Real-Time Water Quality Report

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

Deployment Period
May 18, 2021 to June 15, 2021

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

Prepared by:

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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.

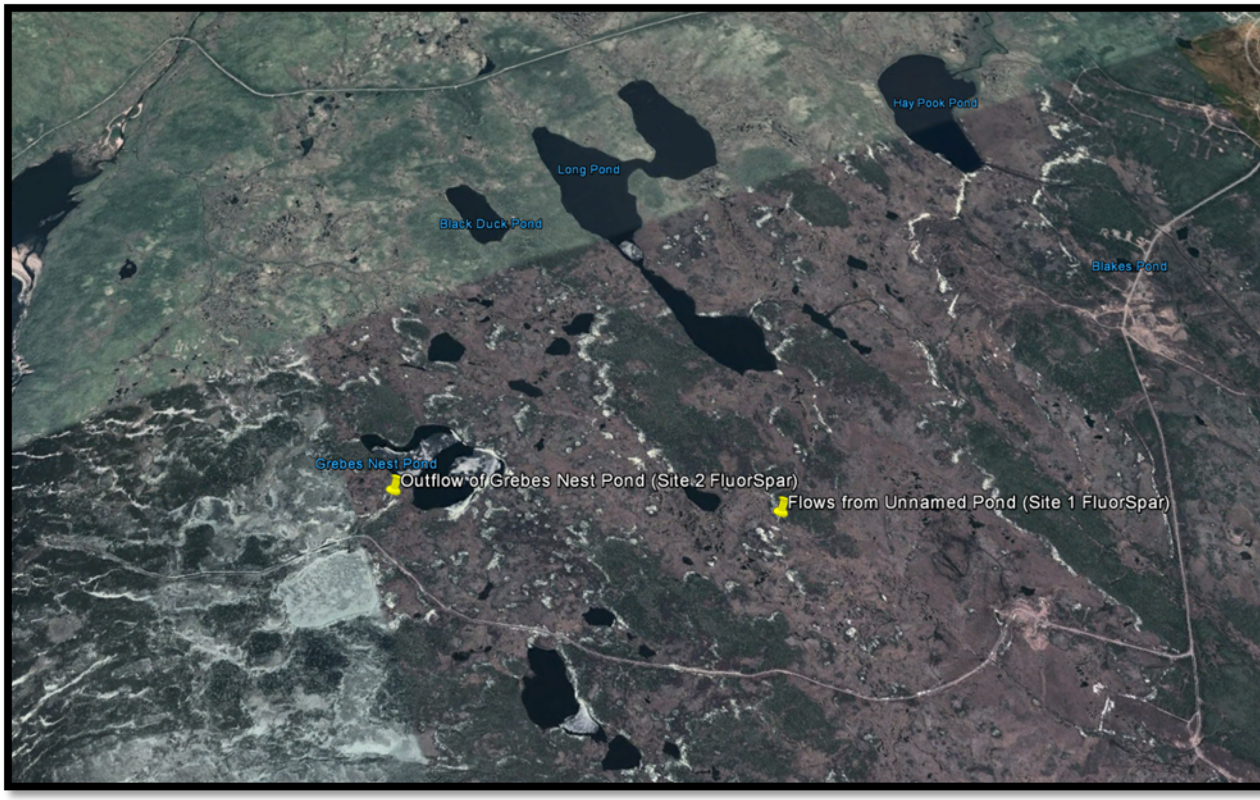

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

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 ECC'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	May 18	Deployment	Good	Good	Excellent	Excellent	Fair
	June 15	Removal	Excellent	Good	Good	Excellent	Excellent
Unnamed Pond	May 18	Deployment	Good	Excellent	Excellent	Excellent	Good
	June 15	Removal	Excellent	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 'Good' against the QA sonde data. Turbidity data ranked as 'fair', which was likely a result of the level of silt present in the brook during deployment. It was high flow at this time and the water conditions were changing quickly.
During removal of the instrument, the ranking for water temperature, pH, conductivity and dissolved oxygen were 'Excellent' or 'Good' against the QA data.

When compared to the QAQC instrument at Outflow of Unnamed Pond south of Long Pond, the field instrument data ranked 'Excellent' or 'Good' for all of the water quality parameters during this deployment.

Concerns or Issues during the Deployment Period

During the deployment at Outflow to Unnamed Pond south of Long Pond, there were intermittent issues with transmission. When graphed, the data will display the missing data with gaps on the line graph. Daily averaged stage levels are displayed alongside the water quality parameters to assist in explaining certain changes in the water quality.

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 pumped from the open mine pit into geo bags that strain out the majority of the sediment and then the water is gravity fed into Outflow to Grebes Nest Pond. 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 6.13°C to 16.11°C during the deployment period (Figure 4). The average water temperature for the deployment is 9.10°C. Outflow to Grebes Nest Pond station does not have consistent flow, thus the stage data can fluctuate significantly.

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 5). There was a slight increase in water temperature, likely a result of the increasing air temperatures as the seasons adjust from Spring into warmer temperatures.

Changes in stage could be a result of precipitation or an increase in the amount of water pumped into the brook. Generally if the stage level increases during low air temperatures, it was likely a result of rainfall. The high temperature recorded on June 3rd, 16.11°C was just before a precipitation event.

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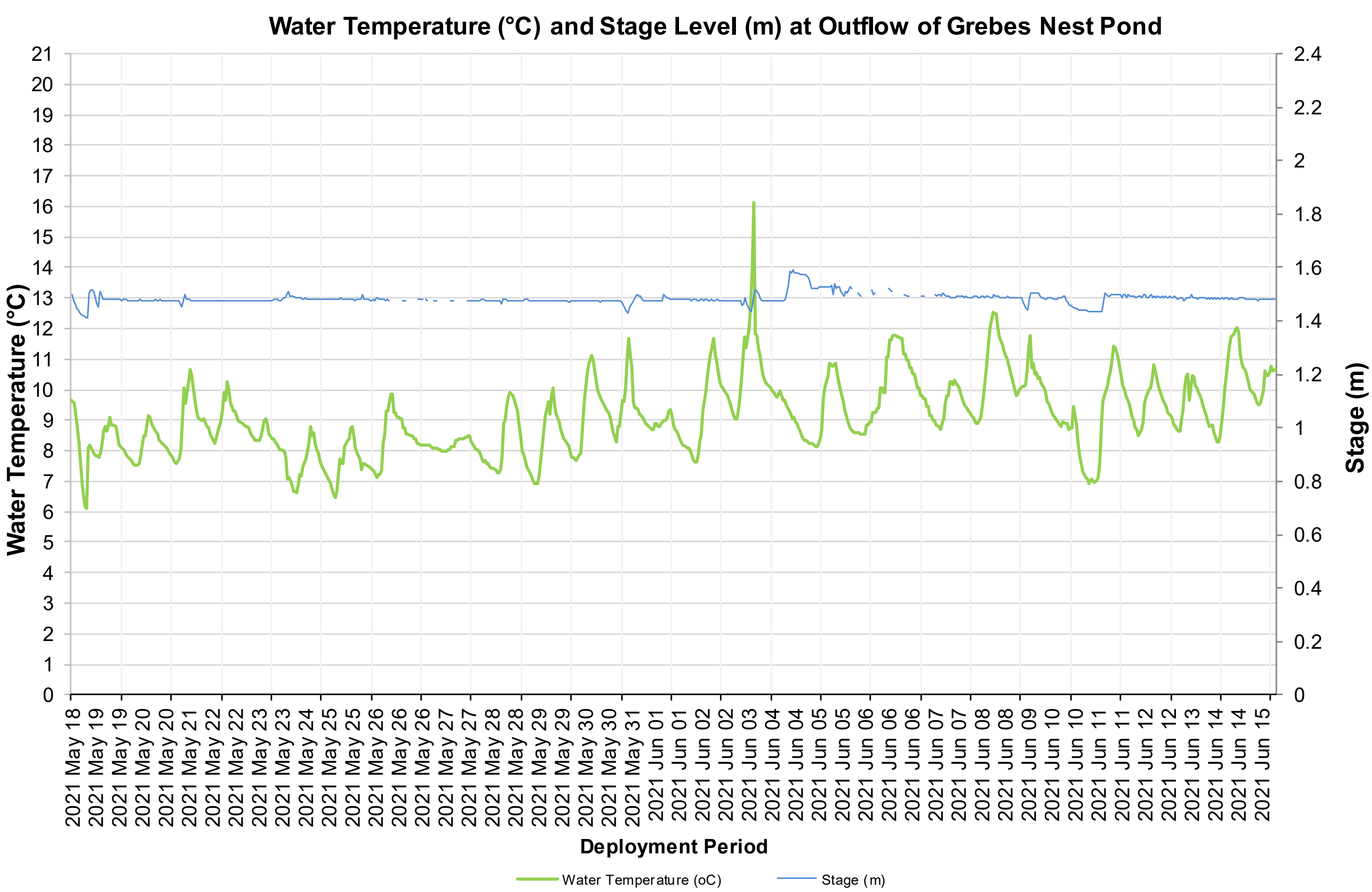

