Real-Time Water Quality Report

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

Deployment Period
April 14, 2021 to May 18, 2021

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Environment & Climate Change
Water Resources Management Division

Prepared by:

Tara Clinton
Environmental Scientist
Water Resources Management Division
Department of Environment & Climate Change
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 originates 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 (Environment & Climate Change (ECC)) 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	April 14	Deployment	Excellent	Fair	Excellent	Fair	Fair
	May 18	Removal	Excellent	Excellent	Good	Excellent	Poor
Unnamed Pond	April 14	Deployment	Fair	Excellent	Good	Excellent	Good
	May 18	Removal	Good	Excellent	Excellent	Excellent	Good

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

During removal of the instrument, the ranking for water temperature, pH, conductivity and dissolved oxygen were 'Excellent' or 'Good' against the QA data. The turbidity data ranked 'Poor' against the QA values. At both the deployment and removal, the brook was experiencing high flow along with extremely turbid water with foam. It is likely that sediment built-up around the sensor during this deployment as the QA value and grab sample were 24NTU and 22NTU respectively, while the field sonde recorded 57.1NTU.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond, the data ranked 'Excellent' or 'Good' for pH, specific conductivity, dissolved oxygen and turbidity. Water temperature ranked as 'Fair' at deployment. This was likely a result of the sensor not being acclimated to the brook before the reading was recorded. At removal the field instrument ranked well with all of the parameters ranking within 'Good' and 'Excellent'.

Concerns or Issues during the Deployment Period

The water supply for Outflow to Grebes Nest Pond station originates at the bottom of an open pit mine. There is also a small influence from runoff and precipitation. The pit water is now pumped from the open mine pit directly into Outflow to Grebes Nest Pond. When the water is sediment laden, the water is pumped directly to the Tailings Management Facility. The water supply is intermittent as the pit water is pumped when water levels reach a certain height in the open pit mine. The lack of consistent flow can result in significant stage level fluctuation across a deployment and have an effect on water quality.

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.

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from 2.51°C to 12.49°C during the deployment period (Figure 4). The average water temperature for the deployment is 6.4°C. Outflow to Grebes Nest Pond station does not have consistent flow, thus the stage data can fluctuate significantly across a deployment.

Water temperature displayed the natural diurnal pattern indicating the influence of air temperature on the brook, with high temperatures during the daylight hours and low temperatures representing the nighttime hours (Figure 5). There was a gradual increase in water temperature over the period. This was a result of the increasing air temperature as the season adjusts to warmer temperatures. Outside of the diurnal movement of the water temperature, the data does indicate small influences associated with stage changes.

These stage changes could be a result of precipitation or an increase in the amount of water pumped into the brook. Generally, if the stage increases occur during low air temperature events it was likely a result of rainfall. 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.

