Real-Time Water Quality Report

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

Deployment Period
September 28, 2021 to November 23, 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.

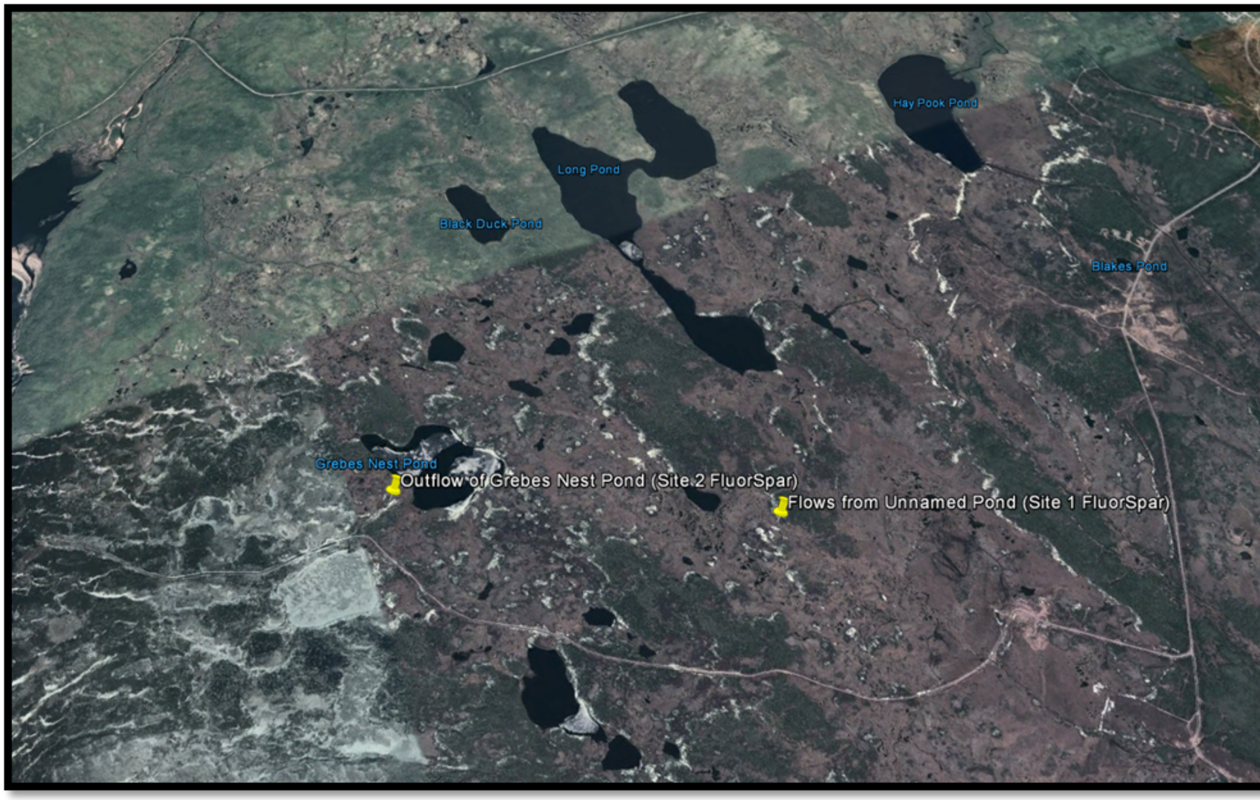

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

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	Sept 28	Deployment	Excellent	Excellent	Excellent	Excellent	Marginal
	Nov 23	Removal	Good	Good	Excellent	Excellent	Marginal
Unnamed Pond	Sept 28	Deployment	Excellent	Excellent	Excellent	Excellent	Good
	Nov 23	Removal	Good	Marginal	Fair	Fair	Good

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, pH, specific conductivity and dissolved oxygen ranked 'Excellent' against the QA sonde data. The turbidity data ranked as 'Marginal' likely a result of the level of sediment disturbance in the brook during the time the reading was taken. At removal of the instrument, water temperature, pH, conductivity, and dissolved oxygen ranked from 'Excellent' to 'Good' with turbidity data again ranking as 'Marginal', likely a result of the level of sediment present on and around the instrument at the end of the 56 day deployment.

