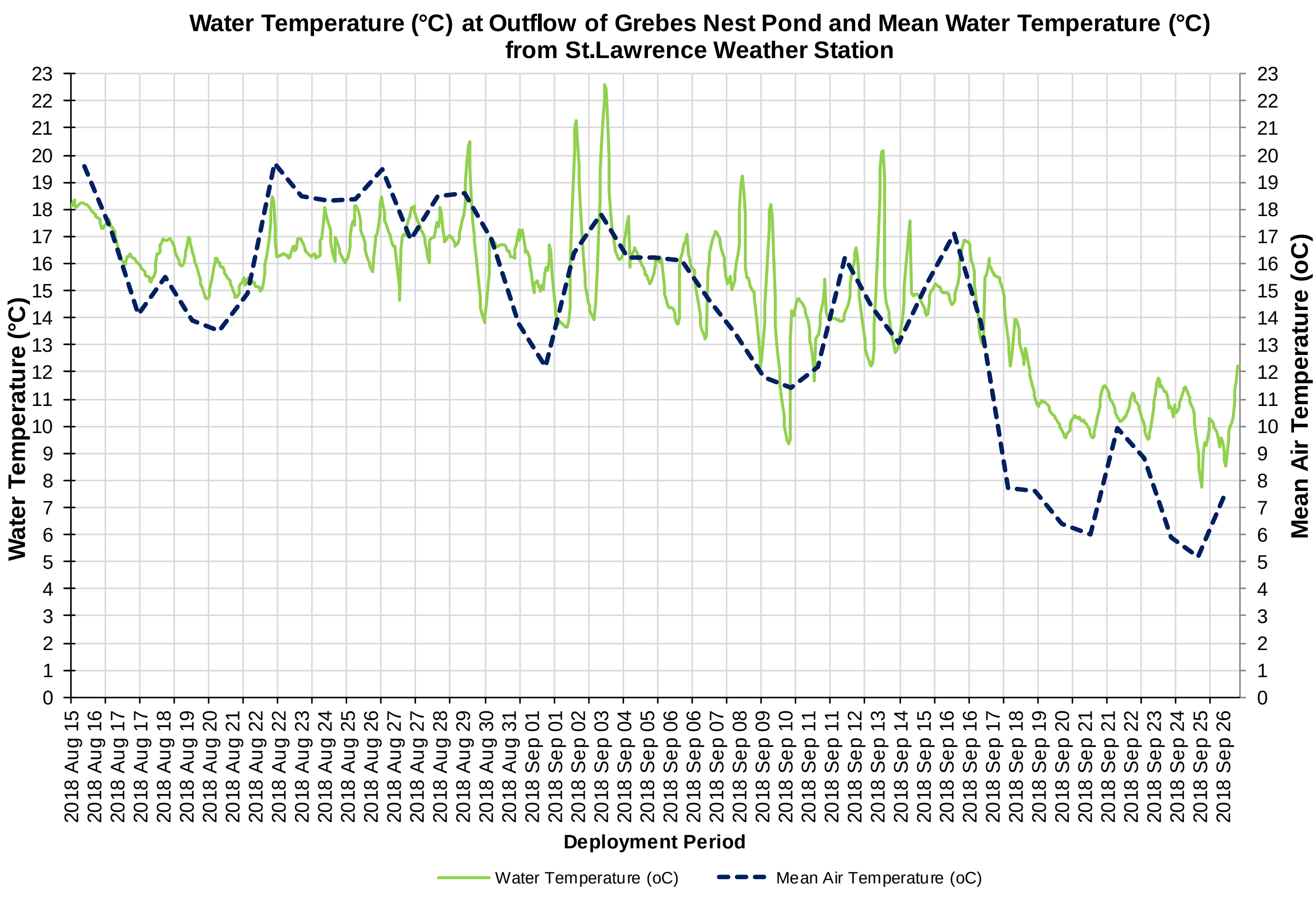

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 7.04 pH units and 7.67 pH units (Figure 5). The pH data remained within the Guidelines for Protection of Aquatic Life the Canadian Council of Ministers of the Environment (CCME).

On September 18th the pH data decreased for a short period of time. When it was compared with the precipitation graph (Figure 9) this drop in pH values corresponded a significant rainfall. Natural processes such as rainfall, runoff from snowmelt and evaporation will alter the pH of a brook for a period of time.

