Real-Time Water Quality Report

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

Deployment Period
June 15, 2021 to July 27, 2021

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

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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.

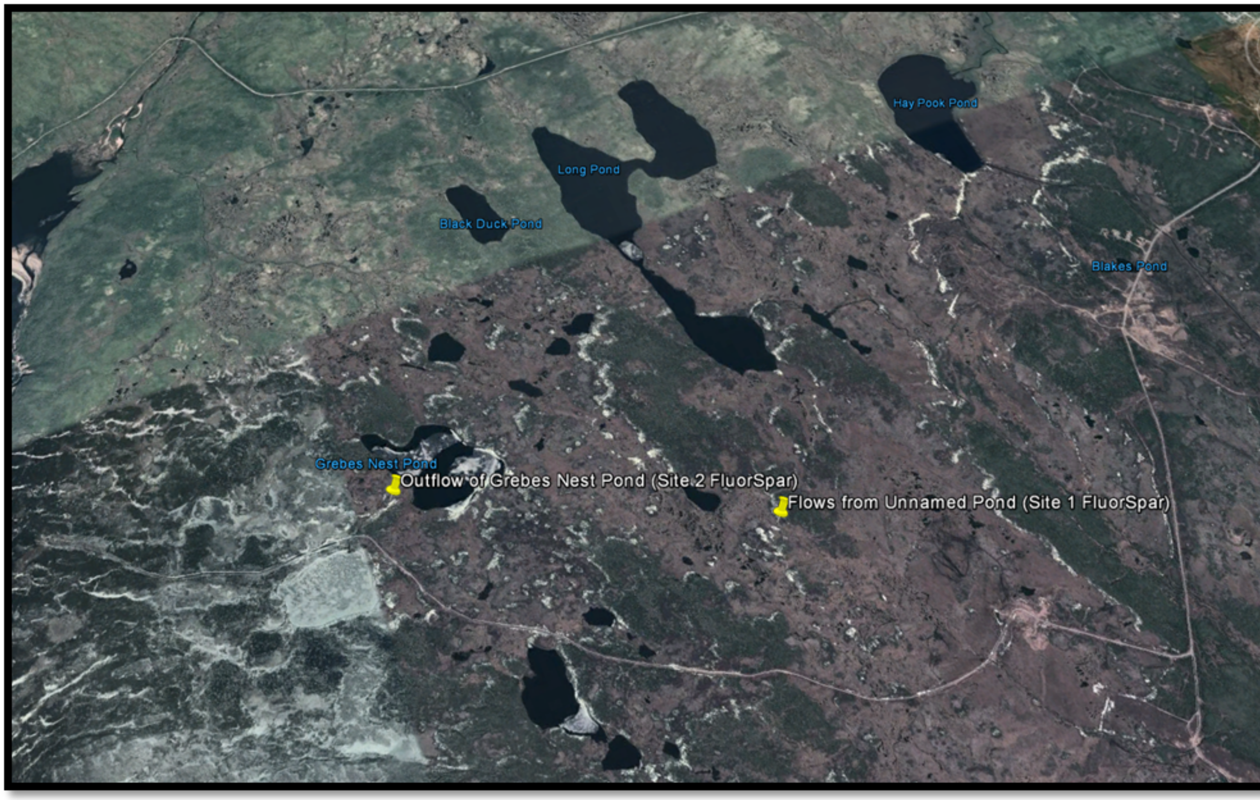

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

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	June 15	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	July 27	Removal	Excellent	Fair	Fair	Excellent	Poor
Unnamed Pond	June 15	Deployment	Excellent	Good	Excellent	Excellent	Good
	July 27	Removal	Excellent	Excellent	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 'Excellent' to 'Good' against the QA sonde data. During removal of the instrument, the ranking for water temperature and dissolved oxygen were 'Excellent' against the QA data. pH data and specific conductivity data ranked as 'Fair' and the turbidity data ranked 'Poor' against the QA values. During removal it was noted that a buildup of silty clay like sediment was layering the sensors on the instrument and it is likely the silt accumulation impacted the field data at removal.

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 across the 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 directly into Outflow to Grebes Nest Pond. If the sedimentation or the turbidity levels in the water increase, the pit water will be redirected into a geo bag before being released into Grebes Nest Brook. 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 8.72°C to 18.06°C during the deployment period (Figure 4). The average water temperature for the deployment is 12.01°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).

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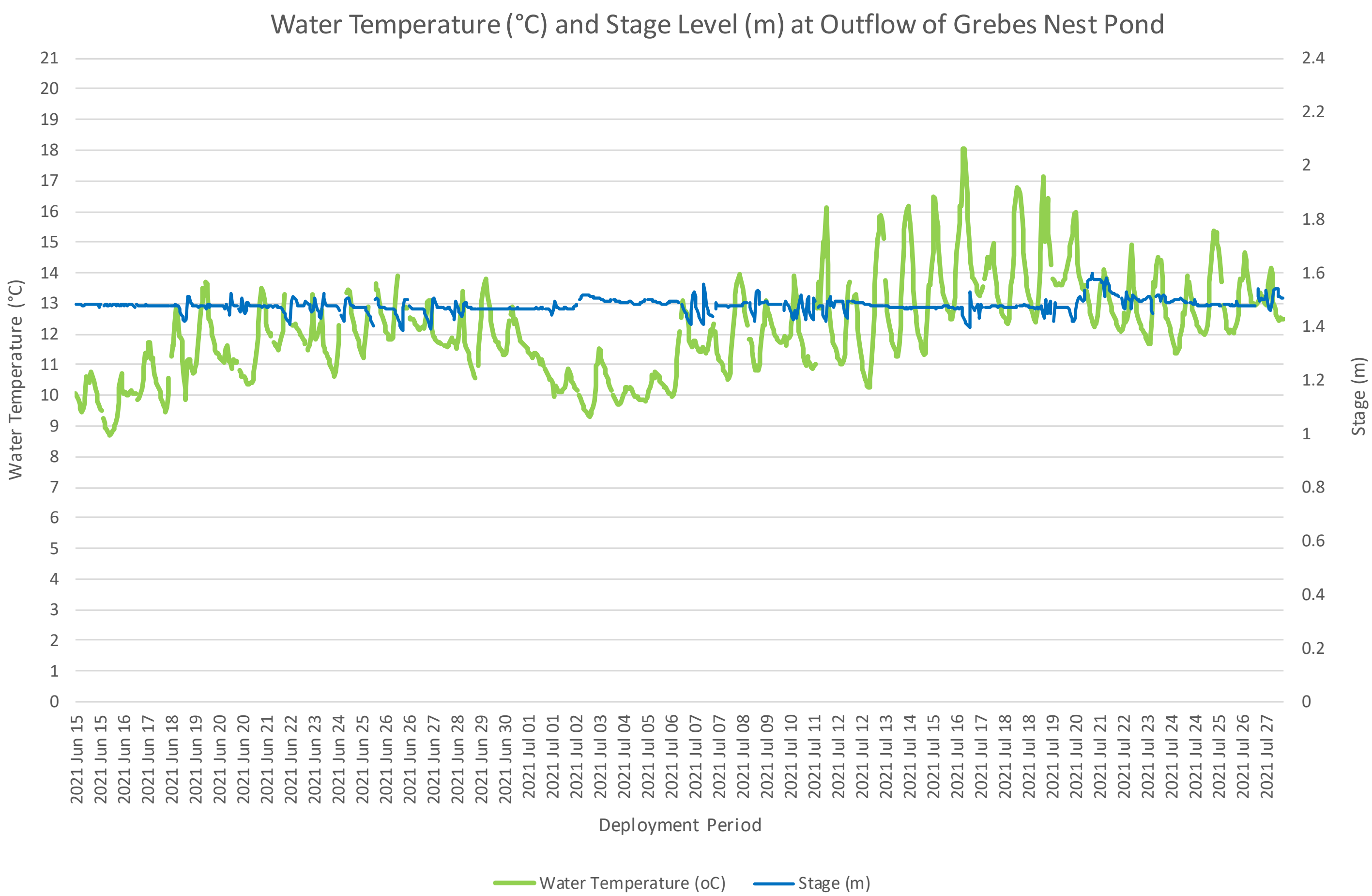