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

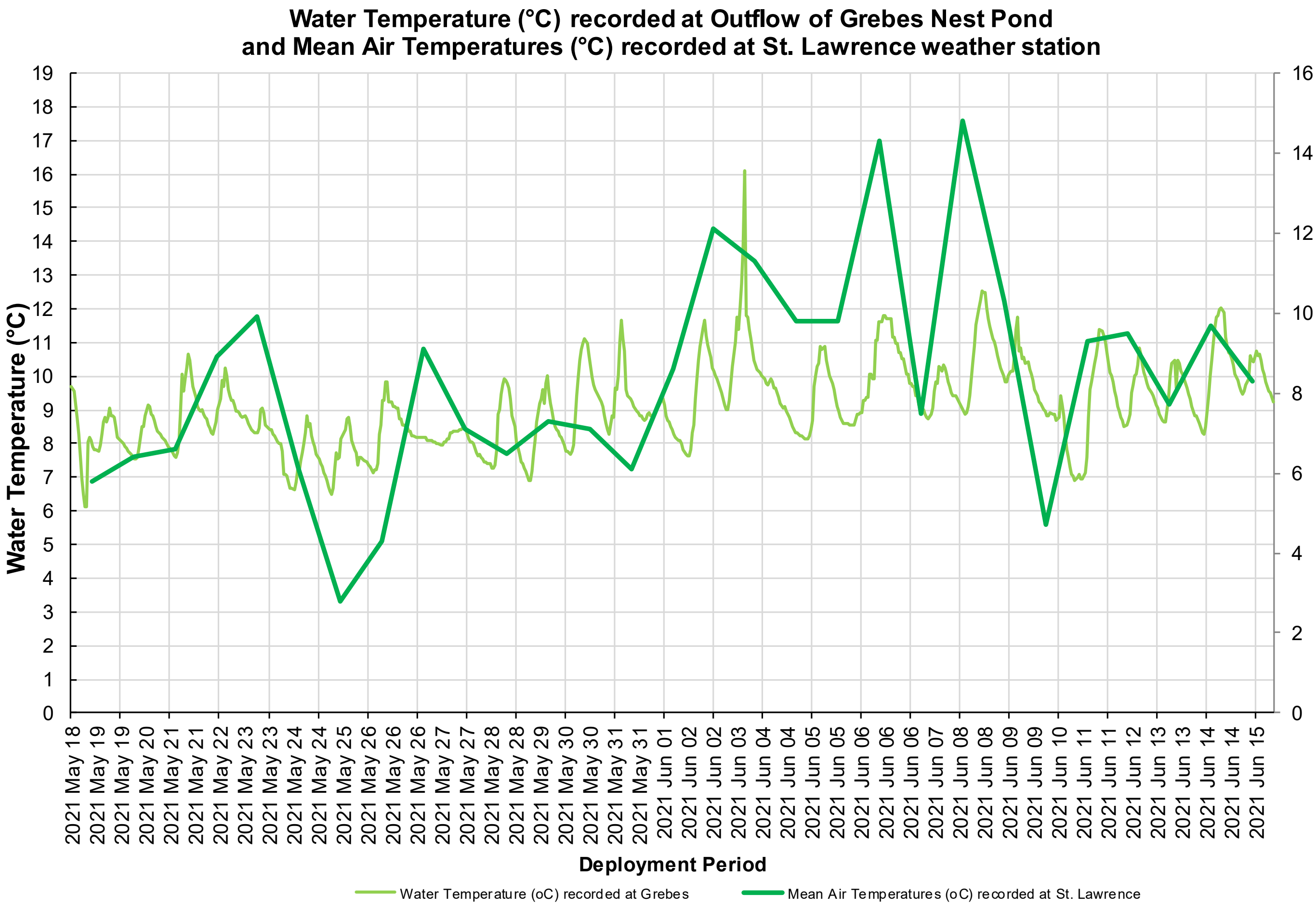

Figure 5: Water temperature (°C) and Mean Air Temperature (°C) at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 7.21 pH units and 8.00 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.

The small increases noted on the graph on June 3rd and June 4th are likely a result of rainfall. Rainfall is slightly acidic and should decrease the pH of a waterbody for a short time. However, at this site, rainfall causes an increase in pH. This is likely due to the increase in basic pit water being pumped from the work area into the brook when rainfall occurs. The increases were short-lived before pH returned to background levels (Figure 6).