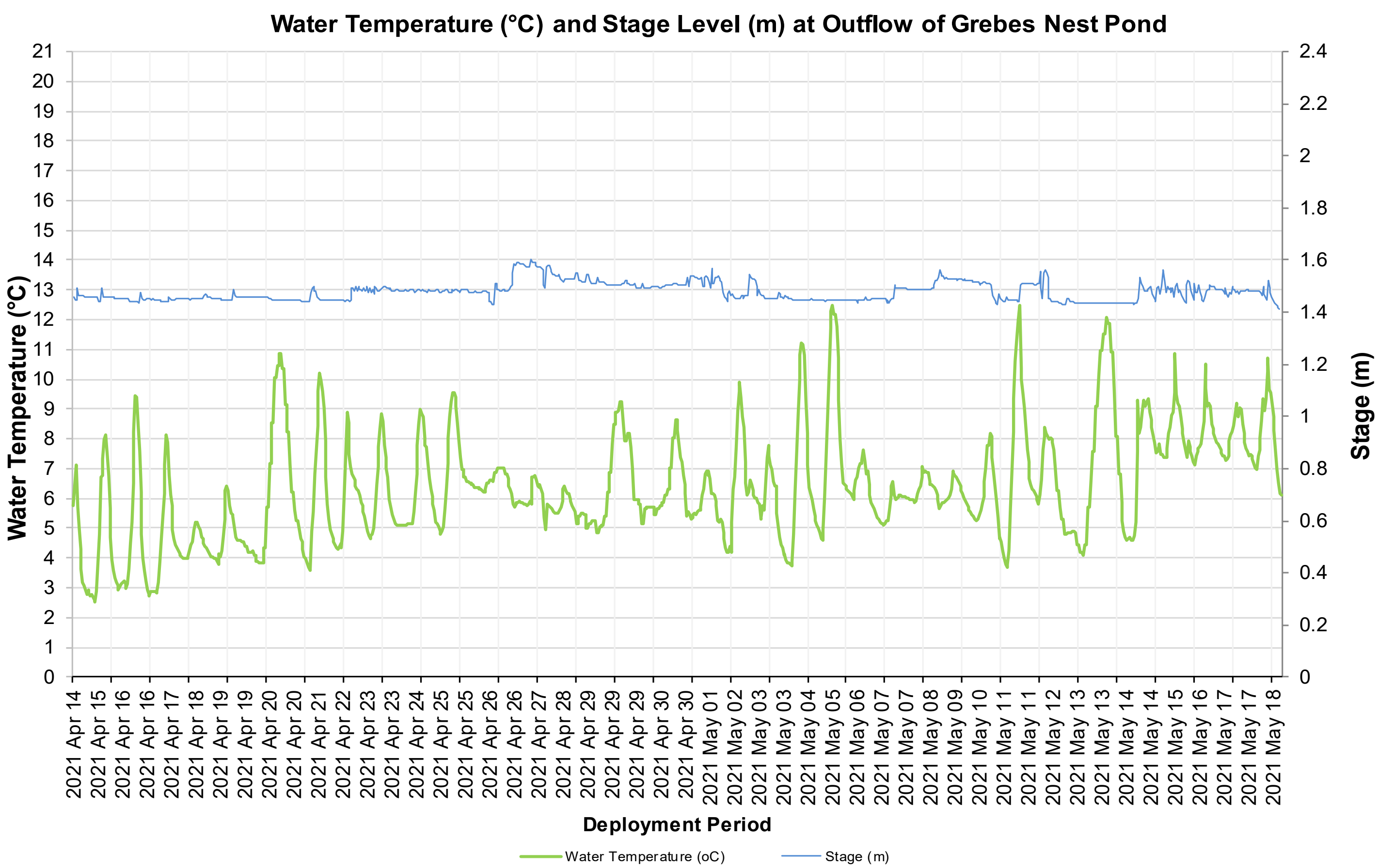

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

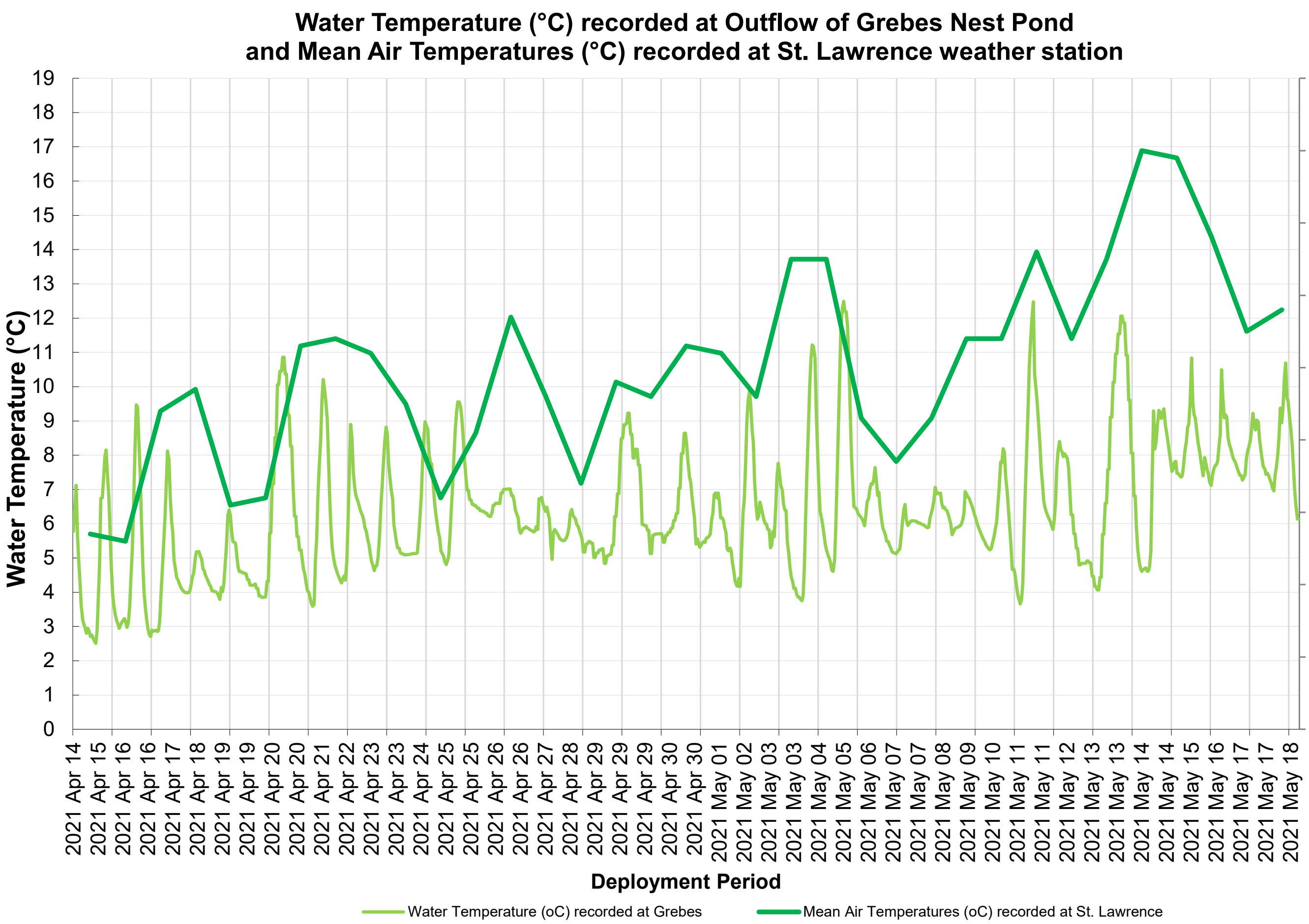

Figure 5: Water temperature (°C) and Mean Air Temperature (°C) at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 6.88 pH units and 8.35 pH units. The pH data remained within the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life for the duration of the deployment.

pH data displayed on Figure 6 is consistent throughout the deployment. The decrease in pH early May, could have been a result of rainfall, which can lower pH for a short period of time.

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.

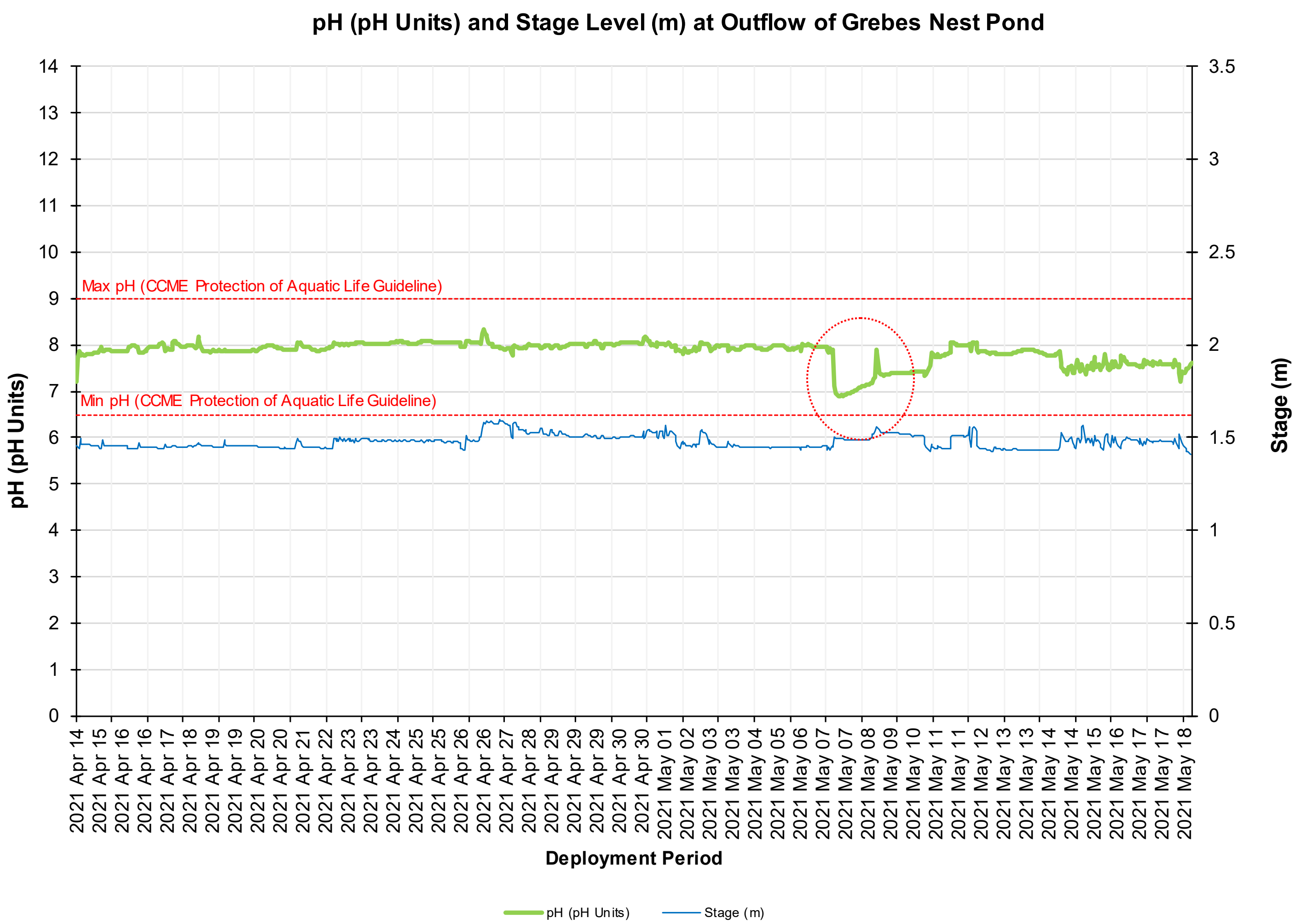

Figure 6: pH (pH units) values

Specific Conductivity

The conductivity levels were within 224.83 µS/cm and 460.24 µS/cm during this deployment period (Figure 7). The specific conductivity probe measured the salts and inorganic materials present in the brook. The conductivity in a brook can be diluted by rainfall or increased by rainfall if there is runoff occurring.

Across the deployment period, the conductivity in the brook fluctuated with the changes in stage level. During stage increases, the conductivity levels responded by decreasing as the diluted salts and inorganic matter present in the brook were flushed through.

During minimal to no stage increases, diluted salts and inorganic material will accumulate in the brook, increasing the conductivity. Until there is a sufficient increase in stage flow to flush the system, conductivity will remain high.

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.