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

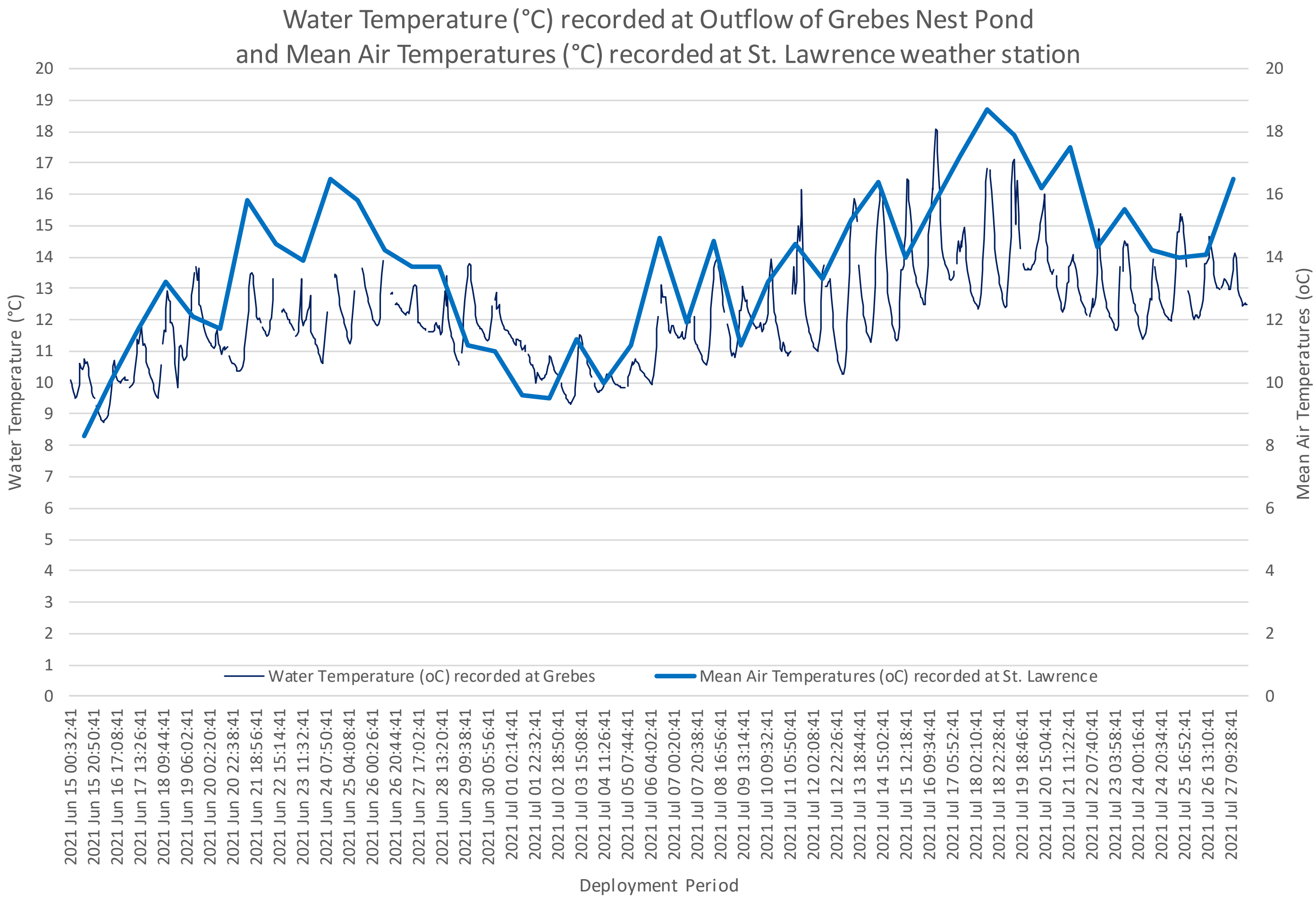

Figure 5: Water temperature (°C) and Mean Air Temperature (°C) at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 7.02 pH units and 8.02 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 circled on the graph in June are likely a result of intermittent stage level (Figure 6). The same days have high air temperatures as well, which may have contributed to some evaporation from the brook (Figure 6). This may also indicate water of higher pH from the mine pit was added to the brook.

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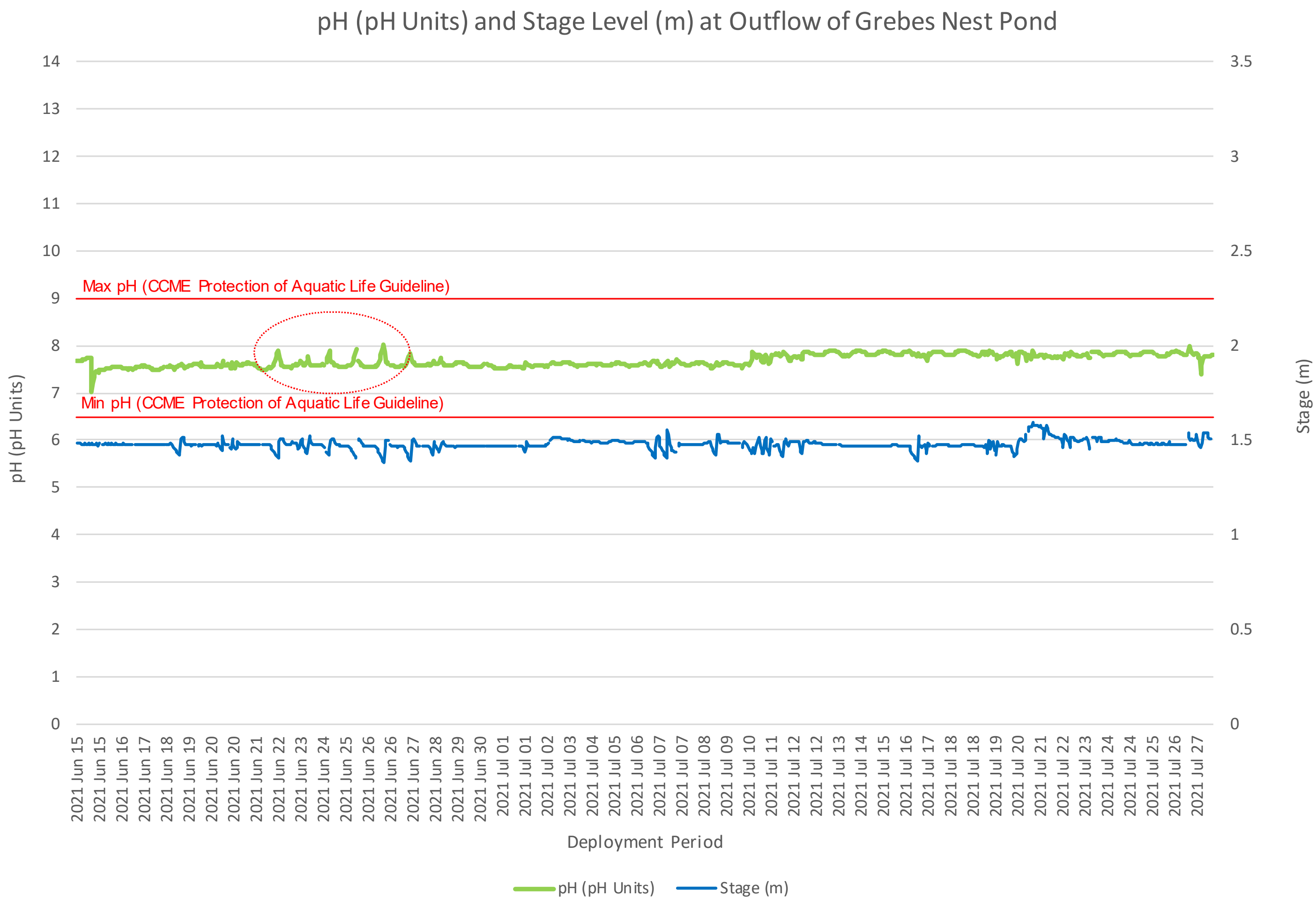