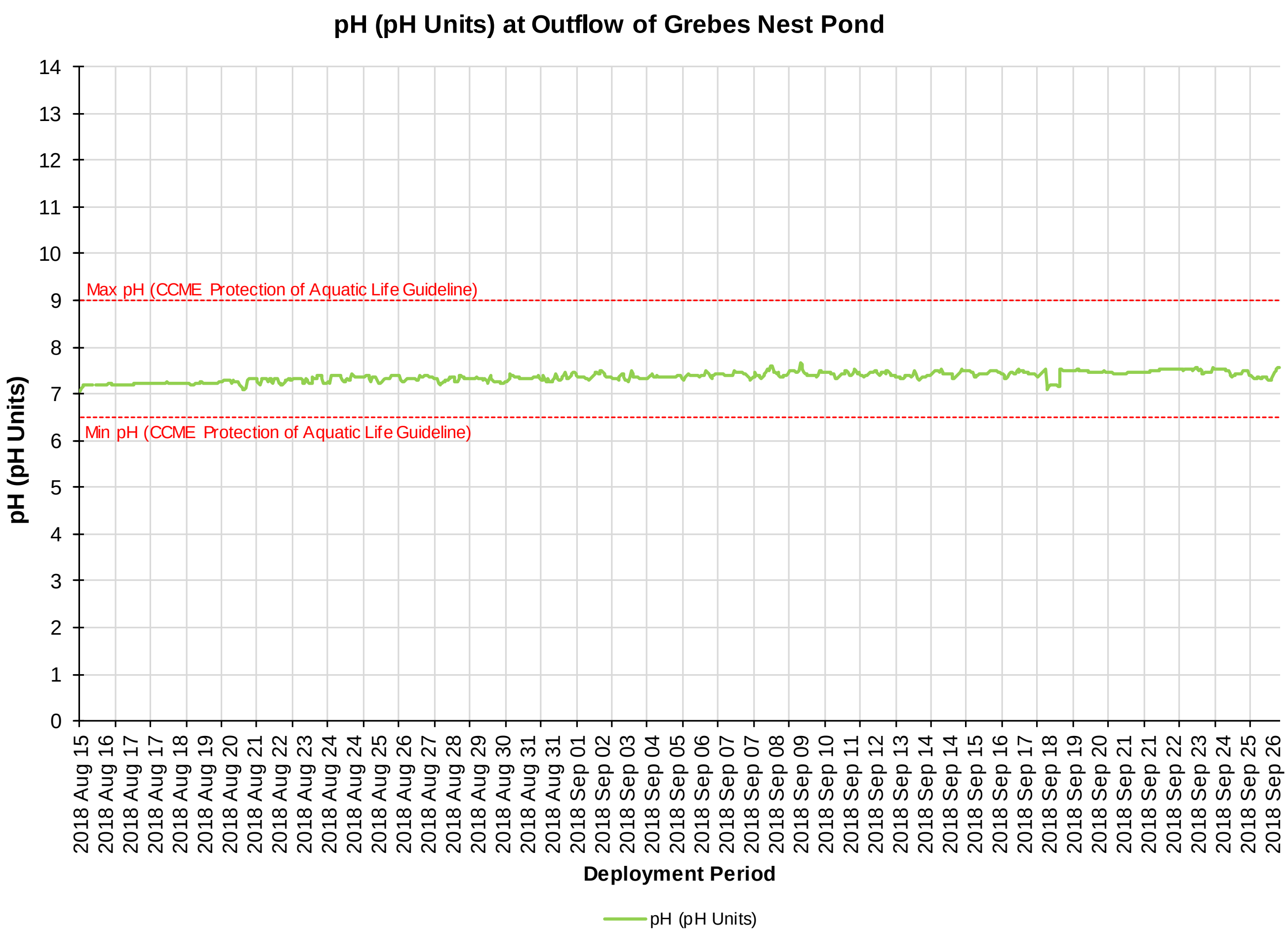

Figure 5: pH (pH units) values

Specific Conductivity

The conductivity levels were within 190.2 µS/cm and 649.3 µS/cm during this deployment period (Figure 6). The specific conductivity probe measures the diluted salts and inorganic materials present in the brook. The conductivity in a brook can be diluted by rainfall or increased if there is runoff occurring, washing sediment into the water.

During this deployment, the majority of the specific conductivity data ranges within 200 – 400 µS/cm. The precipitation on September 18th influences the conductivity in this brook, resulting in decreased conductivity for a short period of time. However, shortly after the large drop the conductivity levels increase to 649 µS/cm, likely a result of overflow from the sedimentation pond that feeds this brook.

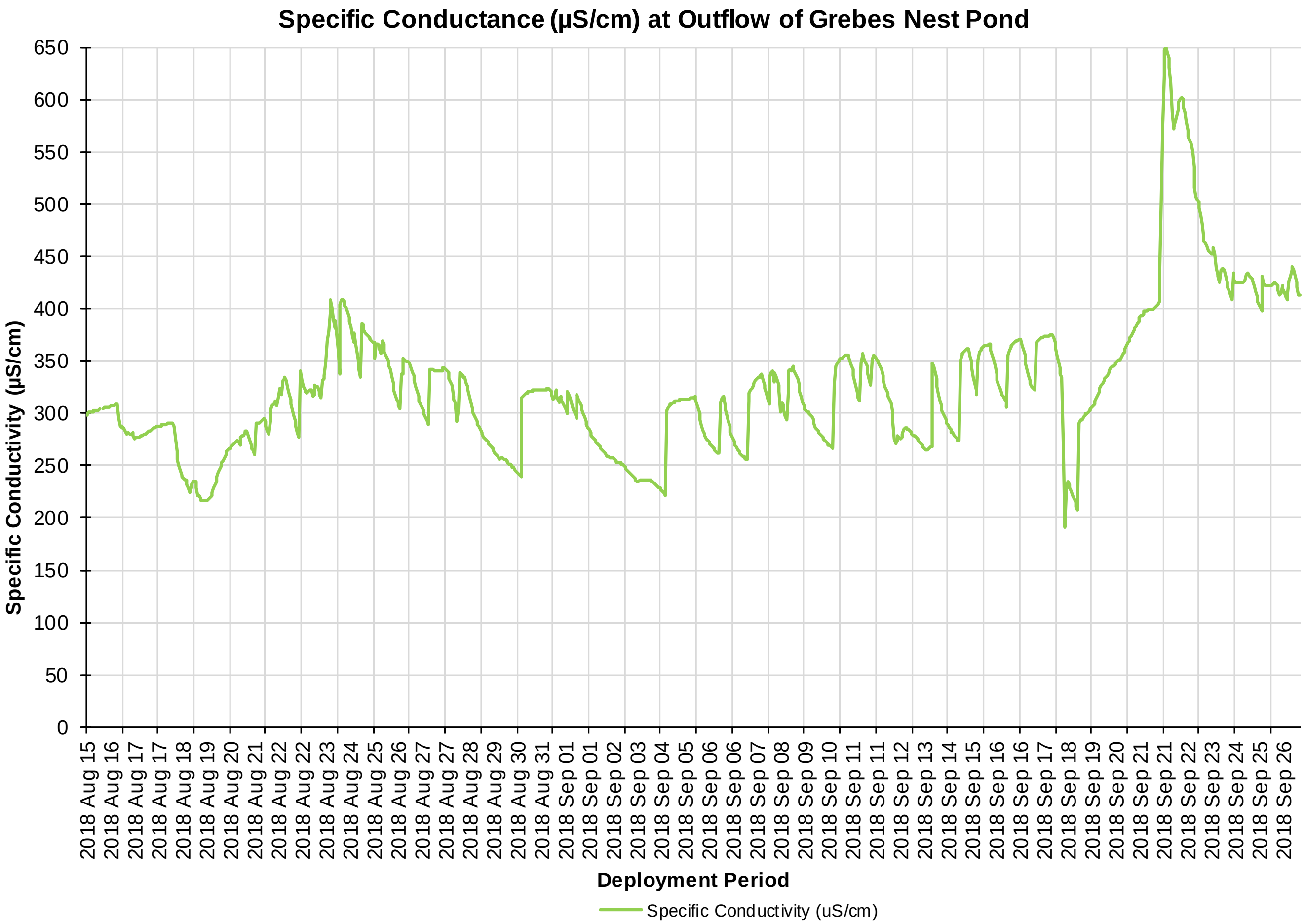

Figure 6: Specific conductivity (µS/cm) values

Dissolved Oxygen

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

During the deployment the dissolved oxygen concentration levels ranged within a minimum of 7.59 mg/L to a maximum of 10.85 mg/L. The percent saturation levels for dissolved oxygen ranged within 76% Saturation to 107.9% Saturation (Figure 7). Dissolved oxygen concentration was slightly higher than the previous deployment, likely a result of the cooler air and water temperatures at this time of year.

Dissolved oxygen concentration data increases gradually as the deployment progresses. This is expected as the temperatures cool and there is more dissolved oxygen present in the brook.