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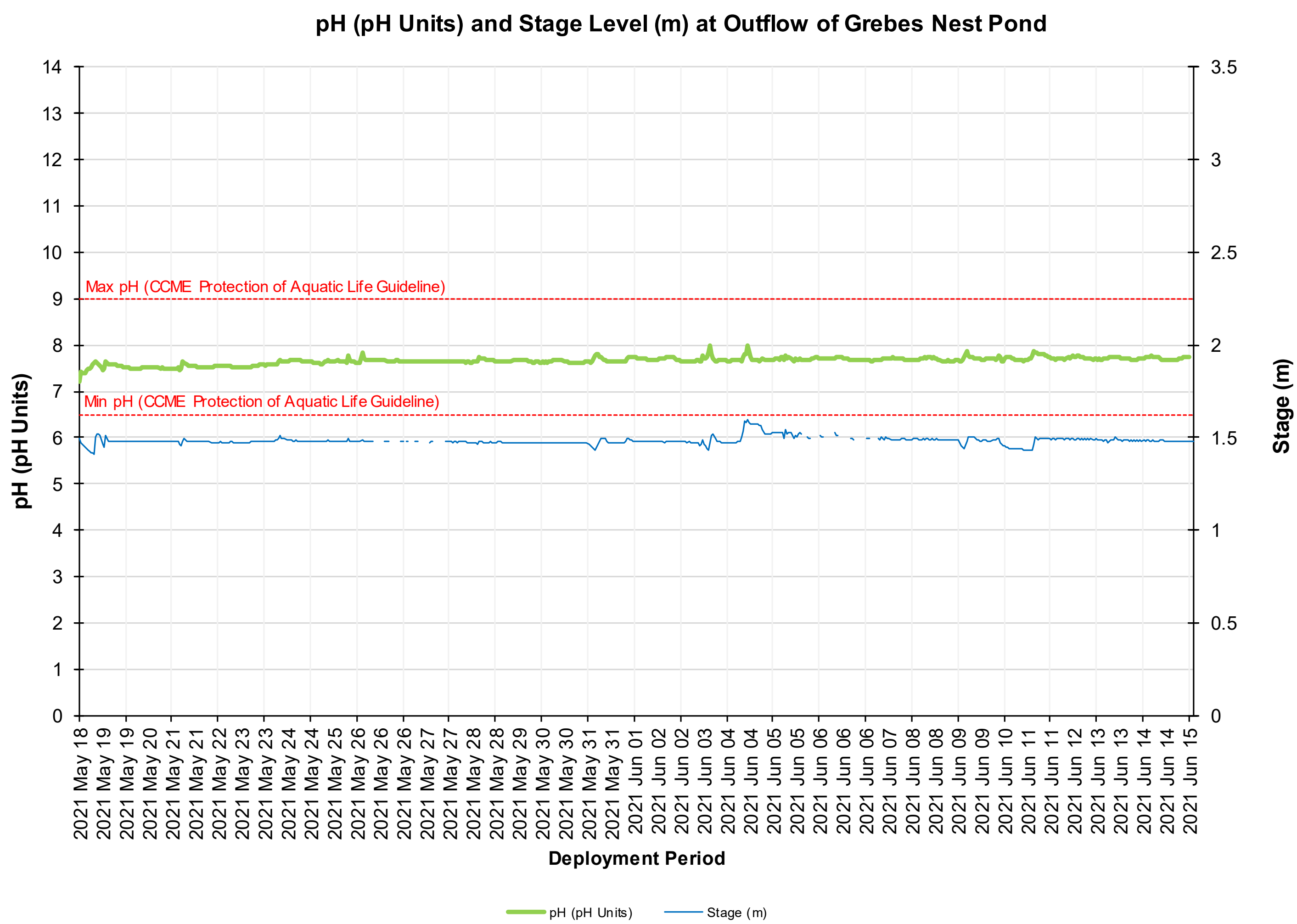

Figure 6: pH (pH units) values

Specific Conductivity

The conductivity levels were within 221.17 µS/cm and 374.27 µS/cm during this deployment period (Figure 7). The specific conductivity probe measured the diluted 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 low to no stage increases, diluted salts and inorganic material will accumulate in the brook, increasing conductivity. During stage increases, the conductivity levels respond by decreasing, as the diluted salts and inorganic matter present in the brook are flushed through the system. This was displayed on June 4th with the large decrease in conductivity to 221.17 µS/cm and again, on June 10th when another rainfall event occurred.

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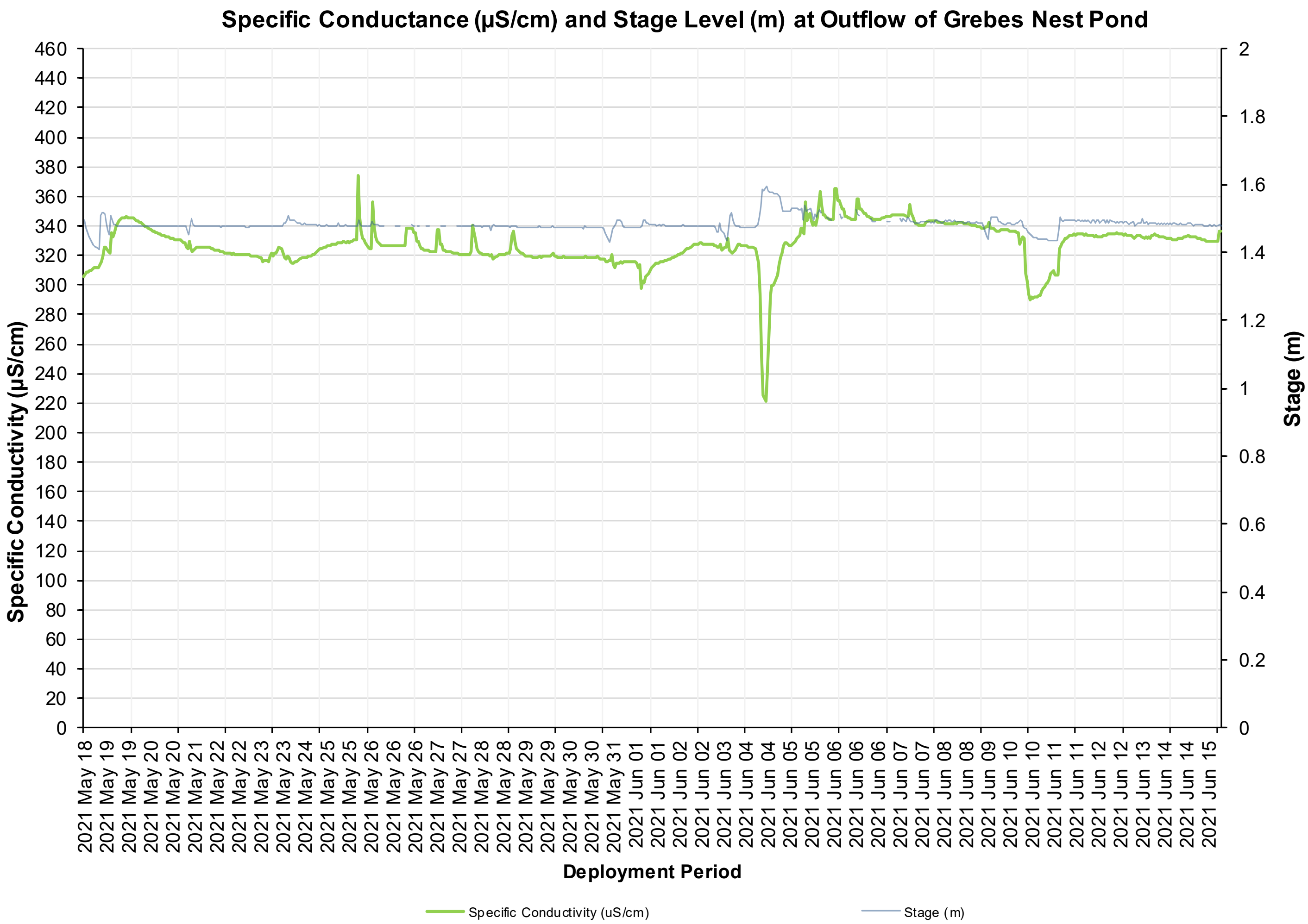

Figure 7: Specific conductivity (µS/cm) values

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 9.83 mg/L to a maximum of 11.53 mg/L. The percent saturation levels for dissolved oxygen ranged within 89.5% Saturation to 103.6% Saturation (Figure 8).

Due to the intermittent stream flow at this brook, dissolved oxygen concentration does not always display the expected diurnal pattern that accompanies natural ambient waterways. This was evident from May 26th to May 28th, as DO mg/L data displayed minimal variation. Water temperature is included with dissolved oxygen as it directly influences the water column's ability to store dissolved oxygen. This relationship is shown on June 11th; as the water temperature decreases, the dissolved oxygen increases and vs versa.