Figure 6: pH (pH units) values

Specific Conductivity

The conductivity levels were within 246.86 µS/cm and 394.07 µS/cm during this deployment period (Figure 7). The specific conductivity probe measured the diluted salts and inorganic materials present in the brook.

Across the deployment period, the conductivity in Grebes Nest fluctuated with the changes in stage level. During low to no stage increases, diluted salts and inorganic material will accumulate in the brook, slowly contributing to higher conductivity. During stage increases, the diluted salts and inorganic matter present in the brook are flushed through the system for a period of time. This was displayed on July 20th when the conductivity levels dipped during a stage increase before returning to previous levels (Figure 7).

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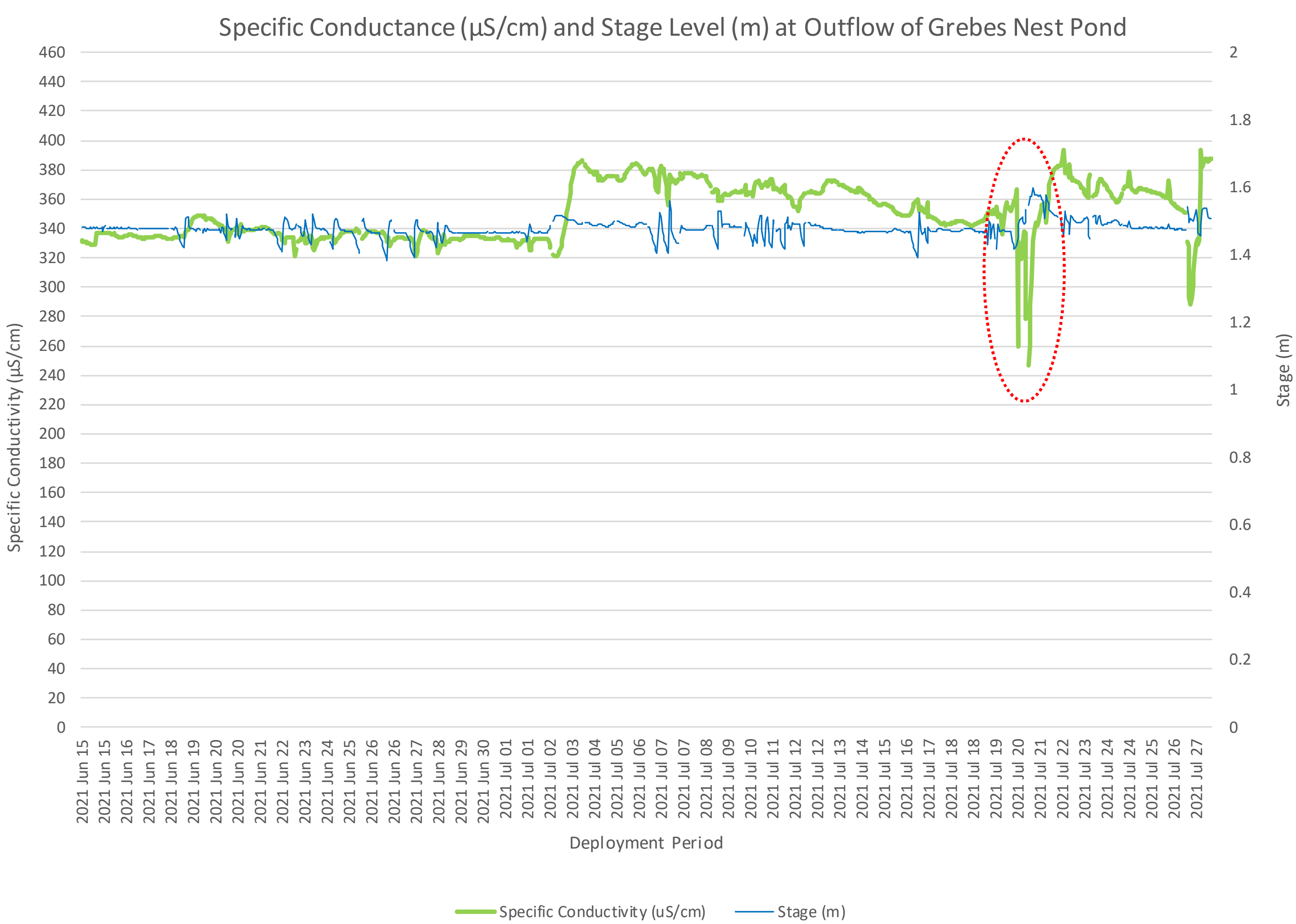

Figure 7: Specific conductivity (µS/cm) values

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 9.36 mg/L to a maximum of 11.31 mg/L. The percent saturation levels for dissolved oxygen ranged within 86.4% Saturation to 108.6% 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. Water temperature is included alongside dissolved oxygen as it directly influences the water column's ability to store dissolved oxygen.