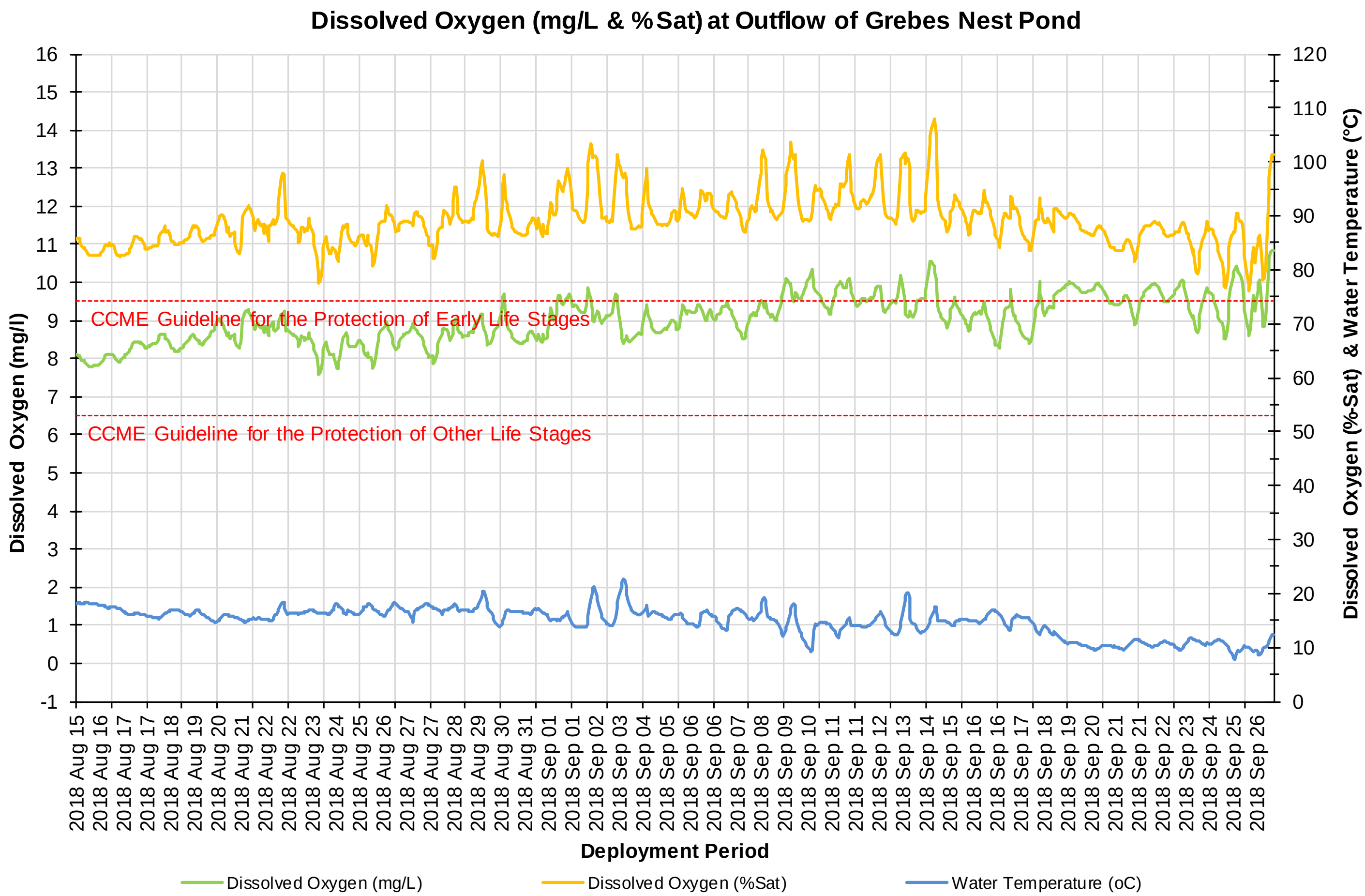

Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 4.23 NTU and 483.76 NTU (Figure 8). The deployment data has a median of 15.78 NTU which is lower than the previous deployment median of 122.3 NTU.

Outflow to Grebes Nest Brook is fed upstream by a sedimentation pond and is heavily impacted by the material that is in the sedimentation pond. This station has much variation in its turbidity values. Generally, the turbidity levels increase for a short period of time and then return to baseline range.

During this deployment the turbidity peaks generally correspond with precipitation events (Figure 9). Rainfall suspended sediment, increasing turbidity in the brook or flow from the sedimentation pond upstream increased during the rainfall events, increasing the suspended material in the brook.