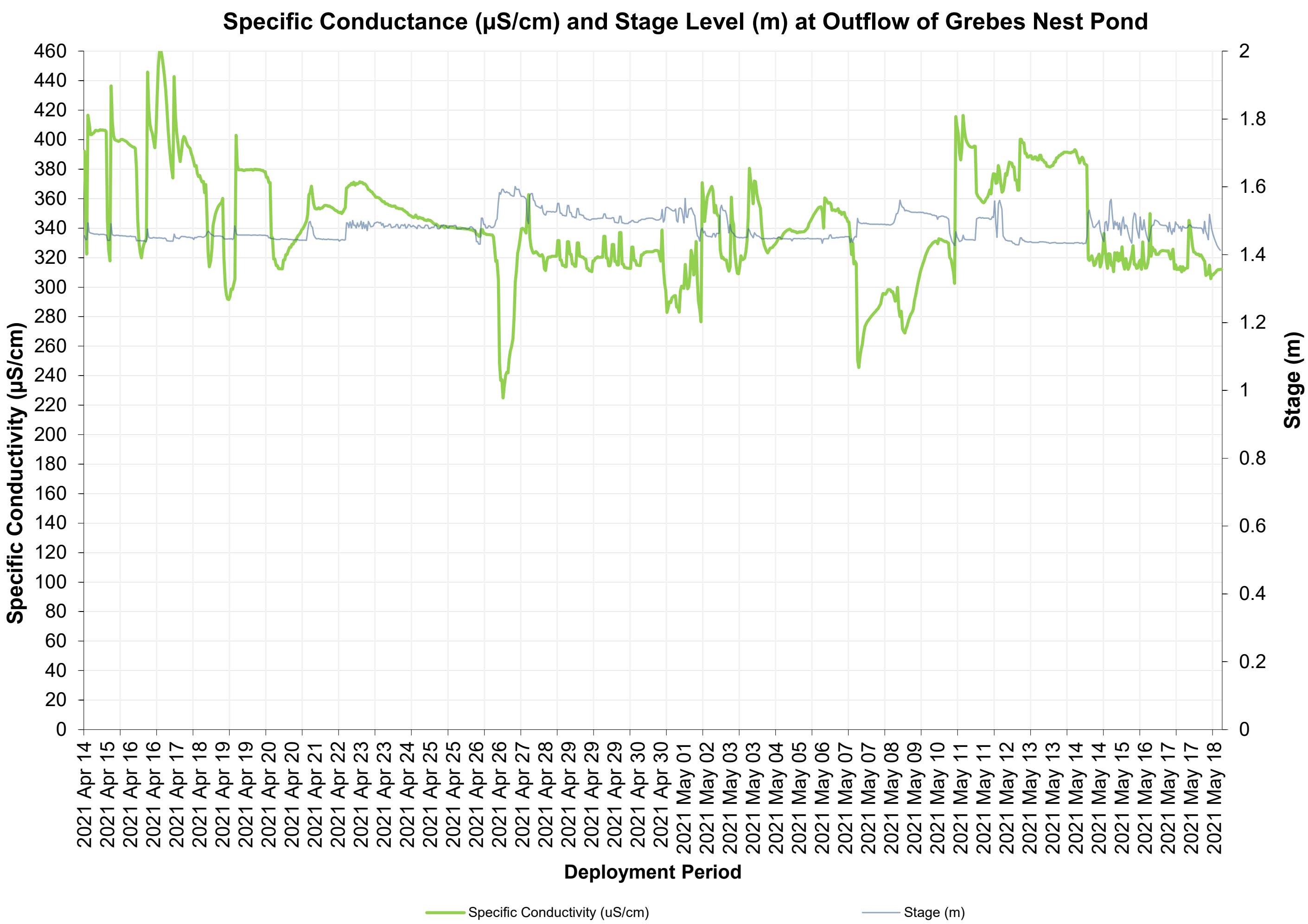

Figure 7: Specific conductivity (µS/cm) values

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 10.95 mg/L to a maximum of 13.68 mg/L. The percent saturation levels for dissolved oxygen ranged within 92.8% Saturation to 106.7% Saturation (Figure 8).

Water temperature is included with dissolved oxygen as it directly influences the water column's ability to store dissolved oxygen. This relationship is notable in Figure 8 on April 20th and 29th. As the water temperature increases, the dissolved oxygen decreases and vs versa.

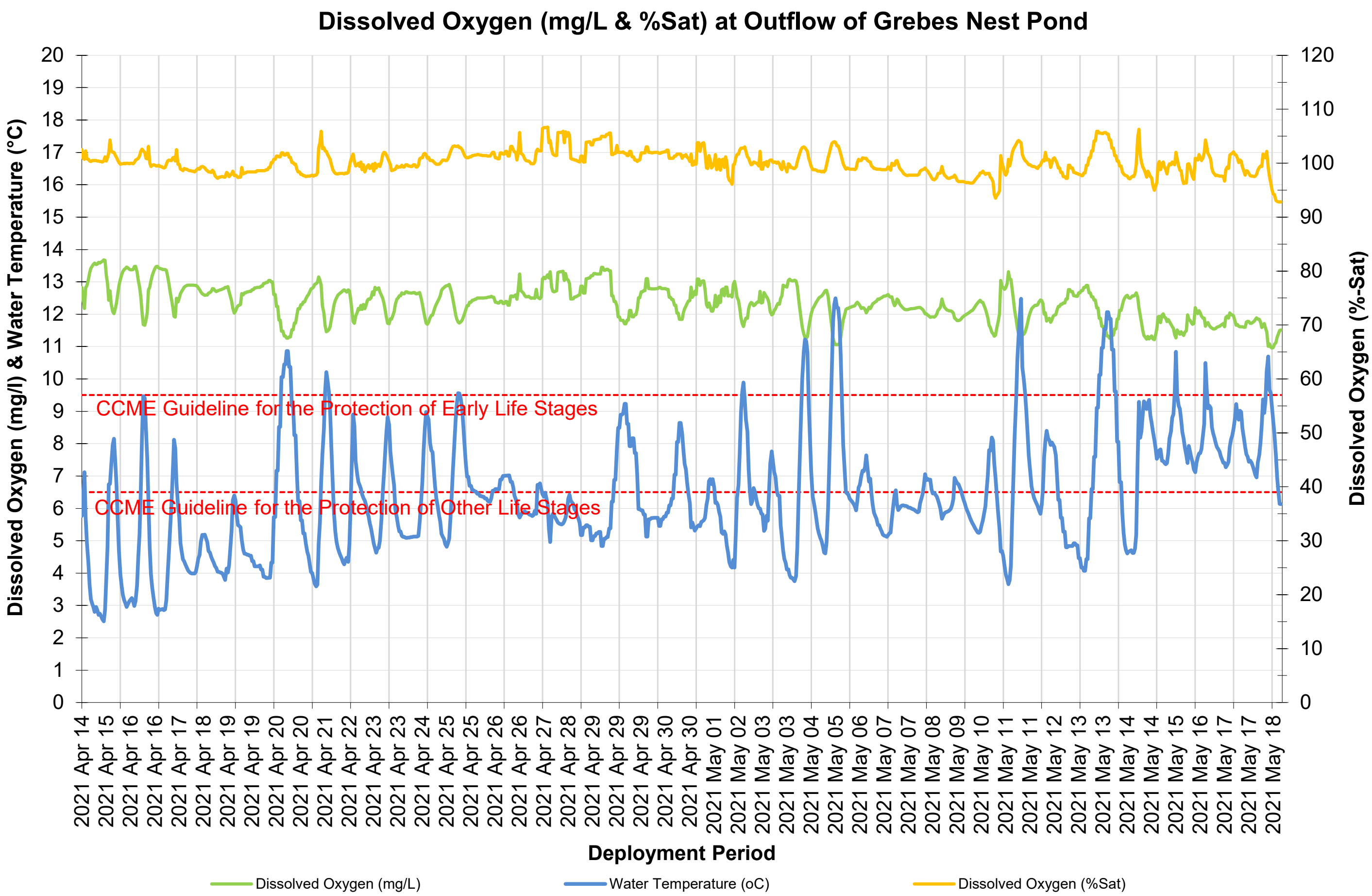

Figure 8: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 4.2 NTU and 6616 NTU (Figure 9). The deployment data had a median of 21.7 NTU.