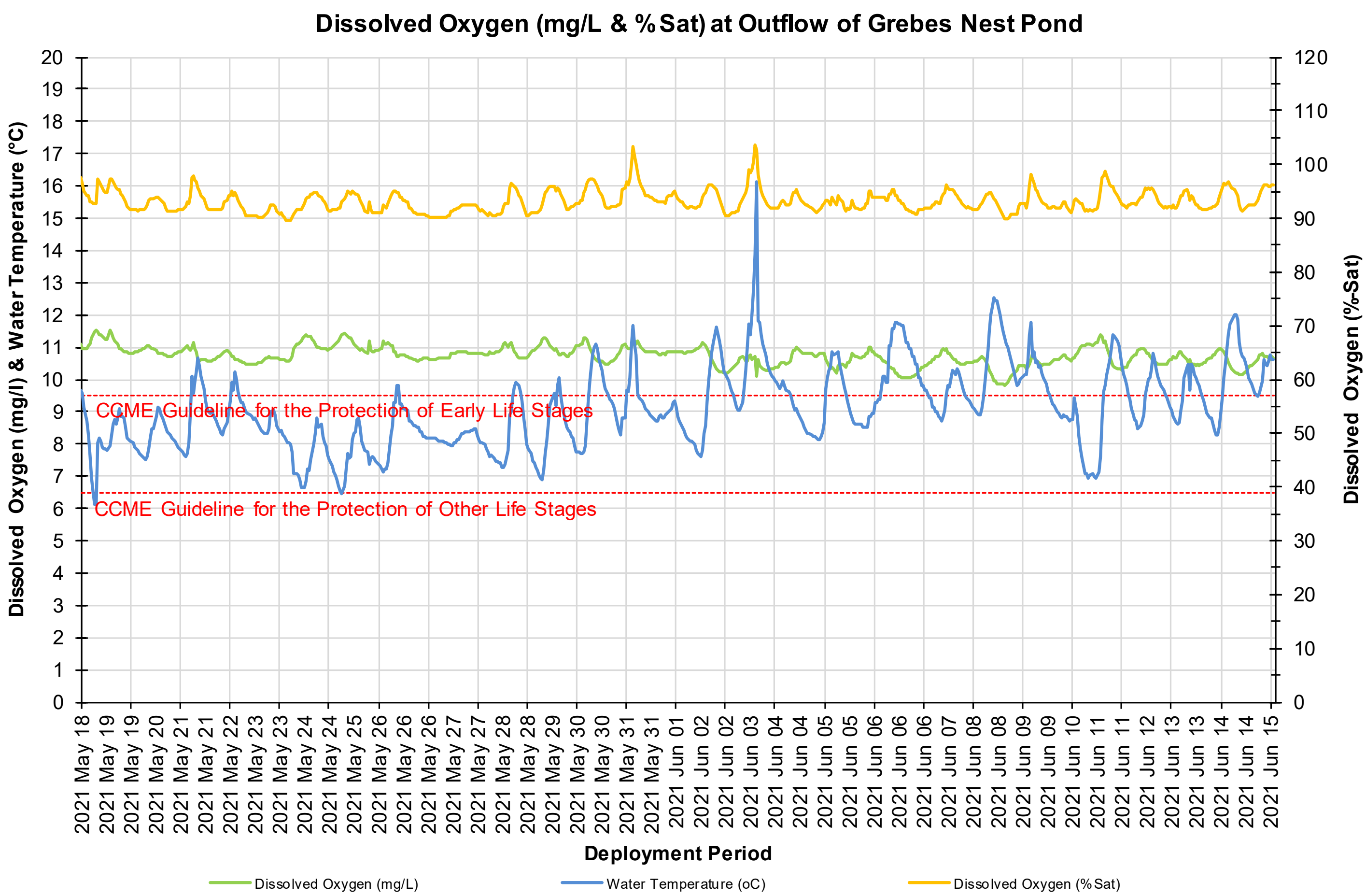

Figure 8: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 4.5 NTU and 1848.8 NTU (Figure 9). The deployment data had a median of 10.9 NTU.

Outflow to Grebes Nest Brook is fed via a sump pump from a pit mine. The pit water is fed through a geo bag before it gravity flows into the 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 with rainfall or pumped water, the water can become stagnant. Evaporation decreases the water level, concentrating sediments in the remaining water.

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.

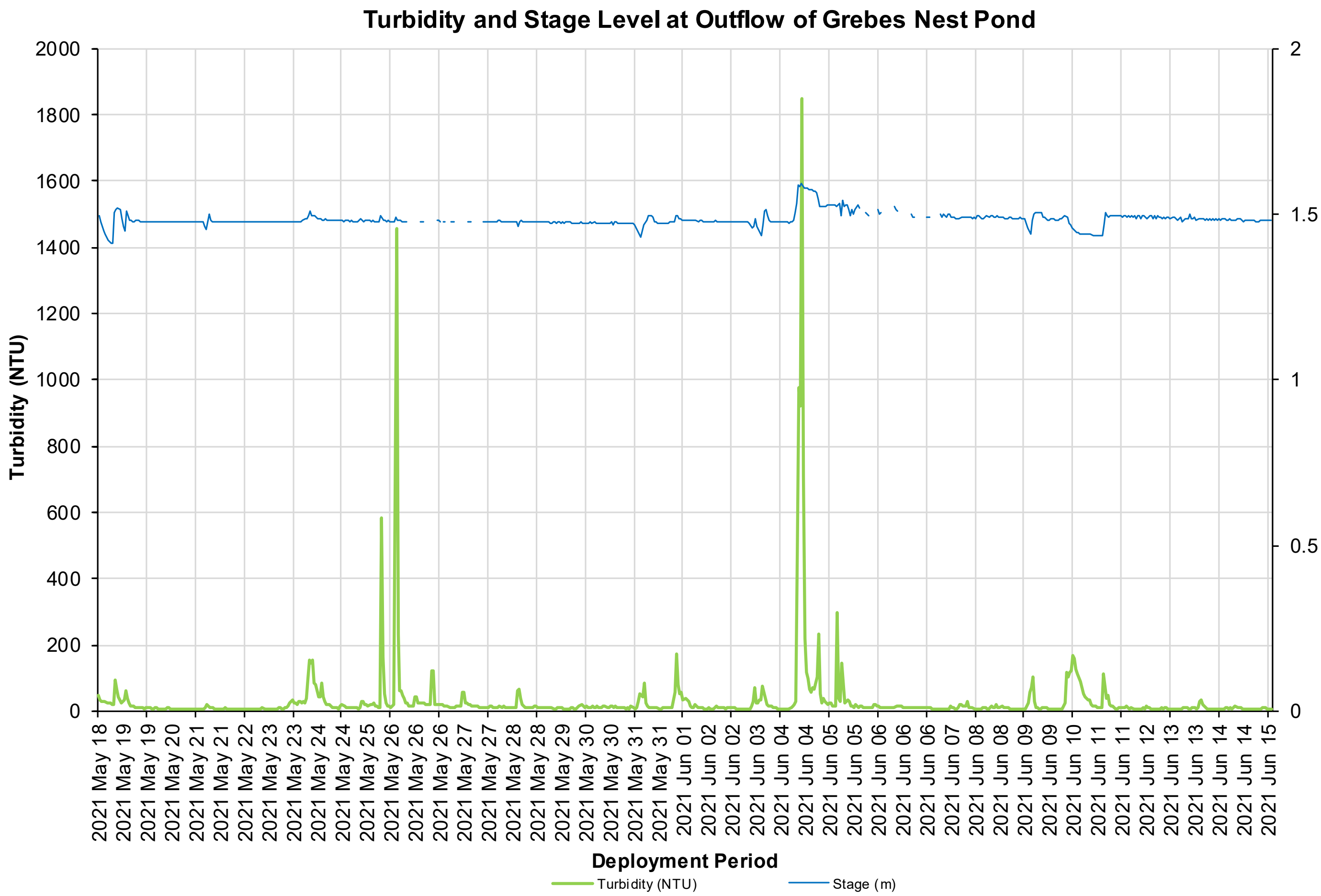

Figure 9: Turbidity (NTU) values.