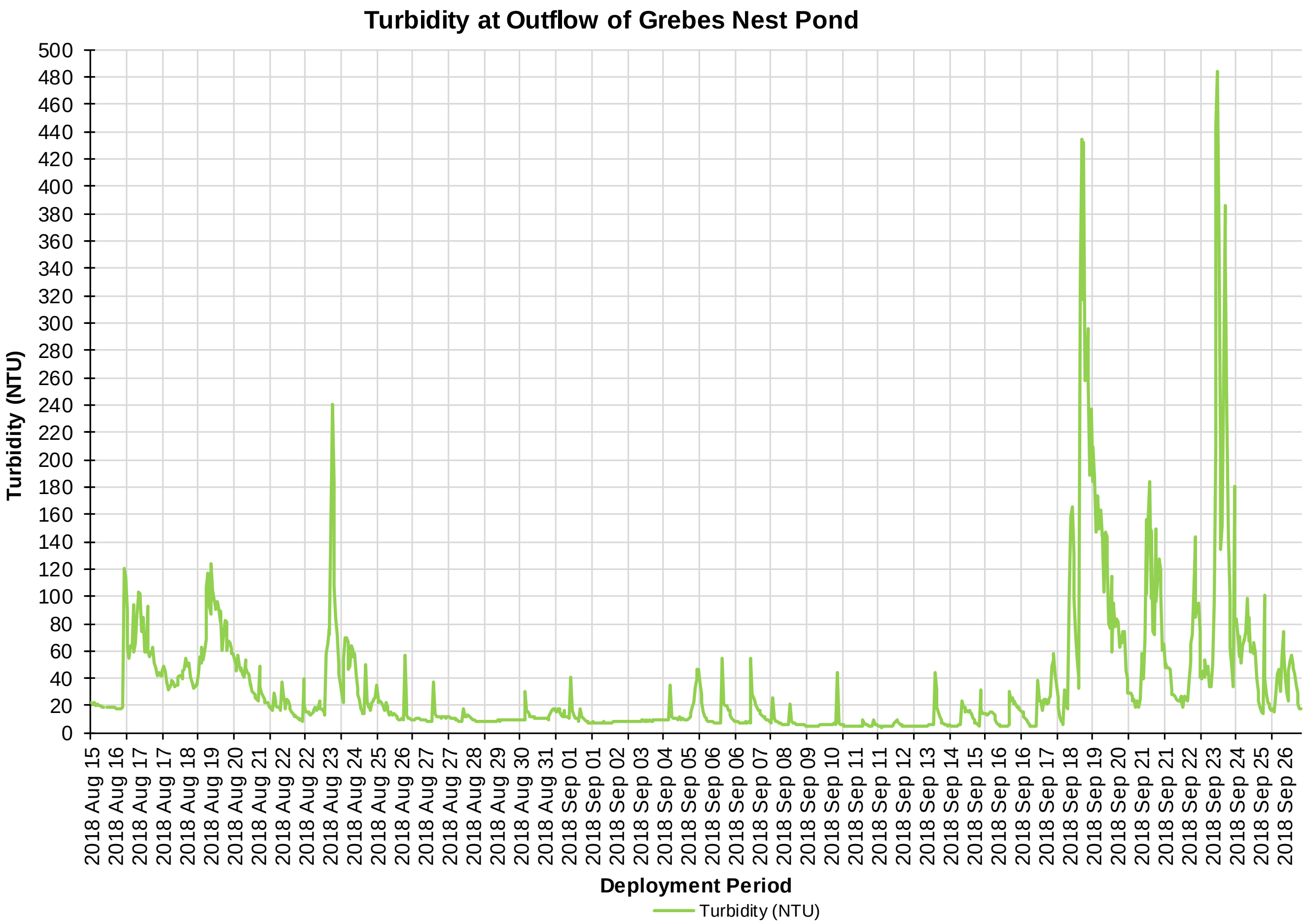

Figure 8: Turbidity (NTU) values.

Total Precipitation

Stage data is normally compared against precipitation data to understand how one influenced the other during deployment. However, due to communication issues during this deployment, stage data is not available. Stage 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 9) and during any surrounding snow or ice melt as runoff will collect in the brooks.

Although this brook is fed via a sedimentation pond, rainfall is very influential and assists in maintaining water level. When there is little to no rainfall recorded the stage level decreases. Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 48.2 mm on August 16th 2018.

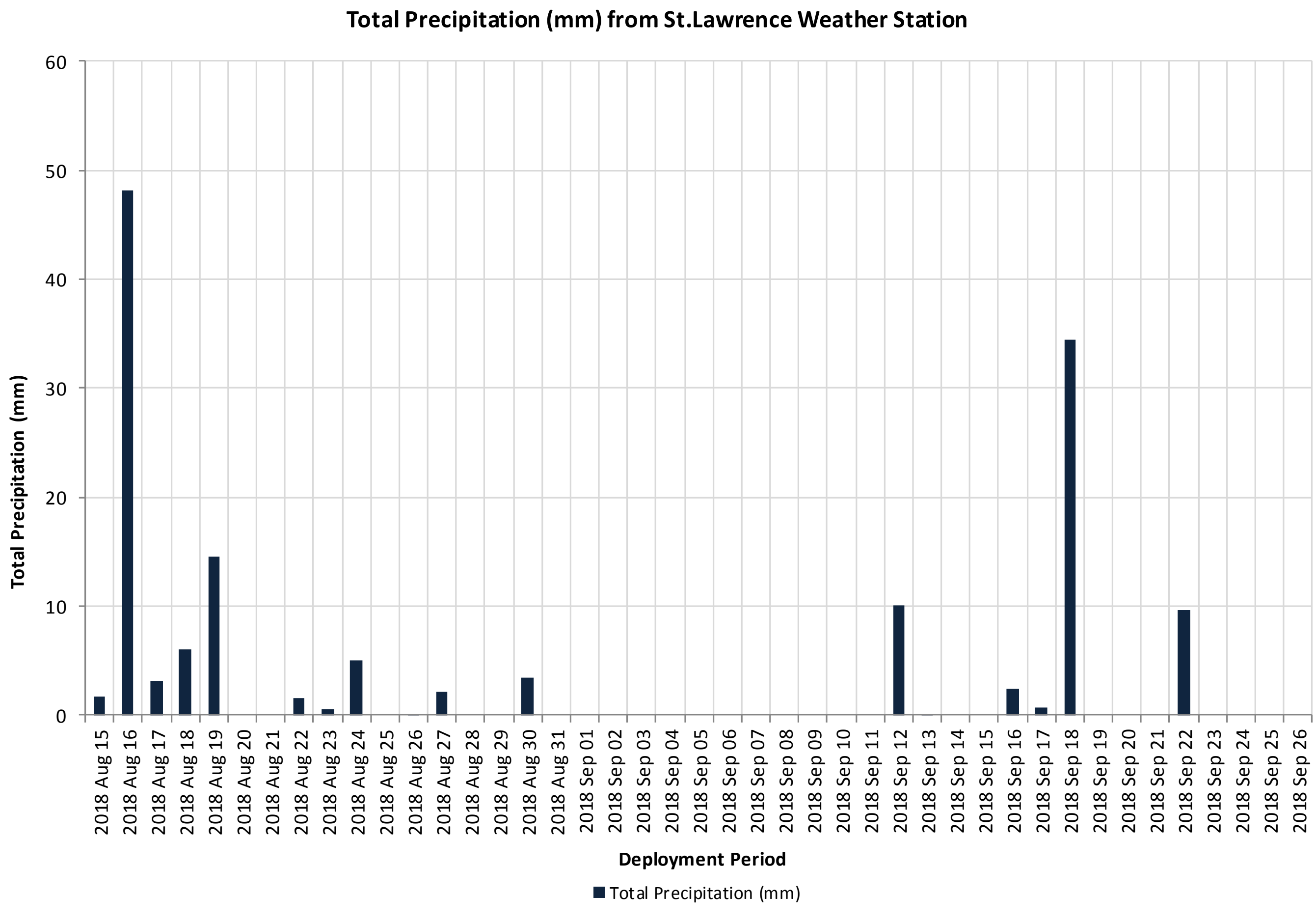

Figure 9: Daily average stage values and daily total precipitation.

Conclusion

Outflow of Grebes Nest Pond currently flows through a developing mine site. Grebes Nest Pond has been dewatered for mining purposes and no longer exists. The water supply for Outflow of Grebes Nest Pond station has changed.

Currently the water is originating from a sedimentation pond that is upstream of the Real-Time station. The sedimentation pond was developed to assist in settling out the sediment-laden water that is pumped from the open mine pit. Canada Fluorspar has created the sedimentation pond to naturally overflow down into a trough and through a culvert that flows into Outflow of Grebes Nest Pond.

These factors can impact the water quality during climatic events such as precipitation. When reviewing the data it is evident that the larger precipitation events caused various effects on the water quality. It can be assumed that the increased flow from the sedimentation pond was responsible for the variations in the above mentioned water quality parameters.

Overall the water quality parameters recorded at Outflow of Grebes Nest Pond displayed variations expected of a brook in an environment influenced by anthropogenic activities.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranges from 6.89°C to 23.86°C during this deployment period (Figure 10). The water temperatures remain steady until September 18th when water temperature begins to decrease into fall.