Outflow to Grebes Nest Brook, is fed via a sump pump from a pit mine. The pit water is fed directly into Outflow of Grebes Nest Brook. Based on the nature of the water pumped into the brook, it would be expected for the turbidity at this site to fluctuate throughout the deployment. Turbidity can also increase in the water column through evaporation. If the brook is not replenished consistently, the water can become stagnant.

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.

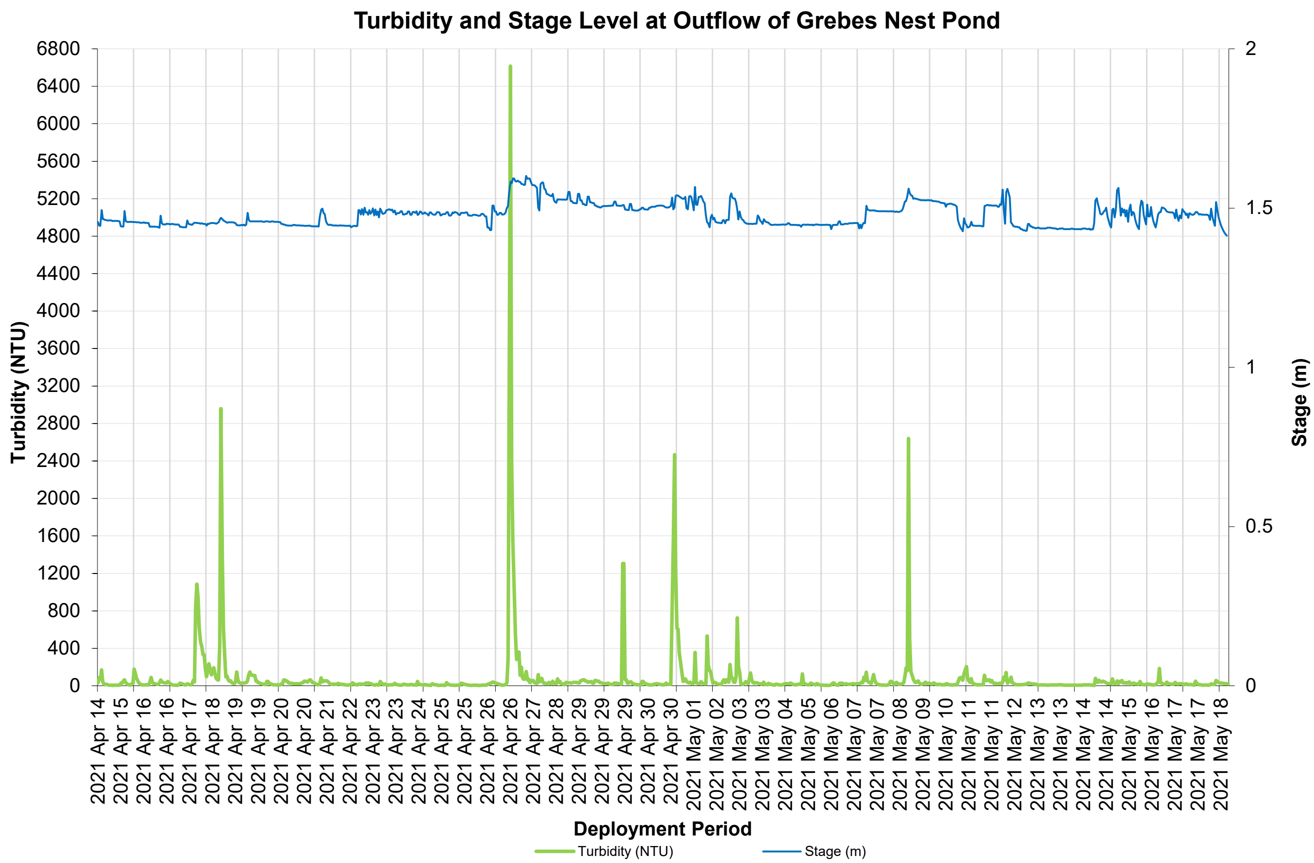

Figure 9: Turbidity (NTU) values.

Conclusion

Outflow of Grebes Nest Pond flows through an evolving mine site. The water supply for Outflow of Grebes Nest Pond station is pit water pumped via a sump pump and fed into the brook. It can be intermittent and can contribute to fluctuations in stage level throughout the brook.

Water temperature will fluctuate with stage changes. During this deployment the water temperature increased as the air temperature changed with the season. pH levels at Grebes Nest station were consistent, until May 7th when the pH levels dipped for a period of time. This fluctuation coincided with a precipitation events on May 7th and 8th.

Conductivity of the brook was influenced by the precipitation events. Each of the larger dips in conductivity occurred during or immediately after precipitation events. The data remained within the range of 200µS/cm to 500µS/cm, showing that there was a minimal change in the conductivity throughout the deployment.

Outflow to Grebes Nest Pond station does not always have consistent flow. The dissolved oxygen concentration can thus change quickly over a few hours or days. During this deployment, dissolved oxygen remained relatively consistent, decreasing periodically and overall in response to warmer water temperatures.

This brook has significant fluctuations in turbidity and the turbidity levels will increase in either high or low stage events due to the influence of brook's water source. This deployment recorded high turbidity throughout the deployment.

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

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranged from 1.81ºC to 17.41ºC during the deployment period (Figure 10). The water temperature increased across the deployment, fluctuating as the air temperatures increased with the warmer climatic change into Spring (Figure 11).

Water temperature displayed the natural diurnal pattern representing the influence of air temperature on the brook, with the high temperatures during the daylight hours and the low temperatures representing the nighttime hours (Figure 10). Outside of the diurnal movement of the water temperature, the data does indicate small influences from the stage changes.

These stage changes could be a result of precipitation. Generally, if the stage increases occur during low air temperature events it was likely a result of rainfall. Please note that the stage data in this document is raw data. The data 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.