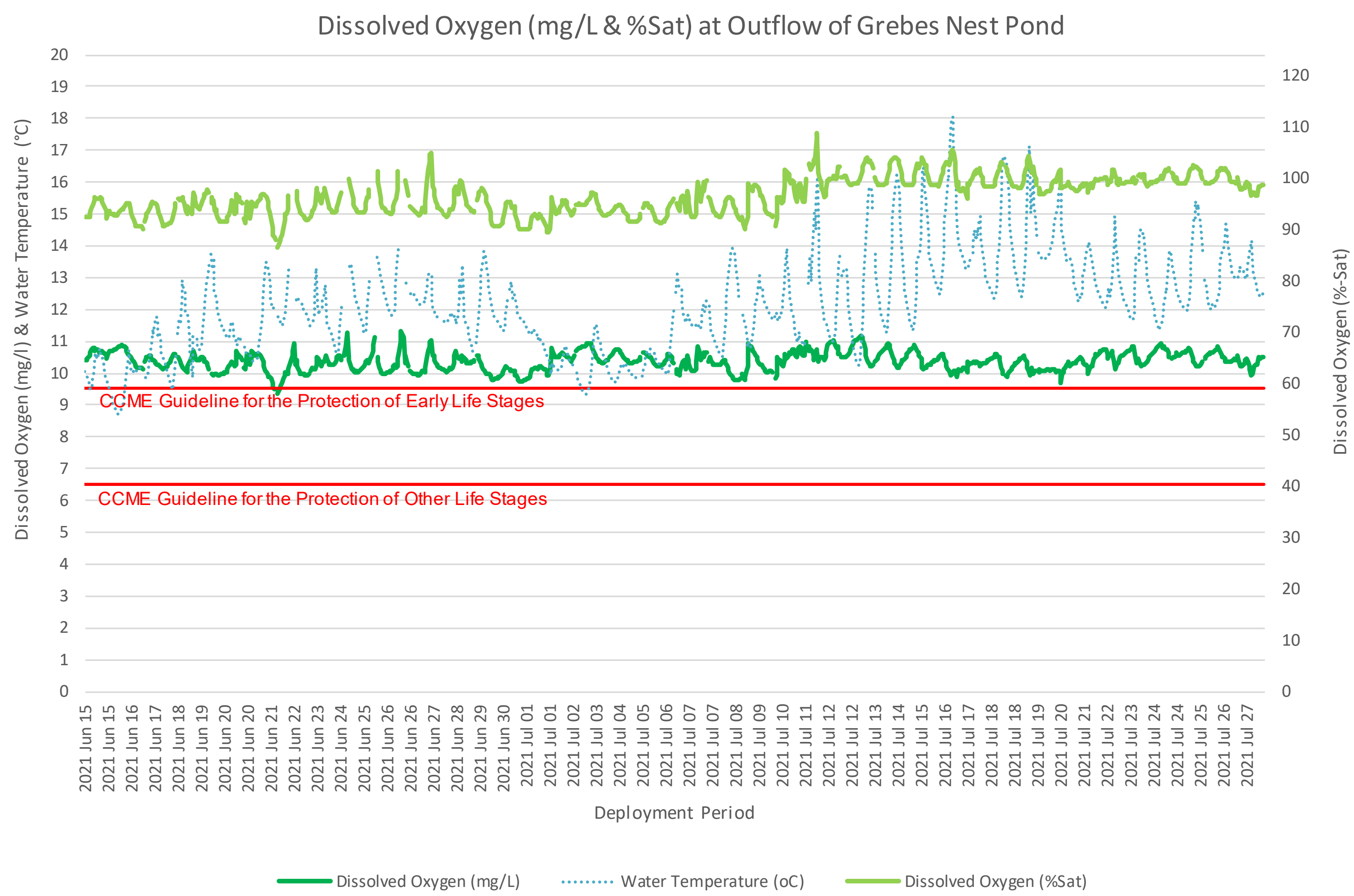

Figure 8: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 3.3 NTU and 2039.6 NTU (Figure 9). The deployment data had a median of 10.7 NTU.

Outflow to Grebes Nest Brook is fed via a sump pump from a pit mine. The pit water is fed into the brook via a large pipe and 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 also decreases the water level, concentrating sediment particles 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.

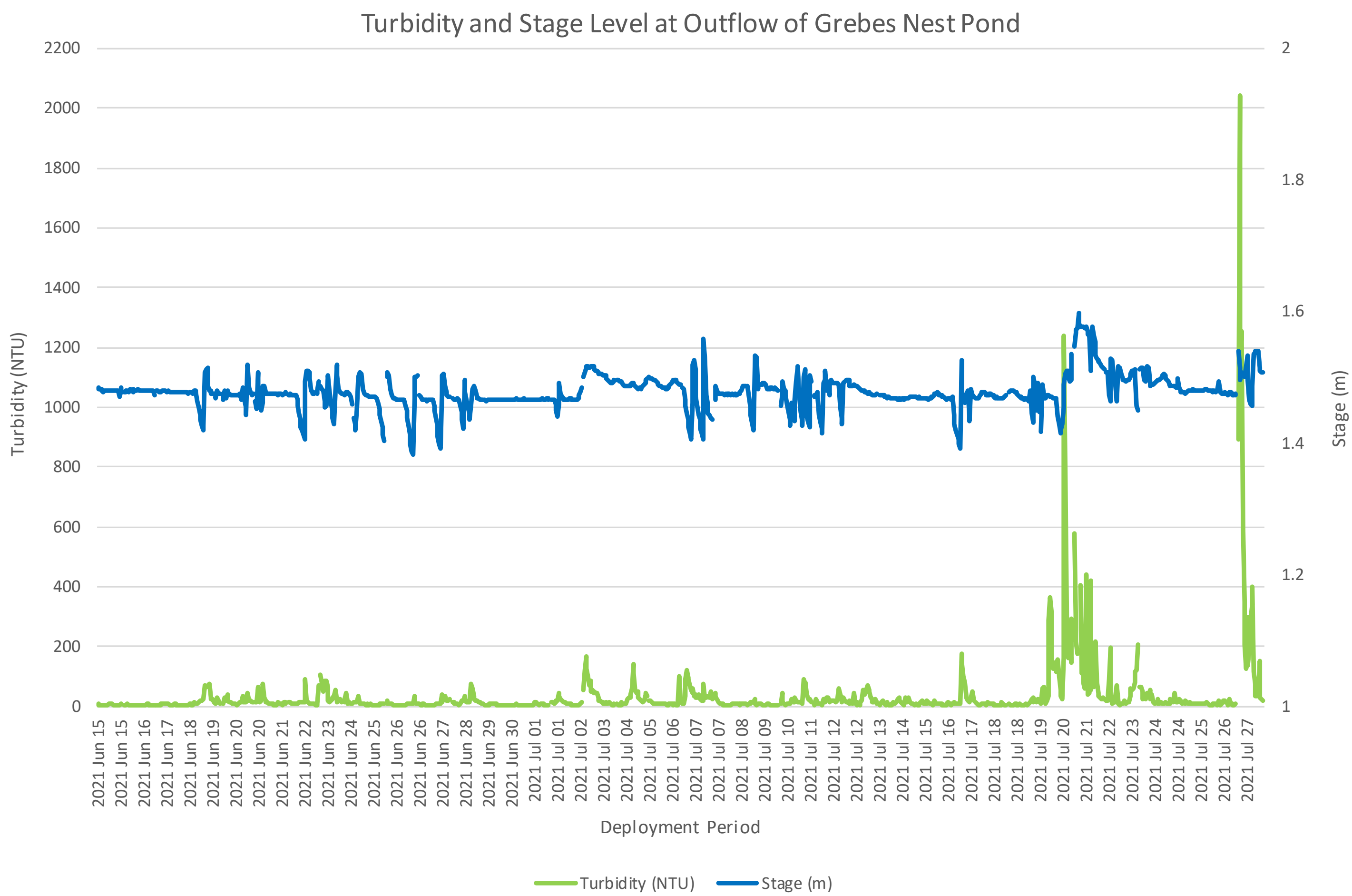

Figure 9: Turbidity (NTU) values.

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. Outflow to Grebes Nest Pond station does not always have consistent flow. This factor can influence changes in the water quality within the station.

Water temperature displayed expected results across the deployment. The temperatures increased slightly toward the end of deployment, which would be expected as the climatic conditions are warming up into the summer months. Water temperatures mirrored the air temperature recorded at the St. Lawrence weather station.

pH data across deployment was consistent. From June 22 to June 26, 2021 the data recorded several increases in pH. These may indicate addition of mine pit water to the brook. The pH levels then returned to background levels.