Conclusion

Outflow of Grebes Nest Pond currently flows through an evolving mine site. Grebes Nest Pond was dewatered and no longer exists. The water supply for Outflow of Grebes Nest Pond station has changed. The water supply is pit water pumped via a sump pump into Outflow of Grebes Nest Pond.

Water temperature remained consistent across deployment except for one spike on June 4th, which was likely a result of rainfall that day. pH data also fluctuated at this time.

Stage level did impact the specific conductivity data at Grebes Nest. As the stage level increased, the conductivity decreased. However, the data remained within the range of 200µS/cm to 380µS/cm, indicating that there was no substantial 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. Throughout this deployment, dissolved oxygen remained relatively consistent.

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 the upstream sedimentation pond. This deployment had high turbidity events throughout June. 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 3.34 °C to 22.28 °C during the deployment period (Figure 10). Water temperature displayed the natural diurnal pattern. Air temperature influences the water in the brook, with the high temperatures recorded during the daylight hours and the low temperatures recorded during nighttime hours (Figure 11).

Outside of the diurnal movement of the water temperature, the data does indicate small influences coinciding with stage changes. High stage fluxes can be a result of precipitation, which was likely the case on June 4th, with an increase in stage followed by a decrease in water temperature for a short period of time.

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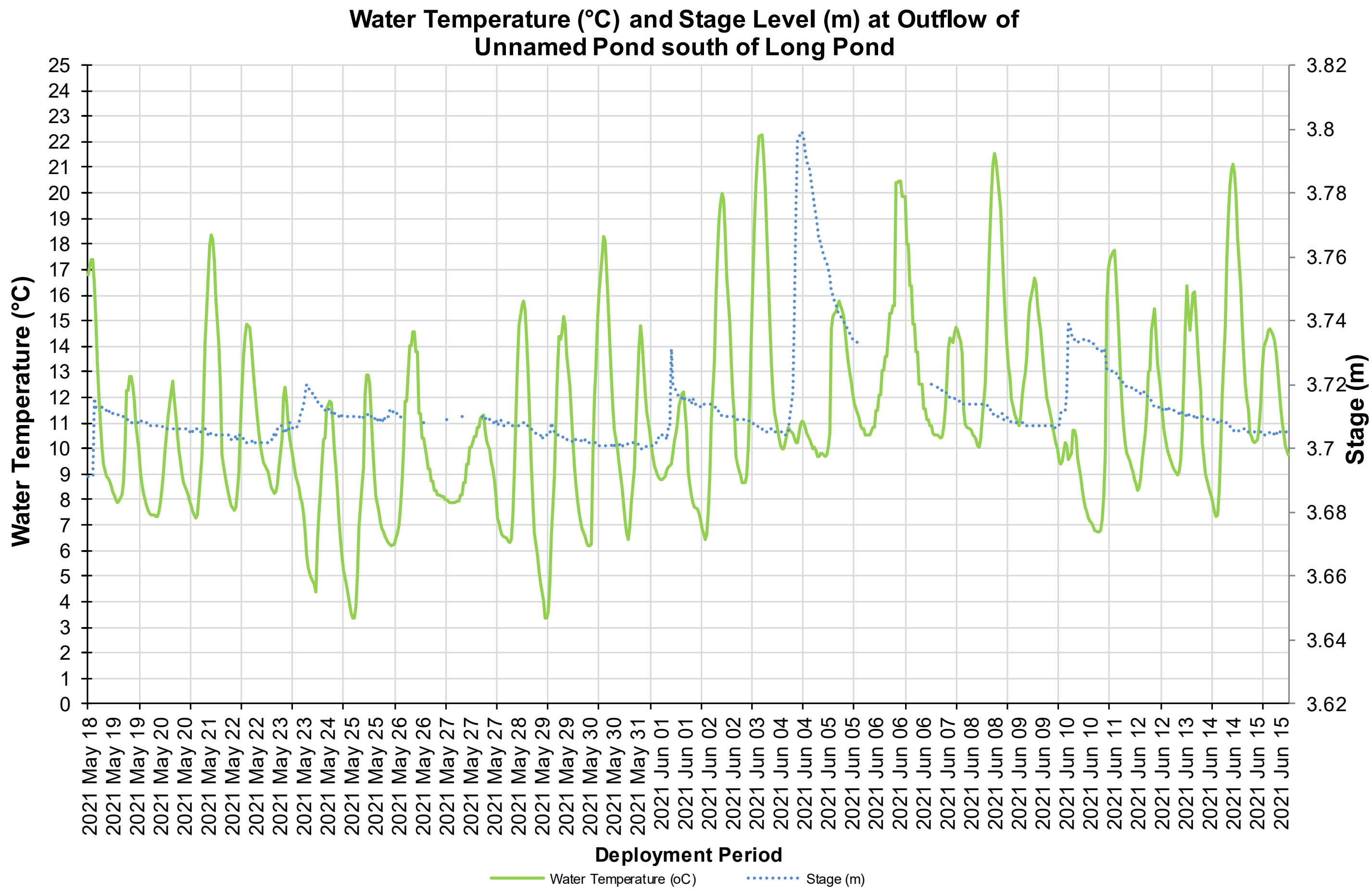