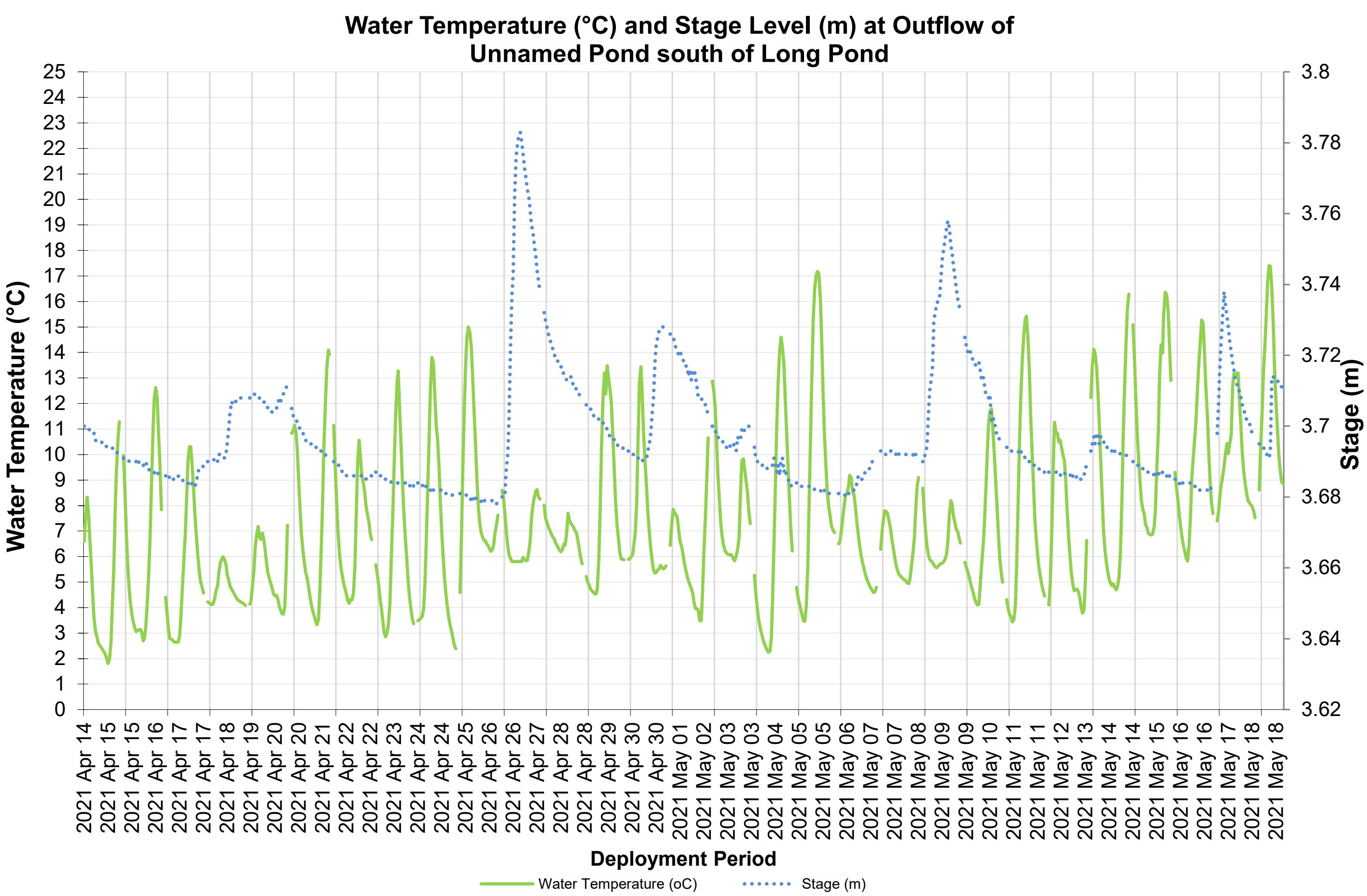

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

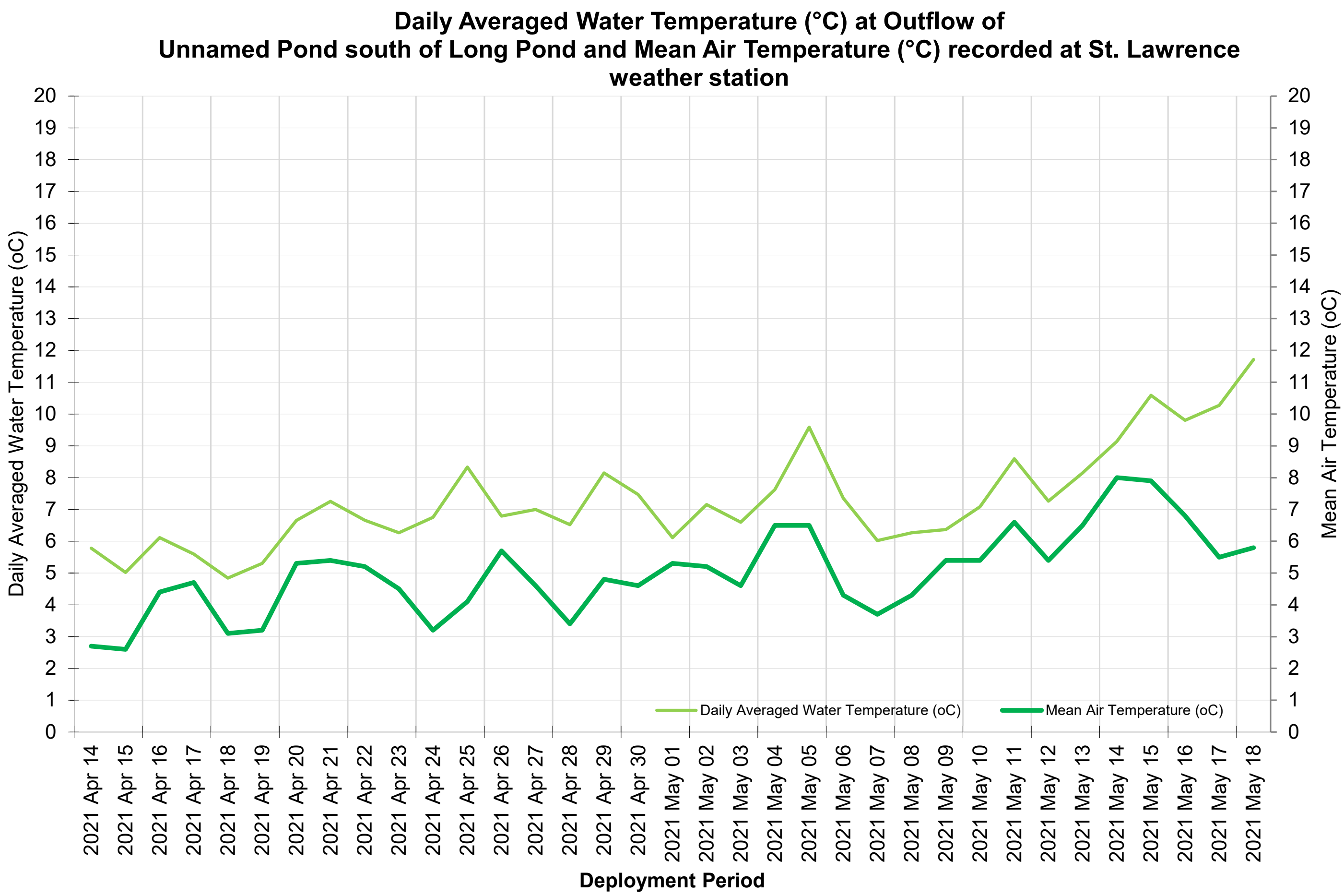

Figure 11: Water temperature (°C) and Mean Air Temperature (°C) at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged within 6.96 pH units and 7.93 pH units (Figure 12), remaining within the Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life. The guidelines provide the overall range for the protection of aquatic life across all waterways in Canada. Every brook is different with its own specific natural background range.

Small decreases in pH during stage peaks are evident on Figure 12 on April 26th, April 30th and again on May 8th, 2021. The pH values returned to background levels shortly after each event, and overall the pH data was consistent across deployment. On May 17th one of the pumps located at the perimeter the large sedimentation pond stopped working, this allowed a volume of sediment laden water to leak into Outflow of Unnamed Pond south of Long Pond station. During this event the pH values increased for a period of 2 days. These increases are evident on the graph (circled in red).

Natural processes such as rainfall, snowmelt and surrounding runoff will alter the pH of a brook for a period; however, it is the persistent long-term changes in pH that create the most damage to the natural aquatic environment.

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.