The larger stage increases are likely a result of rainfall (Figure 15). Rainfall can decrease the temperature of the water for a short period of time.

Please note the daily averaged 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.

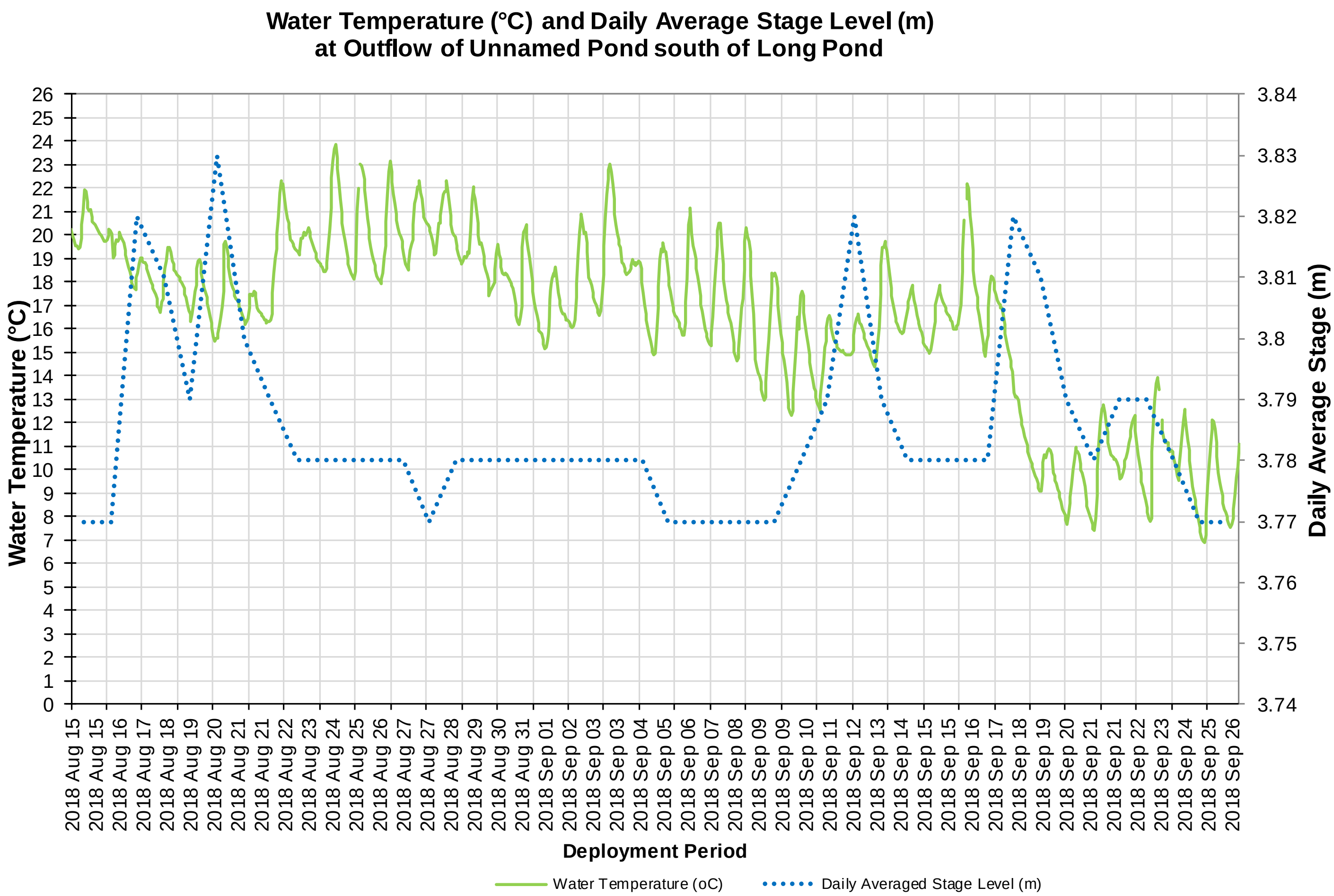

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.12 pH units and 8.26 pH units (Figure 11). The pH data remained within the Guidelines for Protection of Aquatic Life the Canadian Council of Ministers of the Environment (CCME). The pH data is consistent across the deployment with a slight increase as the deployment period ends.

Natural processes such as rainfall and snowmelt will alter the pH of a brook for a period of time. This is evident during and after stage increases as the pH data decreased for a short period of time.

Please note the daily averaged 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.