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

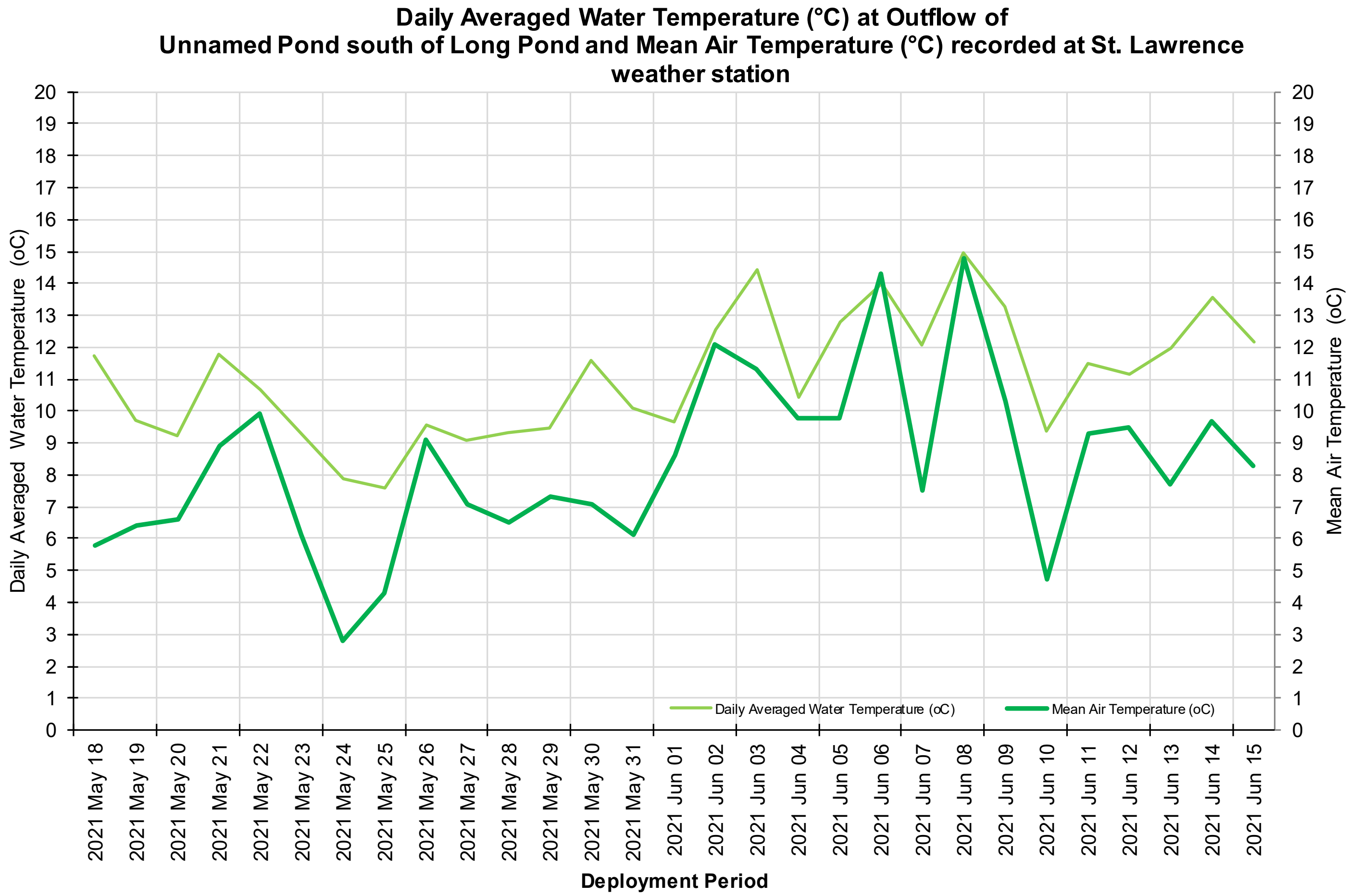

Figure 11: Water temperature (°C) and Mean Air Temperature (°C) at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged within 6.96 pH units and 8.02 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 June 4th and again on June 10th, 2021. The pH values returned to background levels shortly after each event, and overall the pH data was consistent across deployment. 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.

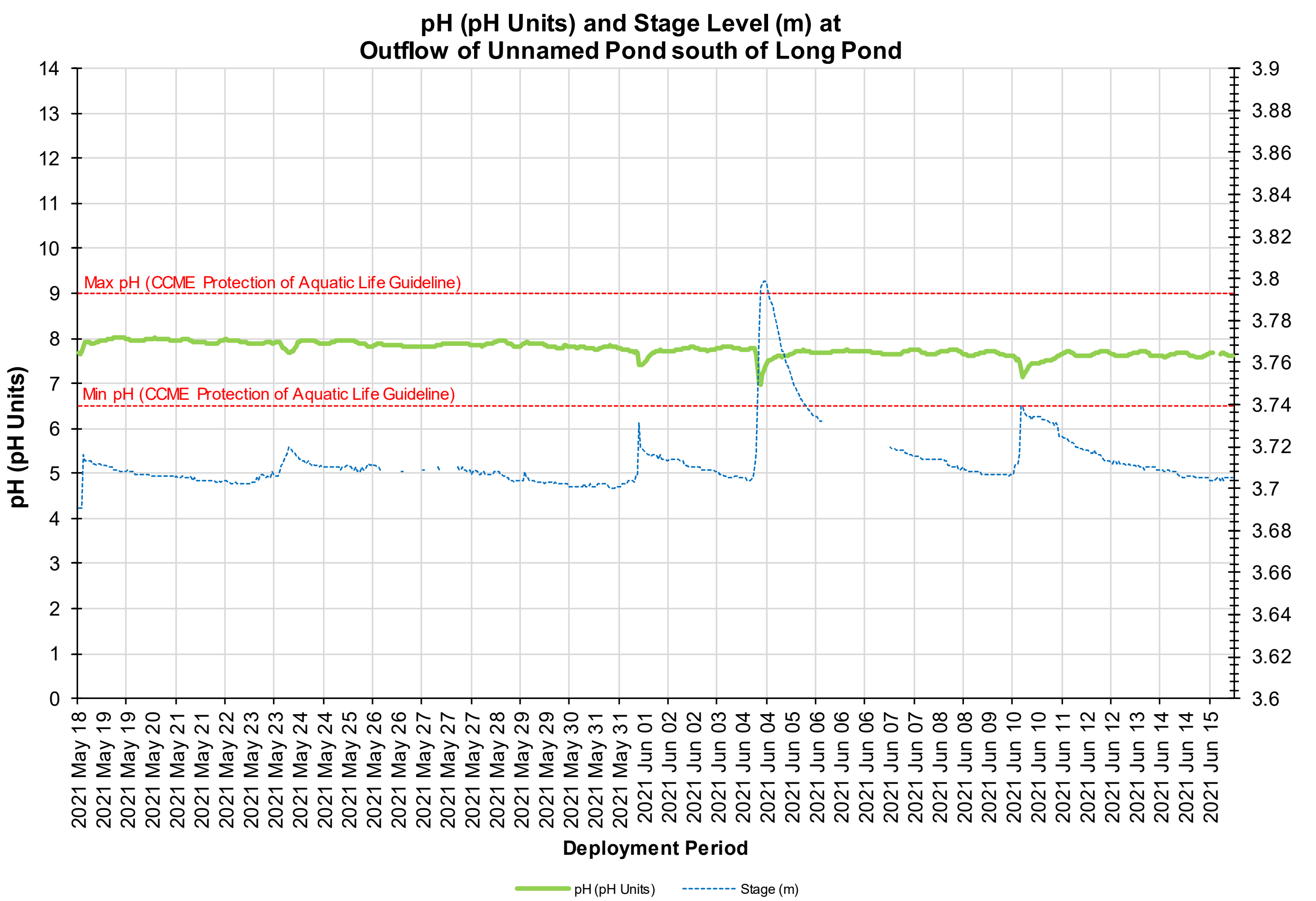

Figure 12: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 101.4 µS/cm and 331.82 µS/cm during deployment (Figure 13). The deployment period had a median of 259.54 µS/cm.

Changes in stage will influence the conductivity data (Figure 13). The extra volume of water during a stage increase will dilute the particle matter present in a water column. When stage level drops, the conductivity levels will increase as suspended solids are concentrated in the water column by the reduced volume of water. This relationship between stage and conductivity can be noted on Figure 13, on May 23, June 1. June 4 and again on June 10, 2021.