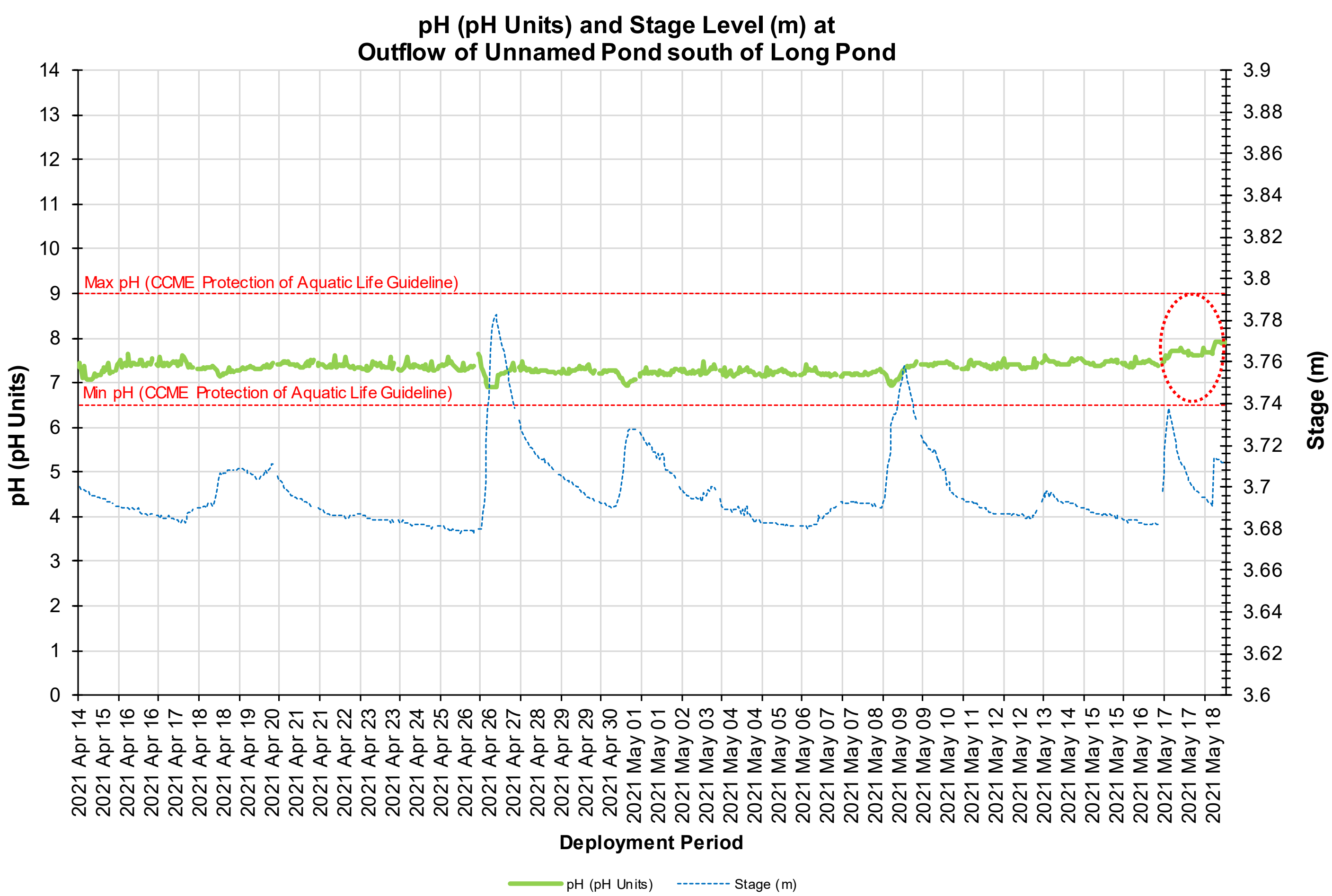

Figure 12: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 97.17 µS/cm and 510.94 µS/cm during deployment (Figure 13). The deployment period had a median of 186.47 µS/cm.

Changes in stage will influence the conductivity data (Figure 13). The extra volume of water during a stage increase will dilute the particulate matter present in a water column. When stage level drops – either through evaporation or headwater interference - the conductivity levels can increase. Suspended solids are concentrated in the water column as the volume of water reduces. This relationship between stage and conductivity is notable on Figure 13, on April 26th, April 30th and again on May 8th when the conductivity data dropped for a short period before returning to previous levels.

On May 17th one of the pumps located at the perimeter the large sedimentation pond stopped working, this allowed a volume of sediment laden water to leak into Outflow of Unnamed Pond south of Long Pond station. During this event the conductivity values increased significantly for a period of a 2 days. These increases are evident on the graph (circled in red). The pump was replaced in a matter of days and the conductivity levels started to decrease almost immediately.

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.

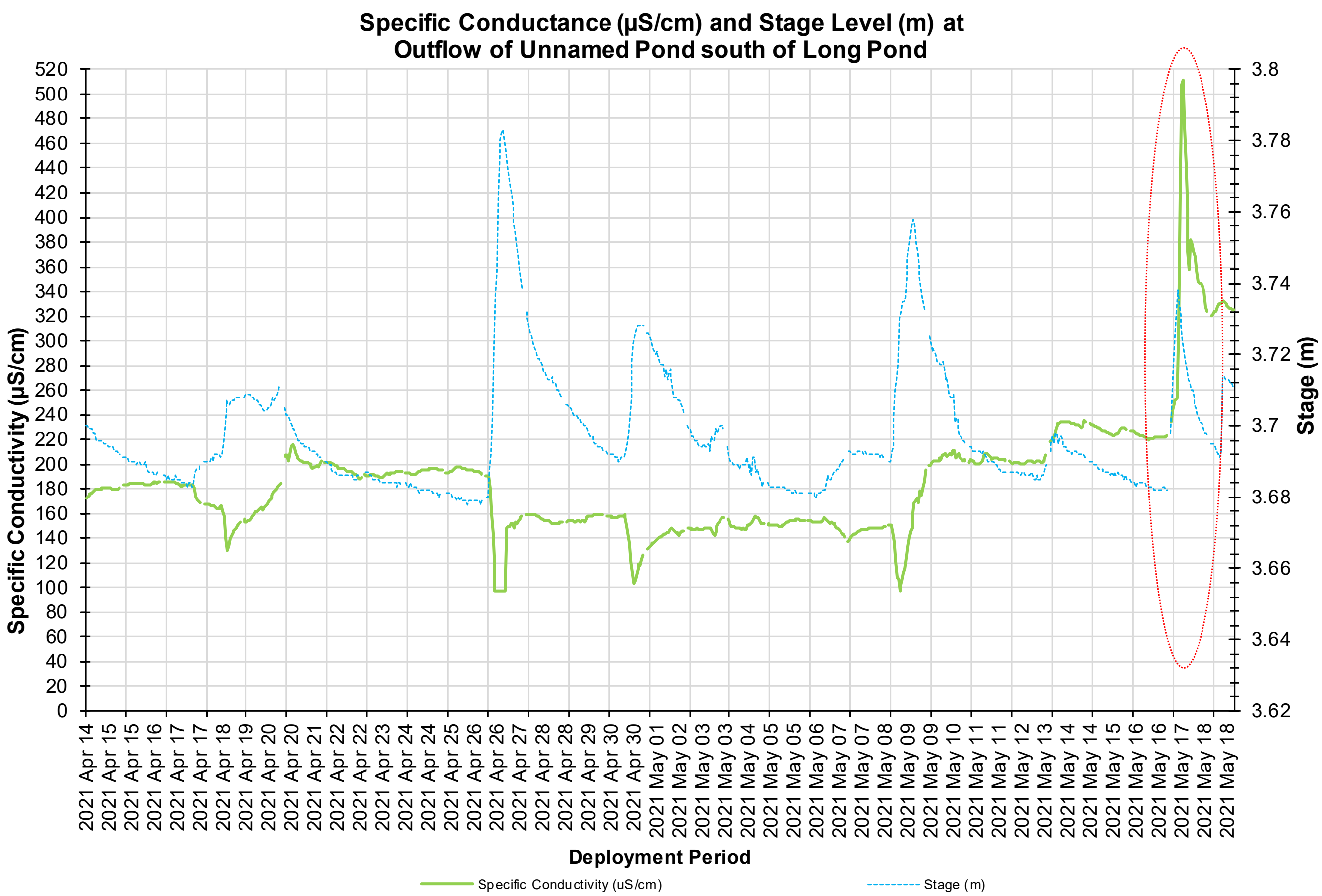

Figure 13: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

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 9.72 mg/L and 13.74 mg/L for concentration and 96.8 % Sat and 104.4 % Sat for percent saturation.