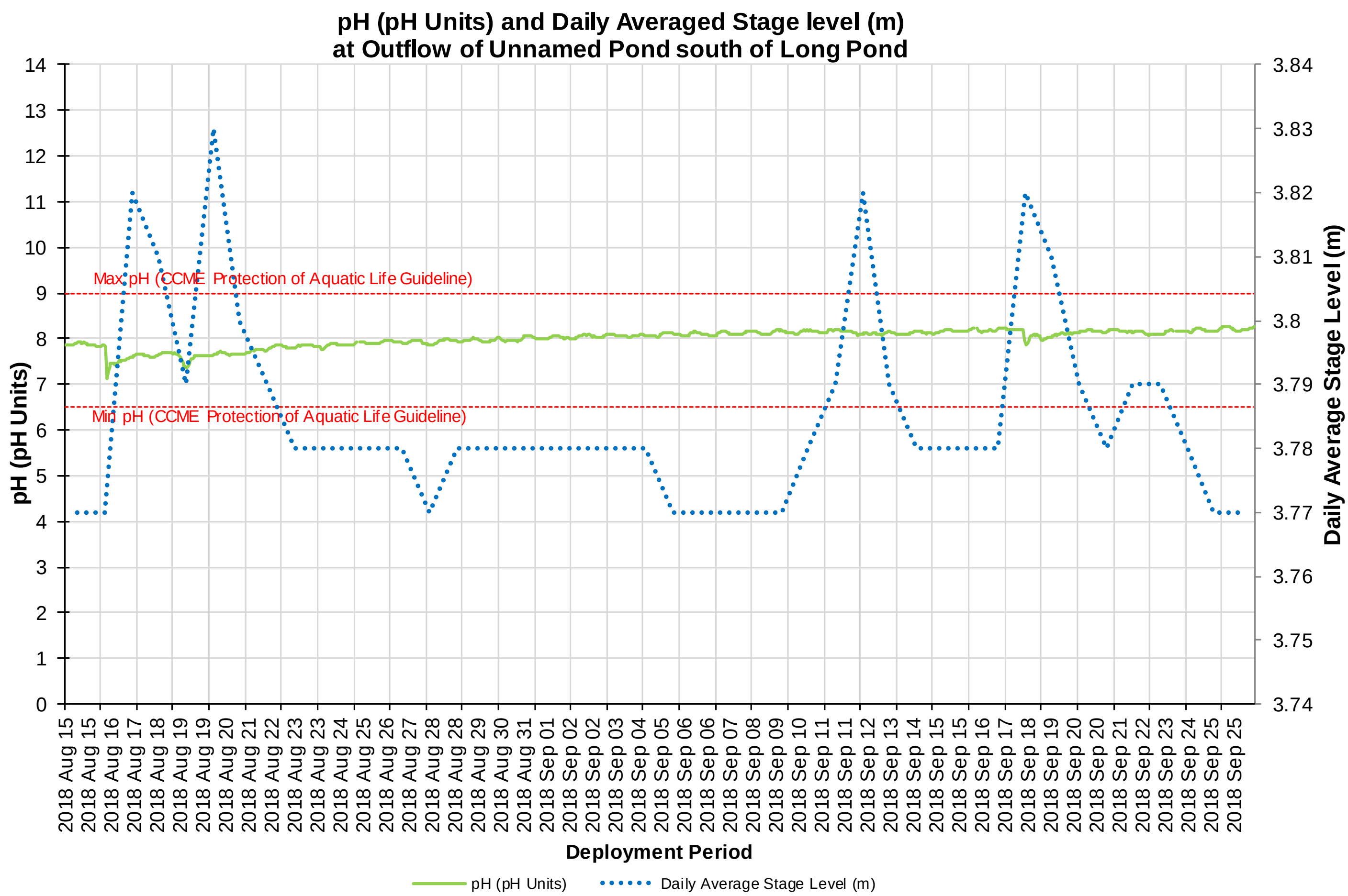

Figure 11: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 136.5 µS/cm and 535.3 µS/cm during deployment (Figure 12). This deployment period had a median of 337.6 µS/cm, which was higher than that of the median of the previous deployment of 179.5 µS/cm.

The conductivity at this station increased gradually throughout the deployment (Figure 12). The stage increases at the beginning of the deployment influenced the conductivity levels by diluting the particle matter and reducing the conductivity. As the stage dipped on August 22nd, 2018 the conductivity levels increased steadily until September 12th, when the stage increased and the conductivity levels dipped again for a short period of time before climbing again as the stage levels decreased on September 13th.

Please note the daily averaged 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.

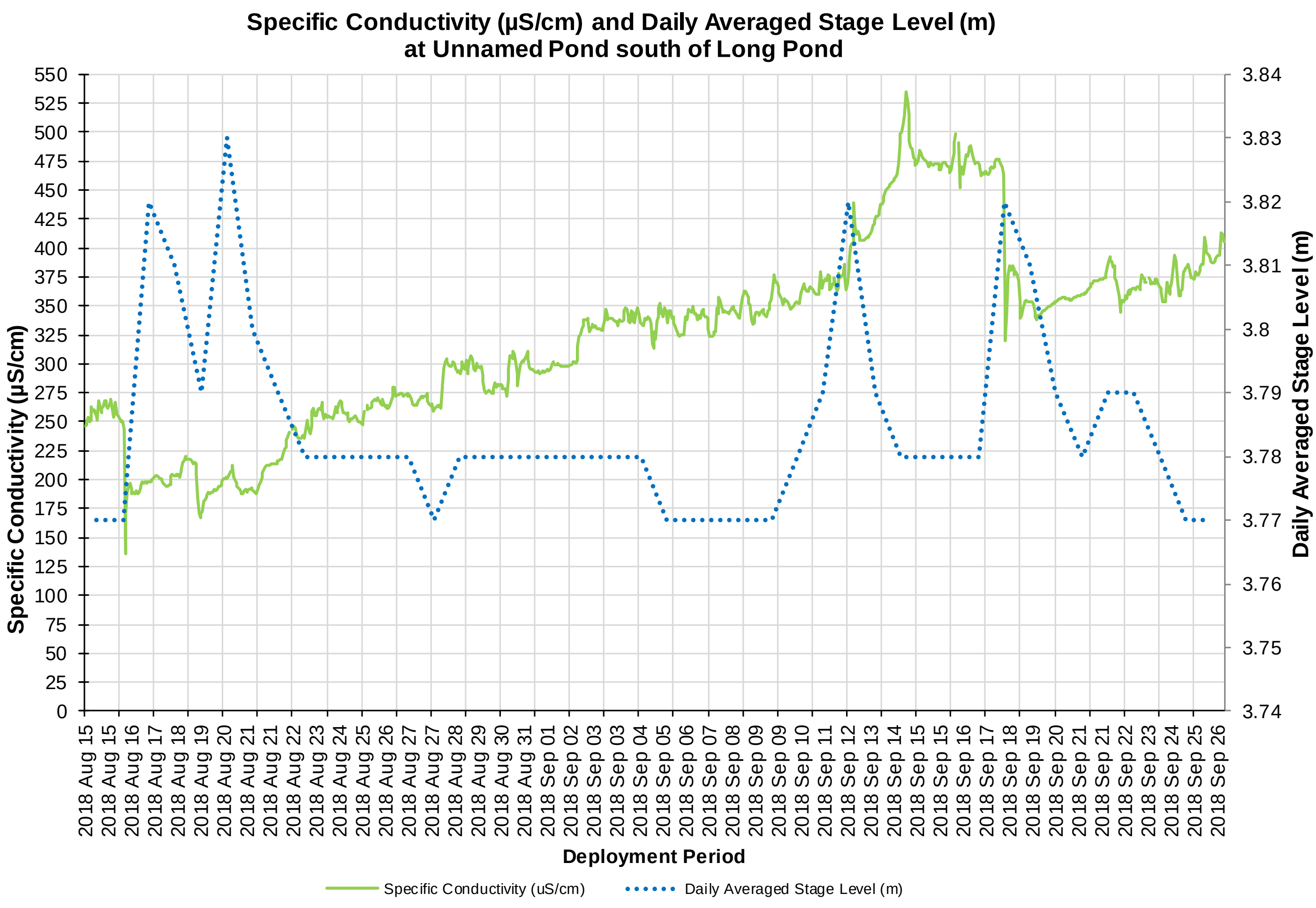

Figure 12: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

Dissolved Oxygen

The water quality instrument directly measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account the water temperature. During this deployment the dissolved oxygen levels where within 8.5 mg/L and 12.5 mg/L for concentration and 95.6% Sat and 105.7% Sat for percent saturation.

There is a natural diurnal pattern with dissolved oxygen data that represents the oxygen levels throughout night and day. The significant dips/peaks outside of the diurnal pattern, are a result of fluctuations in water temperature or influences from rainfall/runoff. This can be seen on Figure 13 on September 17th as the water temperature decreases on this date and the dissolved oxygen concentration increases.