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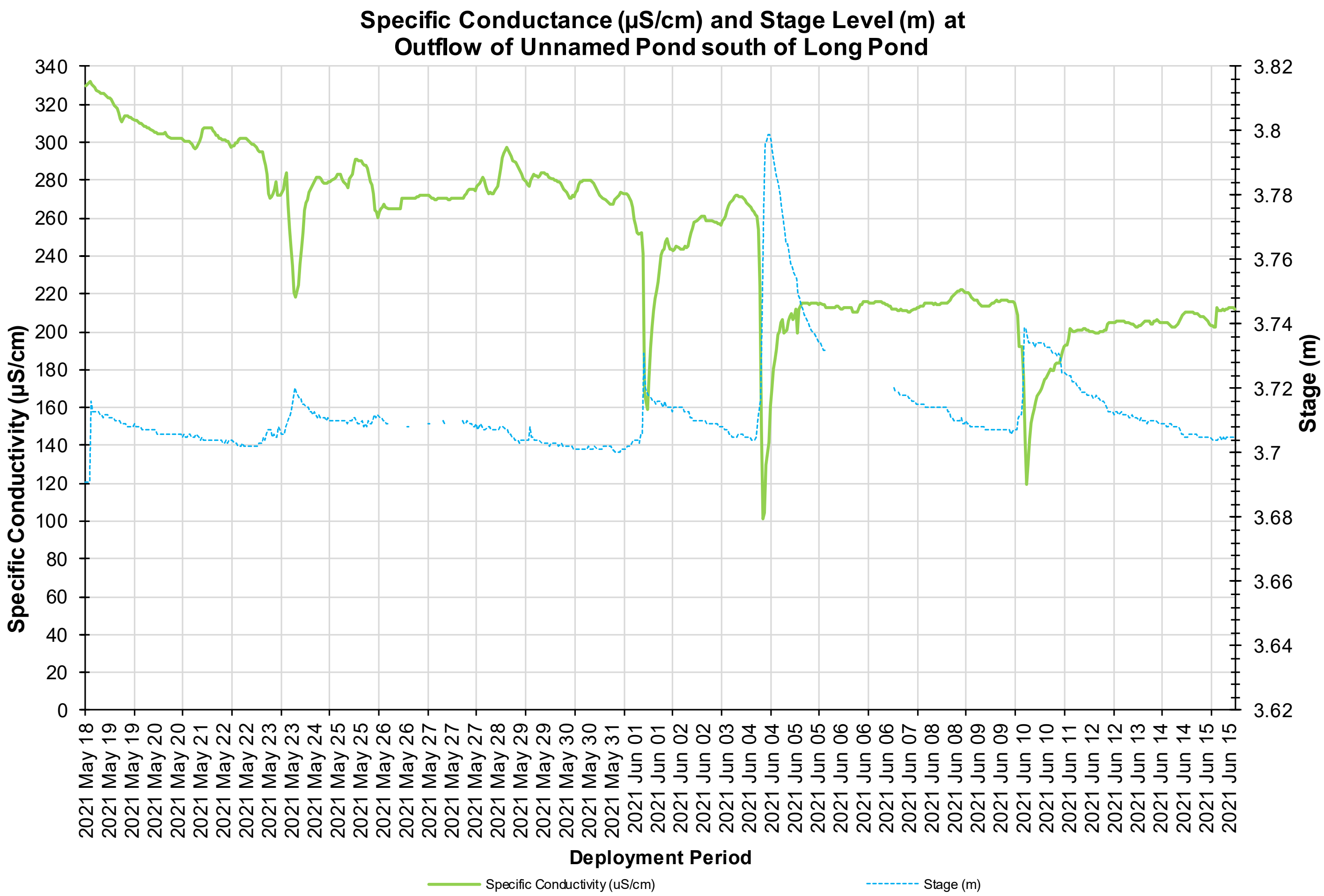

Figure 13: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

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 9.03 mg/L and 13.32 mg/L for concentration and 96.1 % Sat and 107.8 % Sat for dissolved oxygen 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.

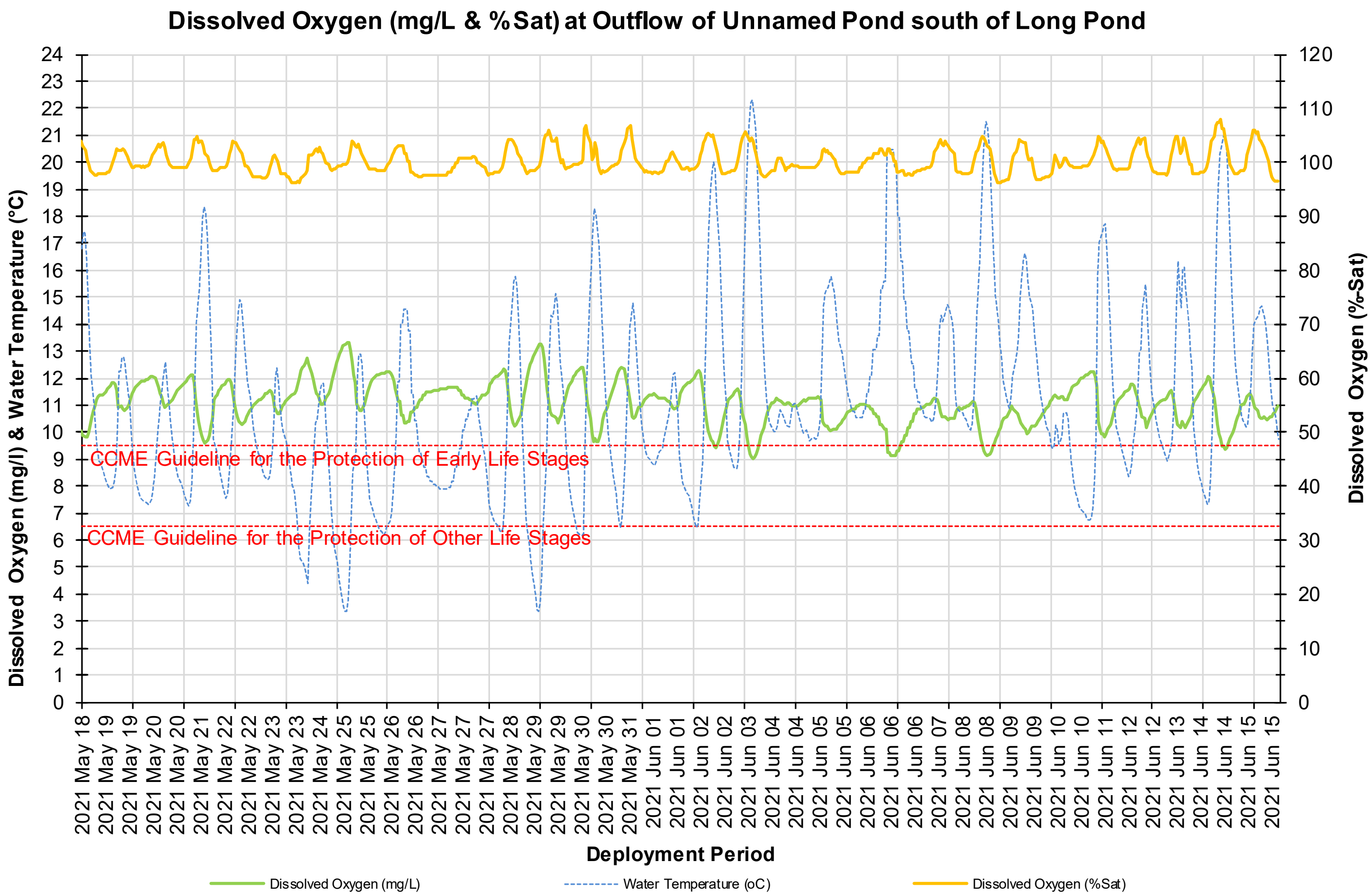

Figure 14: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 24.4 NTU and 289.4 NTU (Figure 15). The deployment data had a median of 105.1 NTU.

At this site, turbidity level decreased across deployment. Several large stage increases assisted in flushing the system and decreasing the turbidity levels.