Water flow did impact the specific conductivity data at Grebes Nest. Stage is consistent during the deployment with small increases and decreases. The largest stage increase on July 20th was a result of precipitation. During this event, conductivity decreased as the sediment and particulate matter was flushed from the brook for a short period of time.

Due to the nature of the water supply for the station, dissolved oxygen levels can be erratic. During this deployment, oxygen content in the brook displays natural movement in the levels. During the higher water temperatures it would be expected to see the oxygen content to reduce for a period of time.

The brook recorded turbidity data under 200 NTU until around July 19th – July 20th, 2021, when turbidity levels spiked for a period of time. Precipitation data recorded at St. Lawrence for the same time frame indicates turbidity may have been a result of rainfall stirring up the sediment. 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 8.63°C to 23.92°C during the deployment period (Figure 9). The water temperature increased slightly across the deployment, fluctuating as the air temperatures increased with the warmer climatic change into Summer (Figure 10).

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 11). Outside of the diurnal movement of the water temperature, the data does indicate some correlation with stage changes. As stage increases there is a slight decrease in the water temperature for a short period of time. This indicates a cool, moist weather system likely passed through the area.

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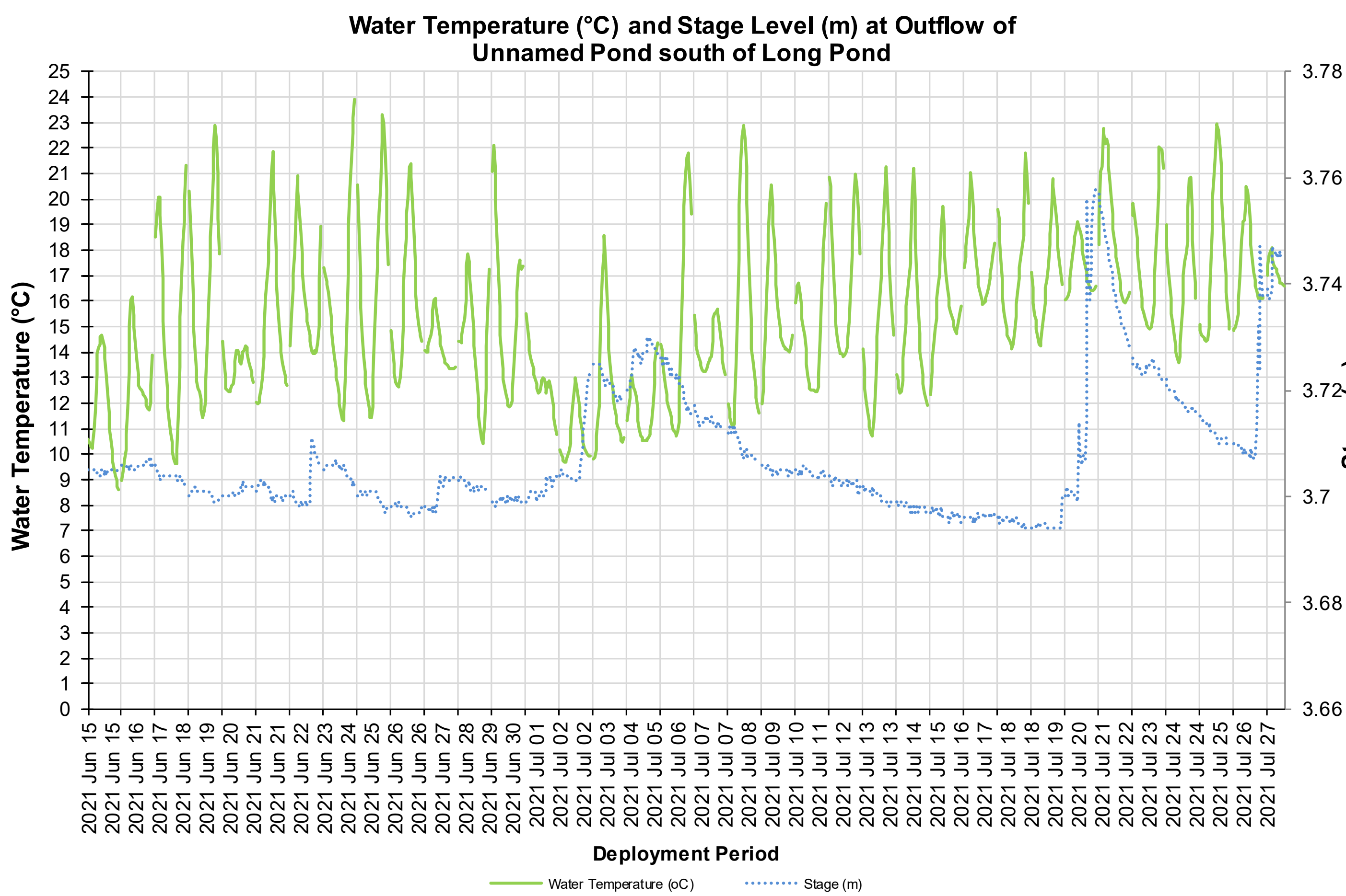