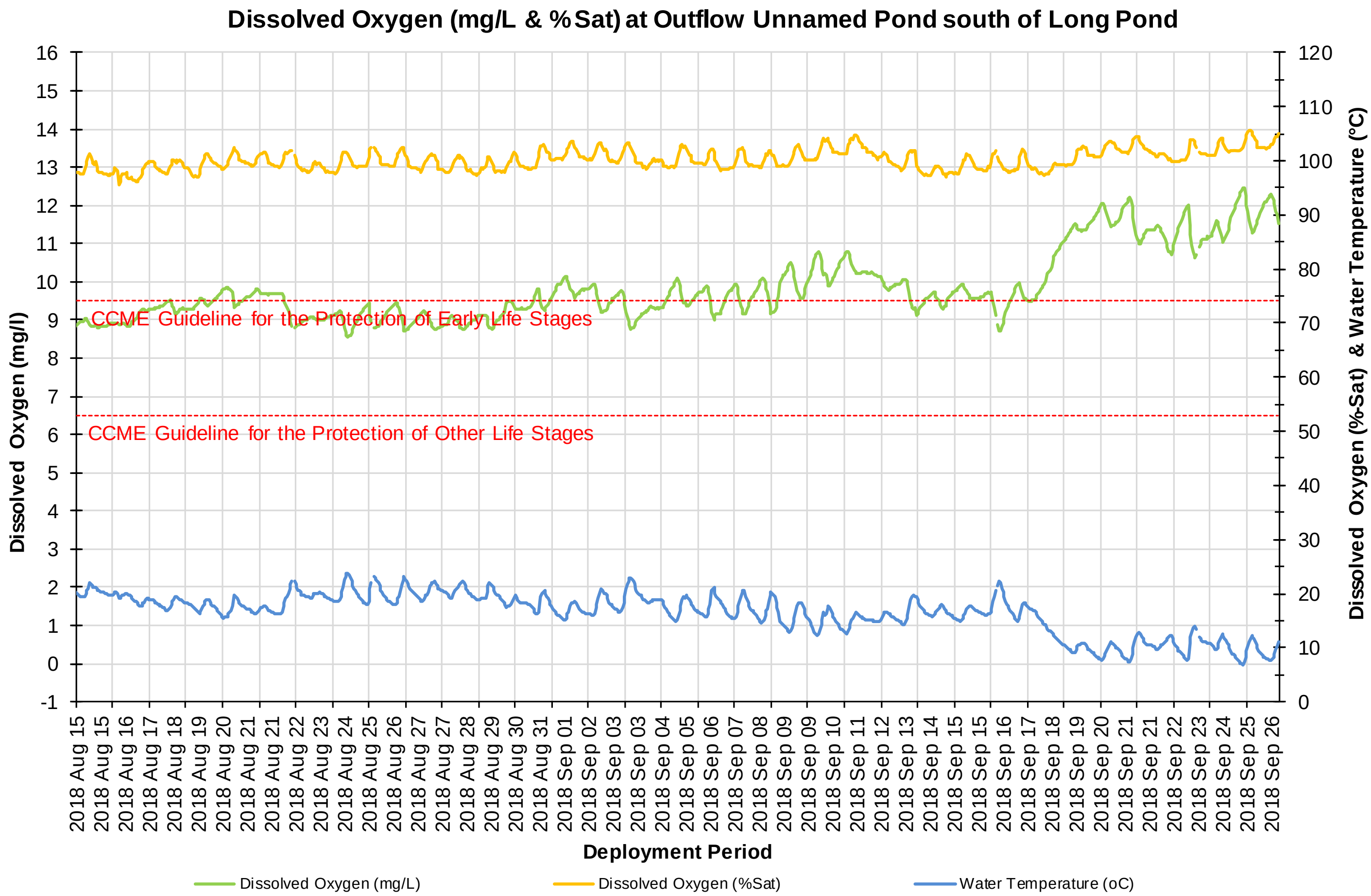

Figure 13: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 1.3 NTU and 76.8 NTU (Figure 14). The deployment data has a median of 2.5 NTU. The median is slightly higher than the previous deployment median of 1.35 NTU.

At the beginning of this deployment the turbidity levels are consistent and no higher than 8NTU. However, after a large increase in stage on September 12th, turbidity increases significantly and remains high as the stage levels dip back down. The precipitation event on September 18th likely played a part in flushing sediment from the brook, decreasing turbidity toward the end of deployment.

Please note the daily averaged 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.