There is a natural diurnal pattern present in aquatic environments with dissolved oxygen. Oxygen concentration levels will fluctuate throughout night and day. Cooler night temperatures influence higher dissolved oxygen concentrations and warmer day light temperature influence lower concentrations. The movement in the diurnal pattern is evident on Figure 14. All other prominent dips/peaks - outside of the diurnal pattern - are a result of fluxes in water temperature or influences from rainfall/runoff.

Dissolved oxygen was relatively consistent until the end of the deployment when it began to decline, likely in response to increasing water temperatures and the event that caused changes to pH and conductivity at this time.

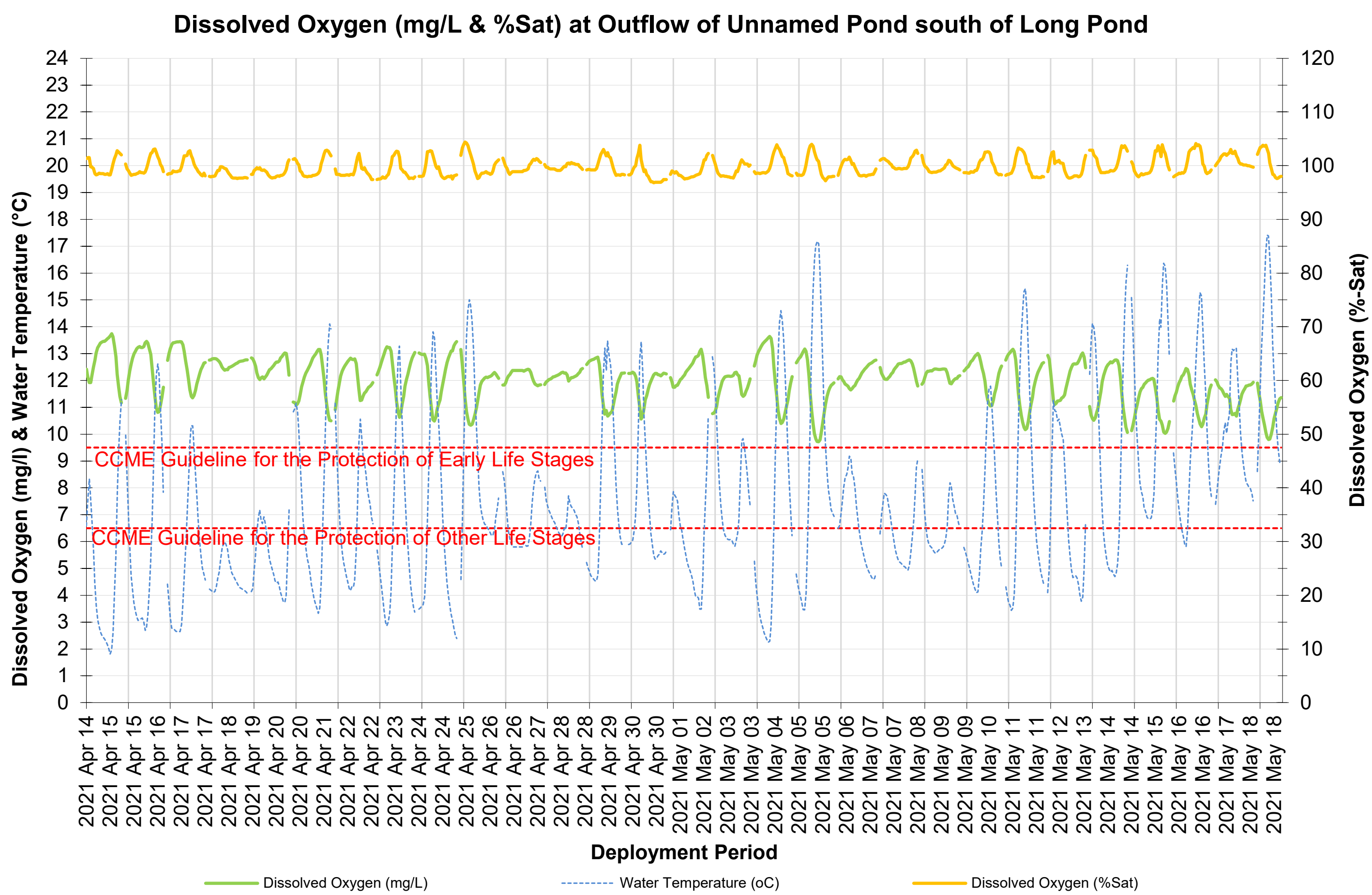

Figure 14: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 21.7 NTU and 792.5 NTU (Figure 15). The deployment data had a median of 63.2 NTU.

Throughout the deployment turbidity measured above 20 NTU, indicating high levels of sediment or suspended material present. Recorded stage events did flush the brook and reduce the turbidity on some occasions such as April 26th, however also influenced an increase in turbidity on other occasions such as May 9th.

On or around May 17th one of the pumps located at the perimeter the large sedimentation pond stopped working, this allowed a volume of sediment laden water to leak into Outflow of Unnamed Pond south of Long Pond station. During this event the turbidity values increased significantly for a period of a 2 days. These increases are evident on the graph (circled in red). The pump was replaced in a matter of days and the turbidity levels started to decrease almost immediately.

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.