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

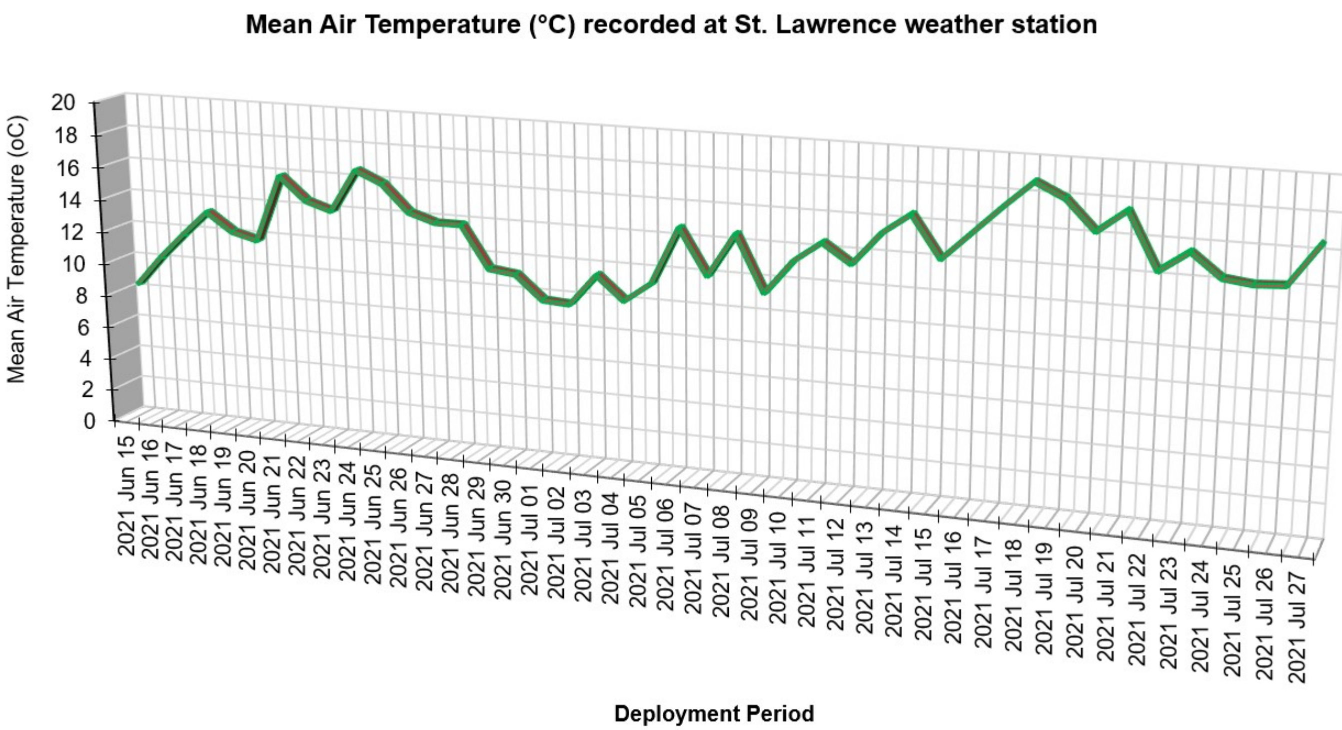

Figure 11: Mean Air Temperature (°C) recorded at St. Lawrence Weather Station

pH

Throughout this deployment period, pH values ranged within 6.66 pH units and 7.81 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 15th, July 2nd, July 20th and again on July 27th, 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.

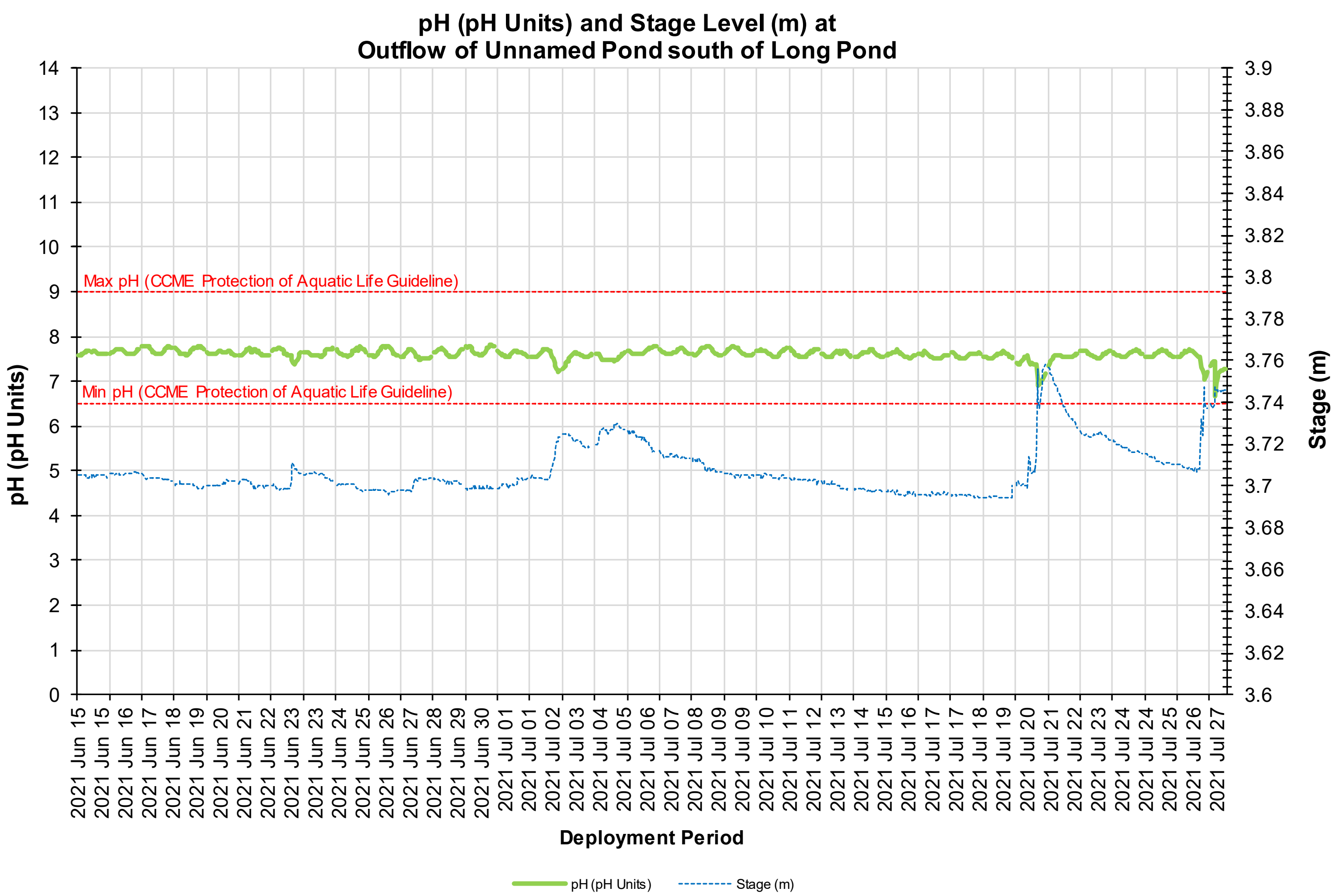

Figure 12: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 96.79 µS/cm and 231.64 µS/cm during deployment (Figure 13). The deployment period had a median of 208.1 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. This relationship between stage and conductivity can be noted on Figure 13, on June 22nd, June 27th, July 2nd to July 5th as well as, July 20th and the end of deployment on July 26th, 2021. The conductivity levels dropped for a short period before returning to previous background levels.

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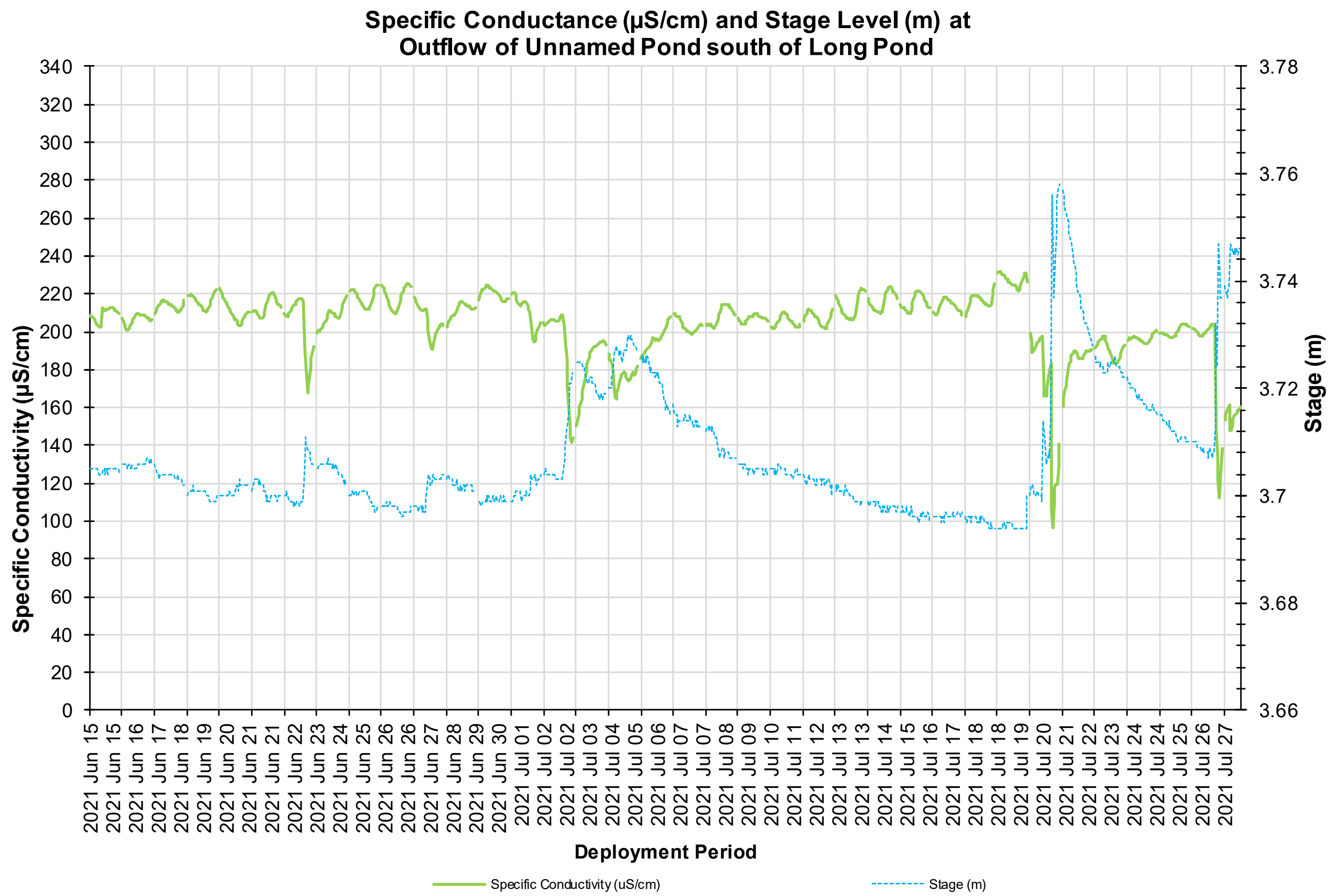