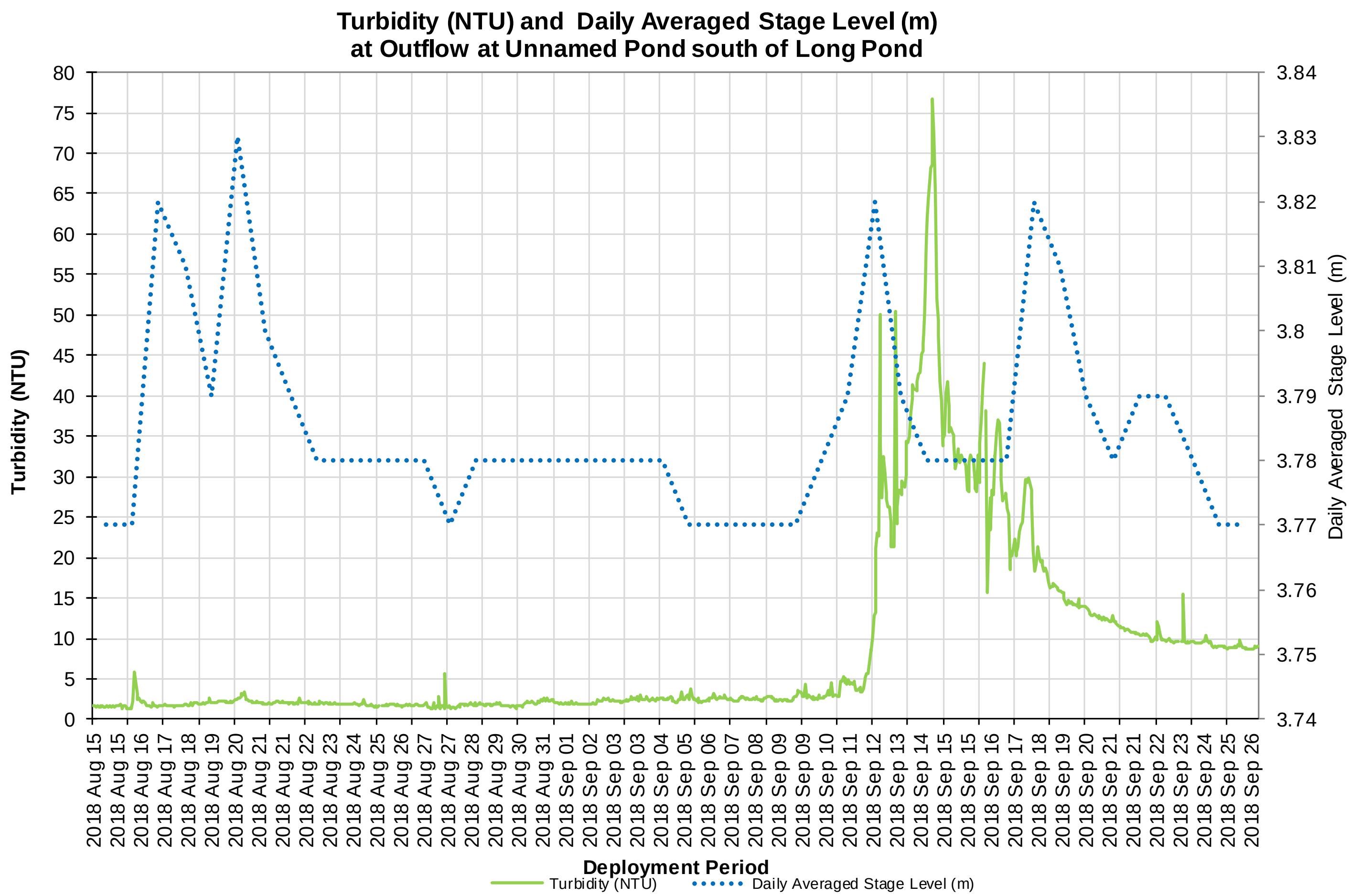

Figure 14: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

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.

Stage is 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 15) and during any surrounding snow or ice melt. However, direct snowfall will not cause stage to rise significantly.

The larger increases in stage correspond with substantial rainfall events as noted on Figure 15. Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 48.2mm on August 16th, 2018.

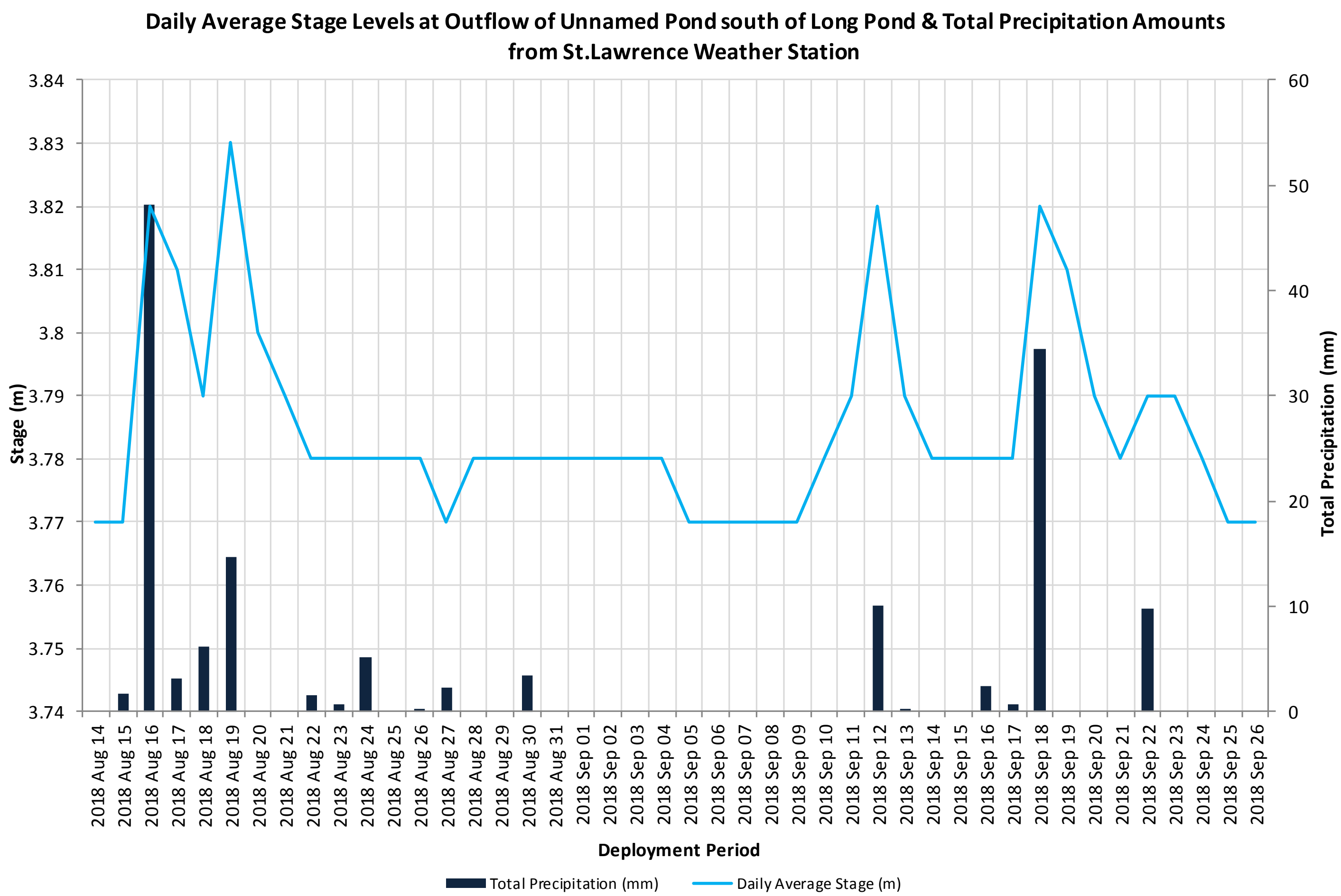

Figure 15: Daily averaged stage values and total precipitation.

Conclusion

As with many shallow brooks and streams, precipitation and runoff play a significant role in influencing water quality. The Outflow of Unnamed Pond South of Long Pond runs through some undeveloped area that includes natural wetlands and marshlands. However, the brook also skirts along the ongoing construction activity. There will be influences from these activities on the water quality. This station is the furthest away from the anthropogenic activities that are occurring on the mine site.

Water temperatures during this deployment were representative of the climate for this time of year. The pH values were consistent for this brook; any significant change in pH data corresponded with a rise in the stage level.

Turbidity levels were low at the beginning of deployment. A large increase in stage caused the turbidity to increase and remain high until a rainfall event on September 18th 2018 flushed the brook and turbidity decreased. This deployment had a turbidity median of 2.5 NTU which is slightly higher than the previous deployment median of 1.34 NTU.

Precipitation brings changes to water quality conditions. Most of these changes are natural, quick adjustments in levels before returning to background levels. Precipitation can influence the transfer of runoff from surrounding construction areas by flushing excess material into waterways. The watershed for this brook is impacted by anthropogenic changes as the mining activity continues. The health of a brook can be determined by how quickly it returns to its background data range after a water quality event.