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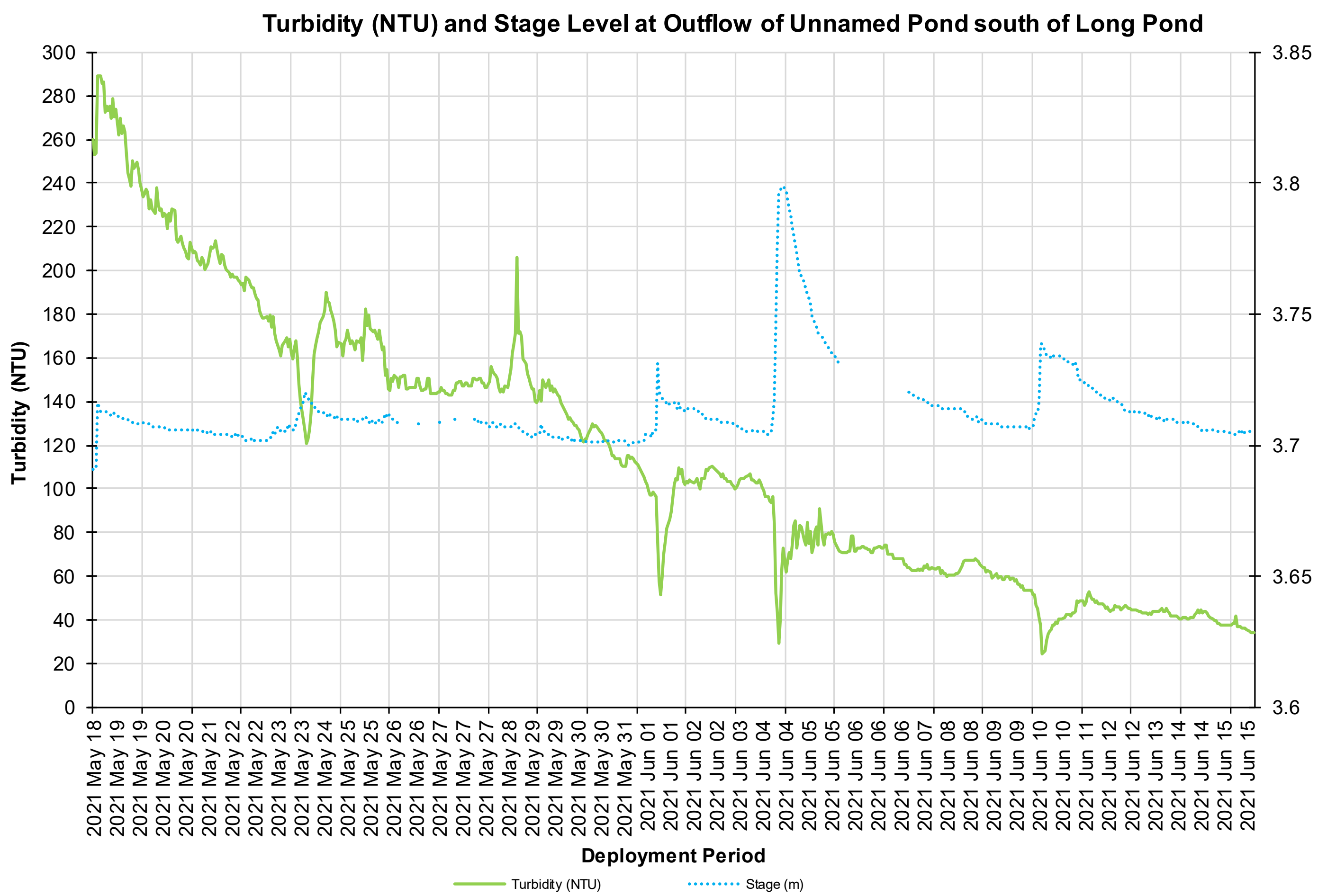

Figure 15: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

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 16) 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. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. The highest daily total precipitation was recorded on June 4th, 2021 at 33.1 mm, which corresponded with the largest stage increase.

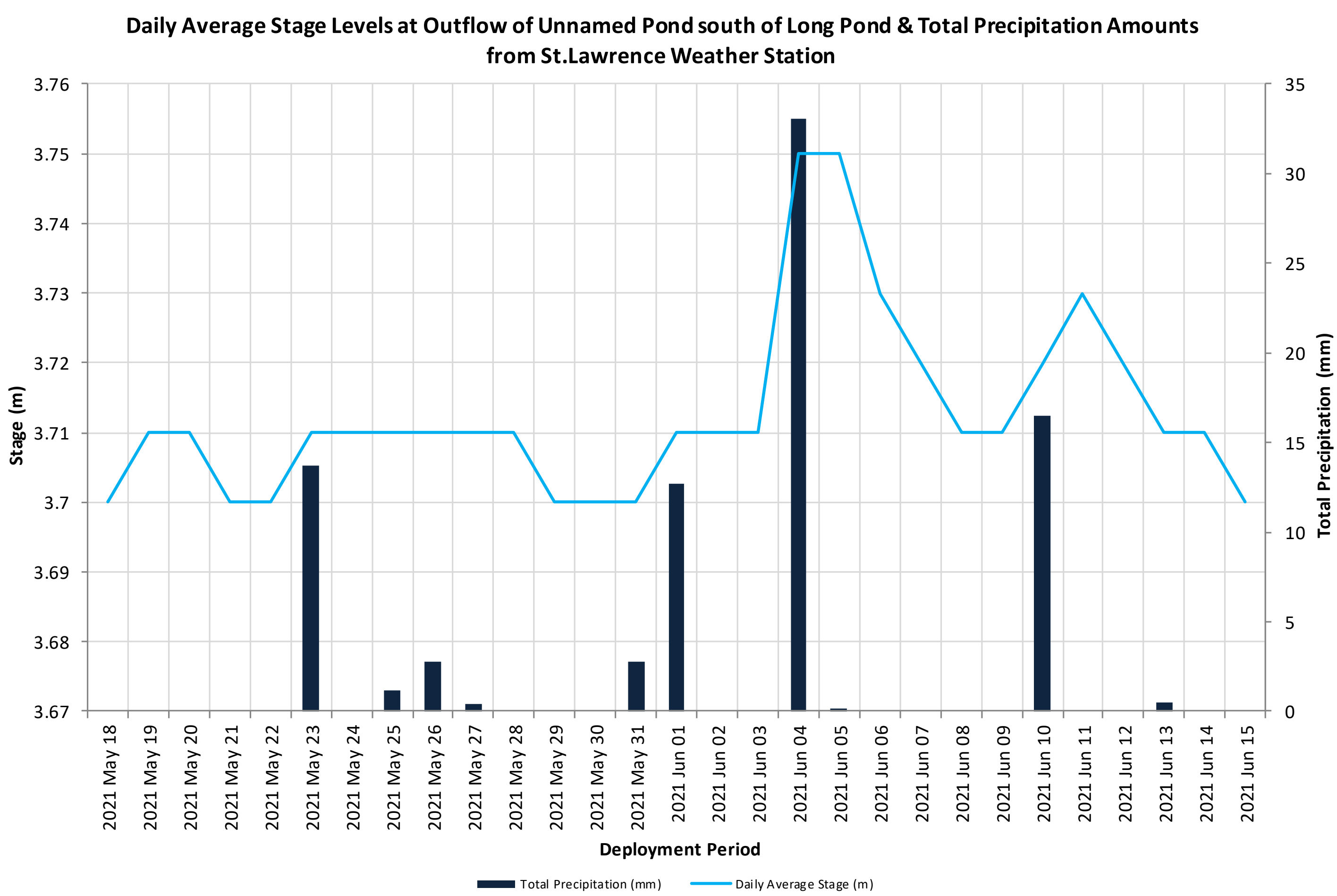

Figure 16: Daily averaged stage values and total precipitation.

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.

Conductivity levels responded to stage fluctuations by decreasing during high stage events and increasing during periods of low stage. Dissolved oxygen levels remained consistent across deployment with small fluctuations a result of rainfall or air temperature variations. Oxygen concentration levels decreased slightly across deployment as air temperature increased with the climatic change into summer.

When compared to the previous deployment this deployment had a higher turbidity maximum of 289.4 NTU. This deployment also had a higher turbidity median of 105.1 NTU, when compared to the previous deployment median of 32.6 NTU.

Precipitation can influence water quality conditions. The majority of the changes are natural and rapid adjustments in parameters before the data returns to background levels. The health of a waterway can be determined by how quickly the parameters return to background data after an event such as precipitation, run off or snowmelt occurs.