Figure 13: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

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 8.62 mg/L and 11.49 mg/L for concentration and 90.4 % Sat and 118.4 % 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 13. All other prominent dips/peaks - outside of the diurnal pattern - are a result of fluxes in water temperature or influences from rainfall/runoff.

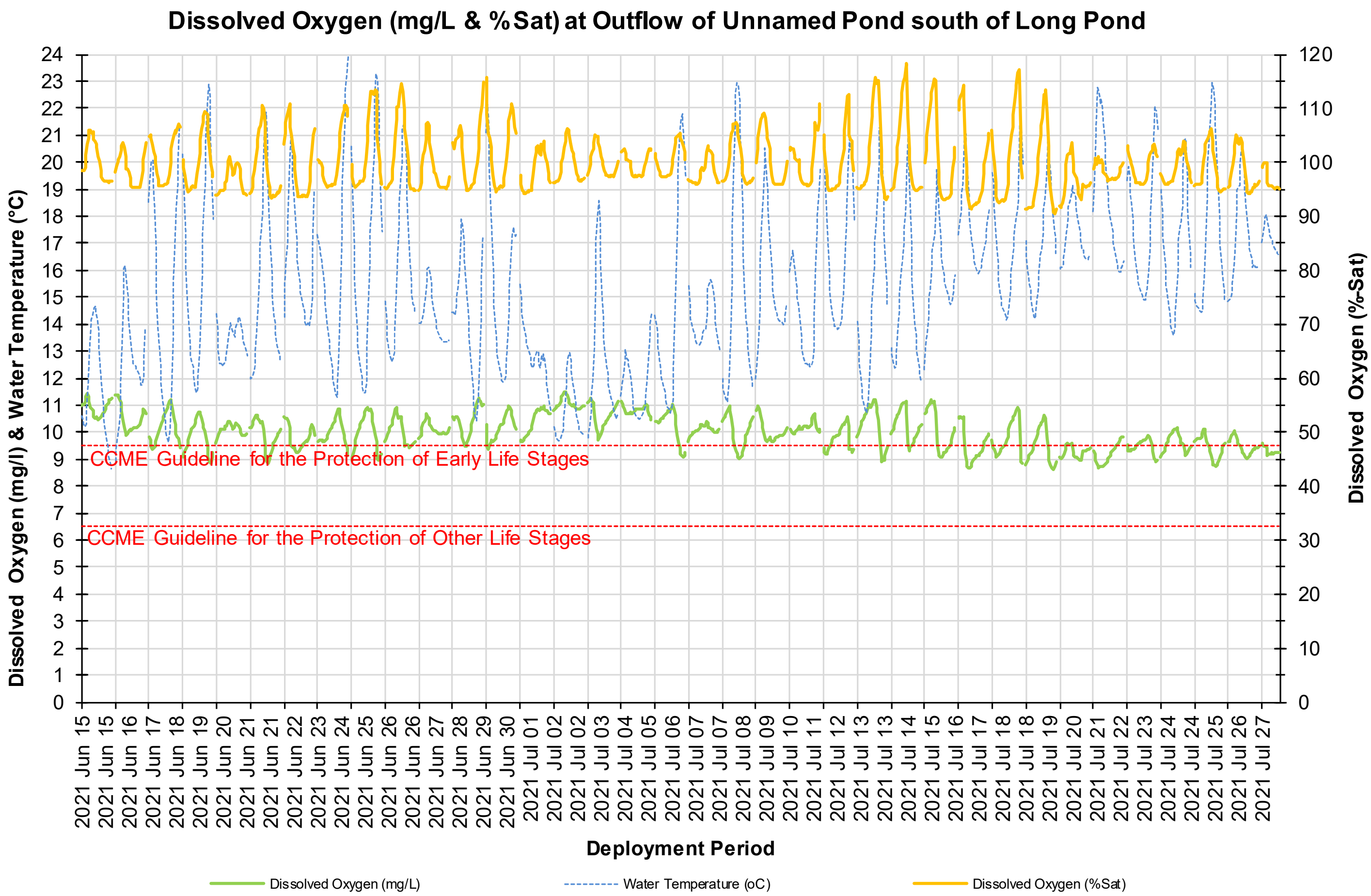

Figure 14: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 3.7 NTU and 41.9 NTU (Figure 15). The deployment data had a median of 11.5 NTU.

The turbidity remained below 50 NTU, throughout the deployment. During this deployment the turbidity levels steadily decreased. Turbidity conditions have improved during this deployment which was likely a result of CFI improving how the sediment is being captured from the settling ponds before being released into the brook.