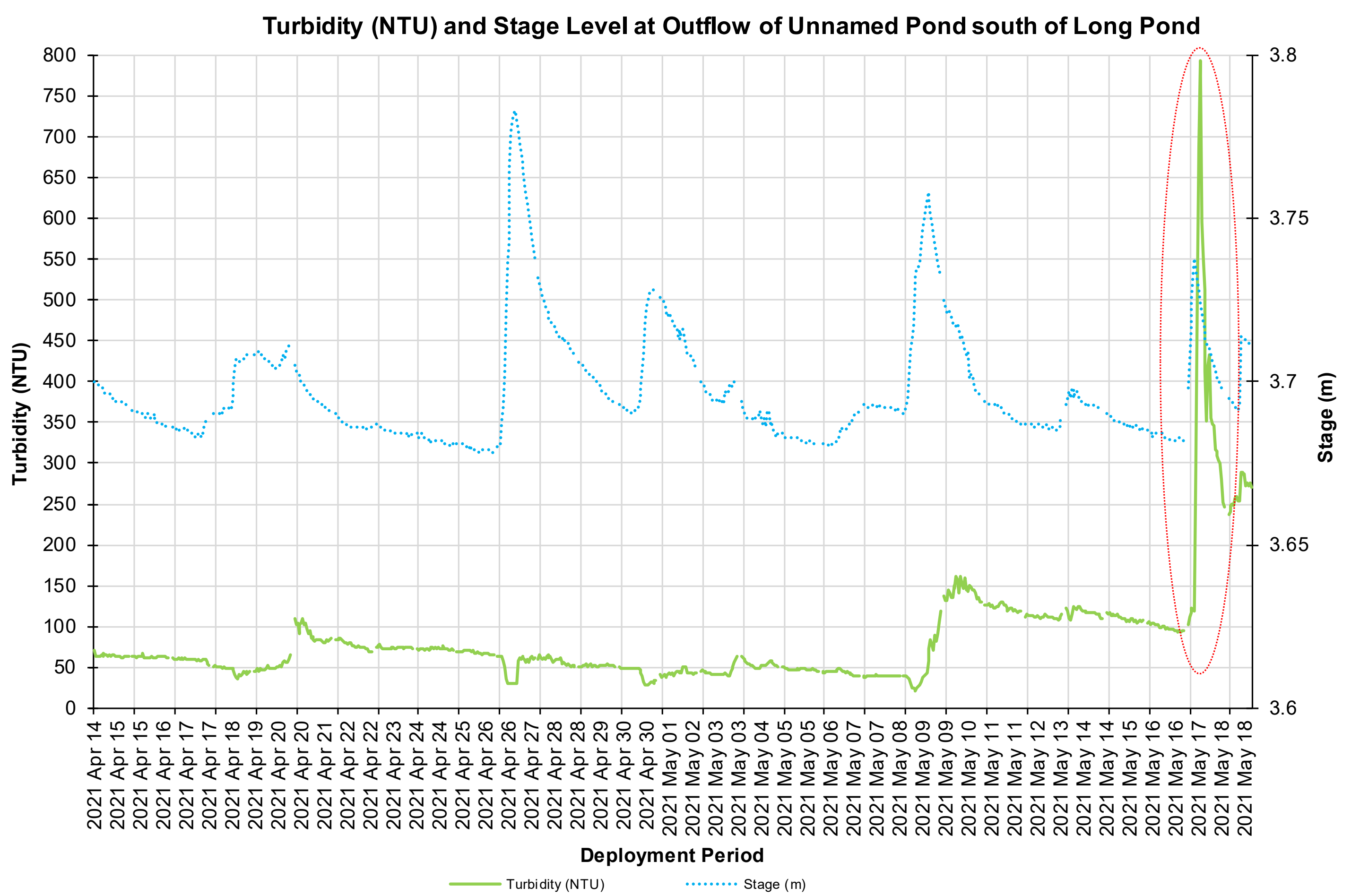

Figure 15: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

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 fluctuations 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.

Large peaks in stage correspond with precipitation events as noted on Figure 16. Daily Total 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 maximum of 33.6 mm on April 26th, 2021.

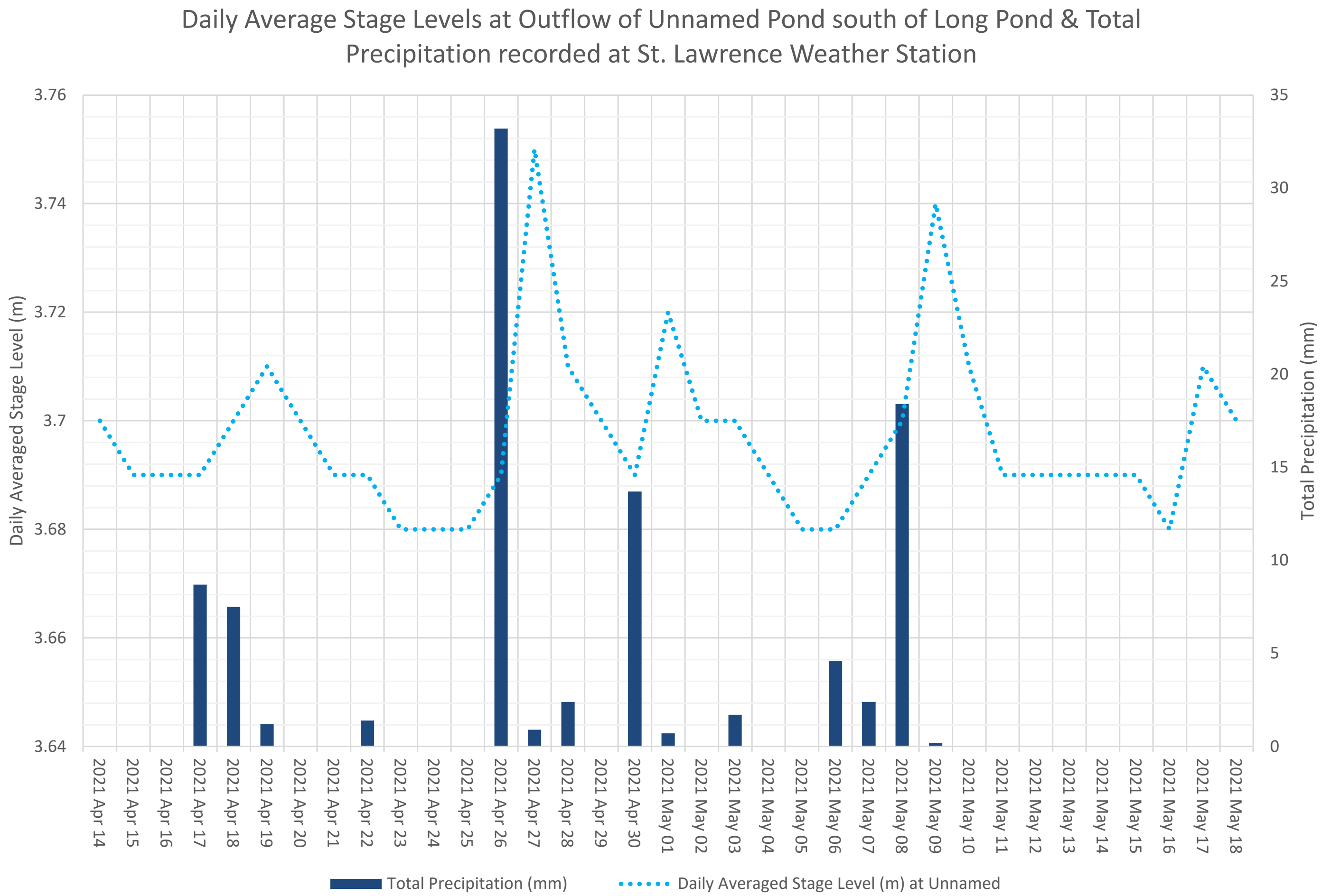

Figure 16: Daily averaged stage values and total precipitation.

Conclusion

The Outflow of Unnamed Pond south of Long Pond is established downstream of the Tailings Management Facility (TMF), to assist in capturing any emerging water quality issues with the management of the tailings facility. The Outflow of Unnamed Pond South of Long Pond also flows through undeveloped area that includes natural wetlands and marshlands. This station is the furthest away from the anthropogenic activities that are occurring on the Canada Fluorspar mine site.

As with many shallow brooks and streams, precipitation and runoff events play a significant role in influencing water quality. Increasing water temperatures during the deployment were representative of the climate for the time of year. The pH values were consistent for this brook with any significant changes in pH data corresponding to a rise in the stage.

On May 17th one of the pumps located at the perimeter the large sedimentation pond stopped working, this allowed a volume of sediment laden water to leak into Outflow of Unnamed Pond south of Long Pond station. During this event the pH, conductivity and the turbidity values increased for a couple of days. These increases are evident on the graphs of pH, conductivity and turbidity data around May 17th. The slight decrease in dissolved oxygen around this time may also be a result of the high sedimentation from the leak.

Outside of the pump failure, the majority of the changes are natural and likely a result of precipitation events. Many of the parameter changes are slight and return to background levels within a short period of time. The health of a waterway can be determined by how quickly the parameters return to background data after a water quality event, such as precipitation, run off or snowmelt.