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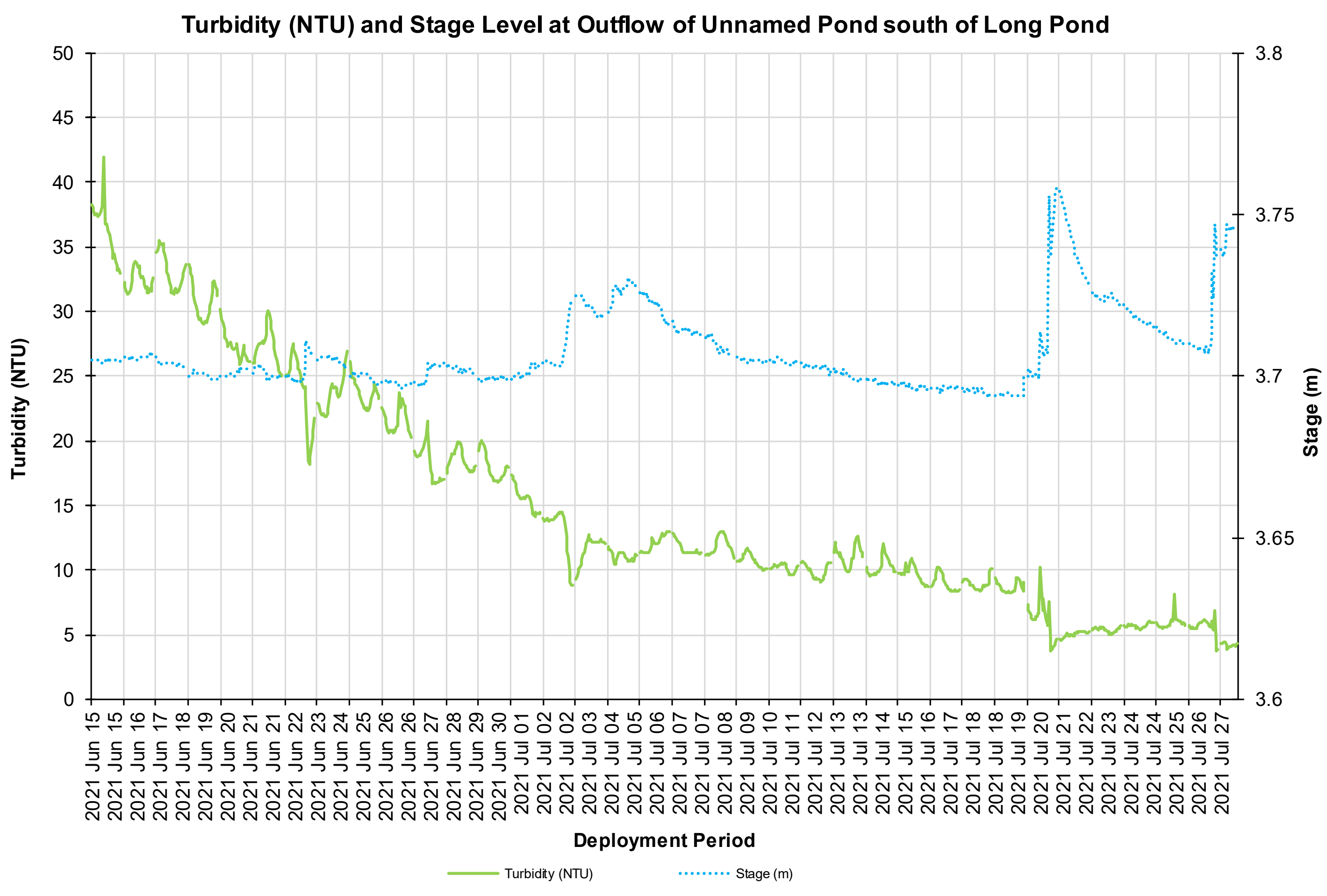

Figure 15: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

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 the total precipitation events as noted on Figure 16. Total Daily Precipitation data was obtained from Environment Canada's St. Lawrence weather station. The highest total precipitation was recorded on July 20th, 2021 at 28.7 mm, which corresponded with a significant stage increase.

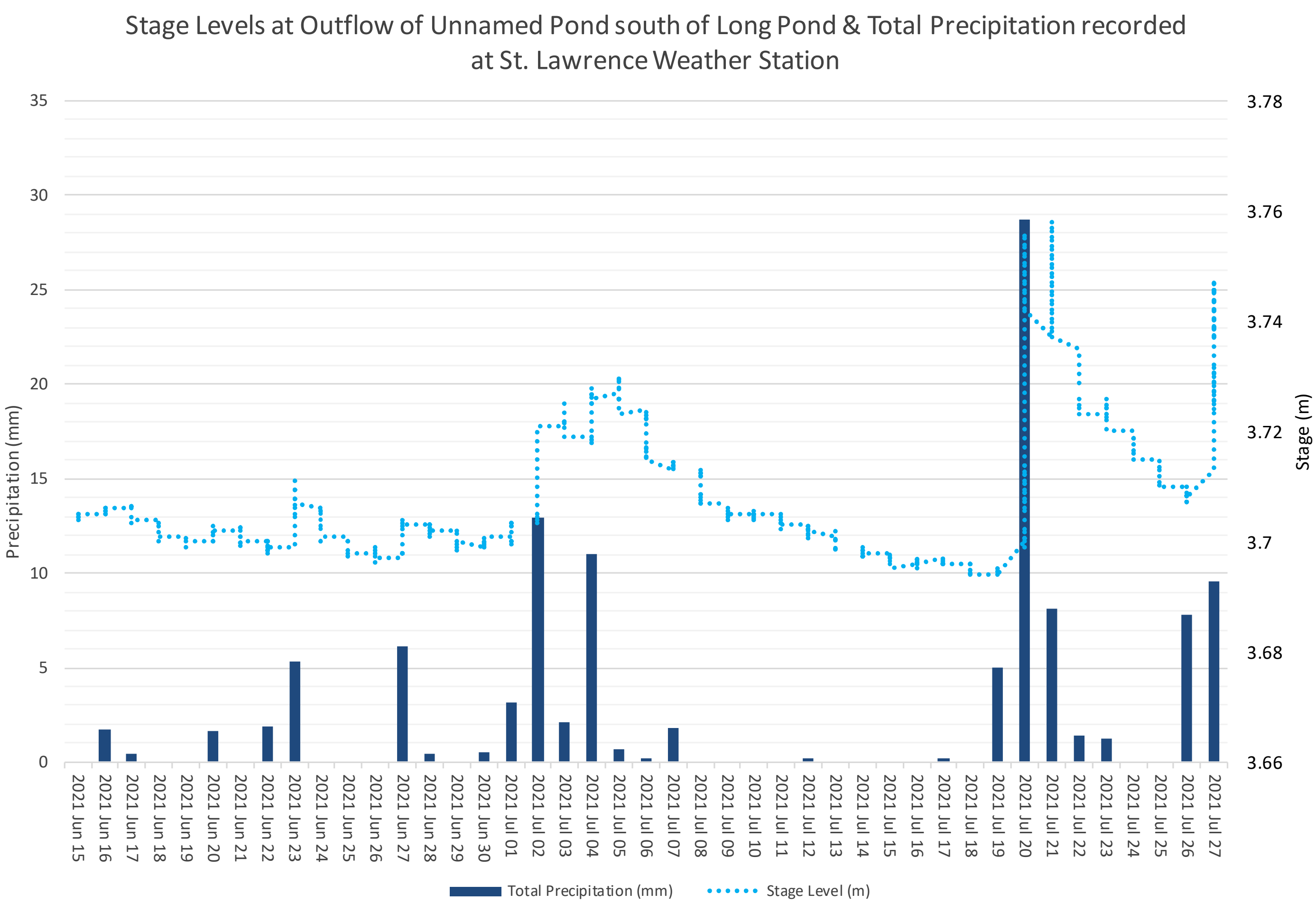

Figure 16: Daily averaged stage values and total precipitation.

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. The changes in dissolved oxygen levels are a result of the warmer water temperatures. Oxygen levels decreased slightly across deployment as the air temperature increased with the climatic change into summer.

When compared to previous deployments this deployment had a lower turbidity maximum of 41.9 NTU. This deployment also had a lower turbidity median of 11.5 NTU when compared to the previous deployment's median of 105.1 NTU. After a large precipitation event on July 20th, stage levels likely flushed the brook and contributed to the decreasing turbidity values for the rest of the deployment.

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