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 the initial deployment. At removal, the instrument had been deployed for approximately 56 days, therefore the rankings against the QA indicated likely influence from sediment buildup around the sonde. The parameters ranked 'Good' and 'Fair' for water temperature, conductivity, dissolved oxygen and turbidity. With the pH data ranking as 'Marginal'.

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 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. Therefore, 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 3.59 °C to 16.66 °C during the deployment period (Figure 4). The average water temperature for the deployment is 9.13 °C, which is lower than the previous deployment due to change in air temperature as the Winter season approaches. 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). The noticeable seasonal decline is natural and expected.

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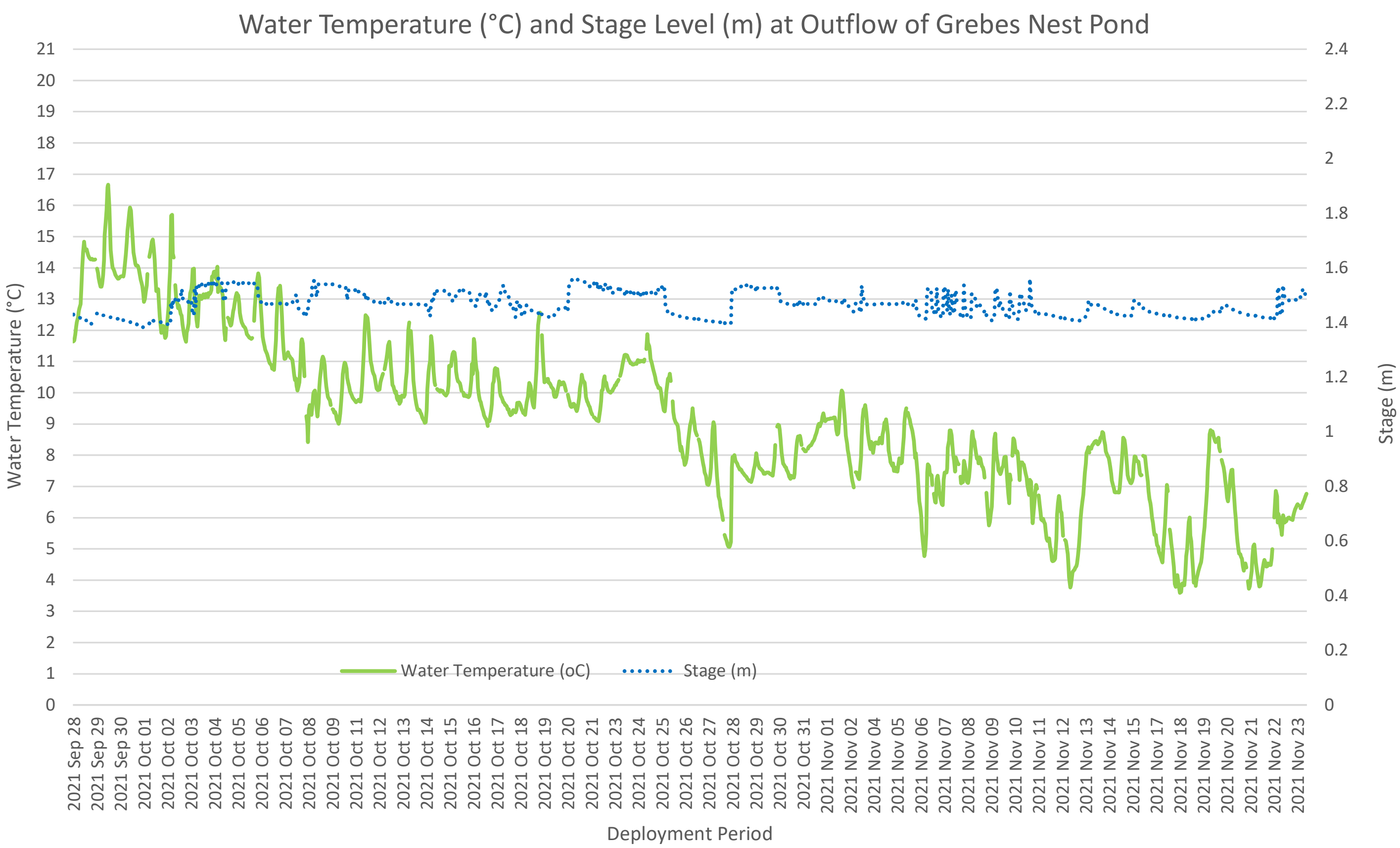

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

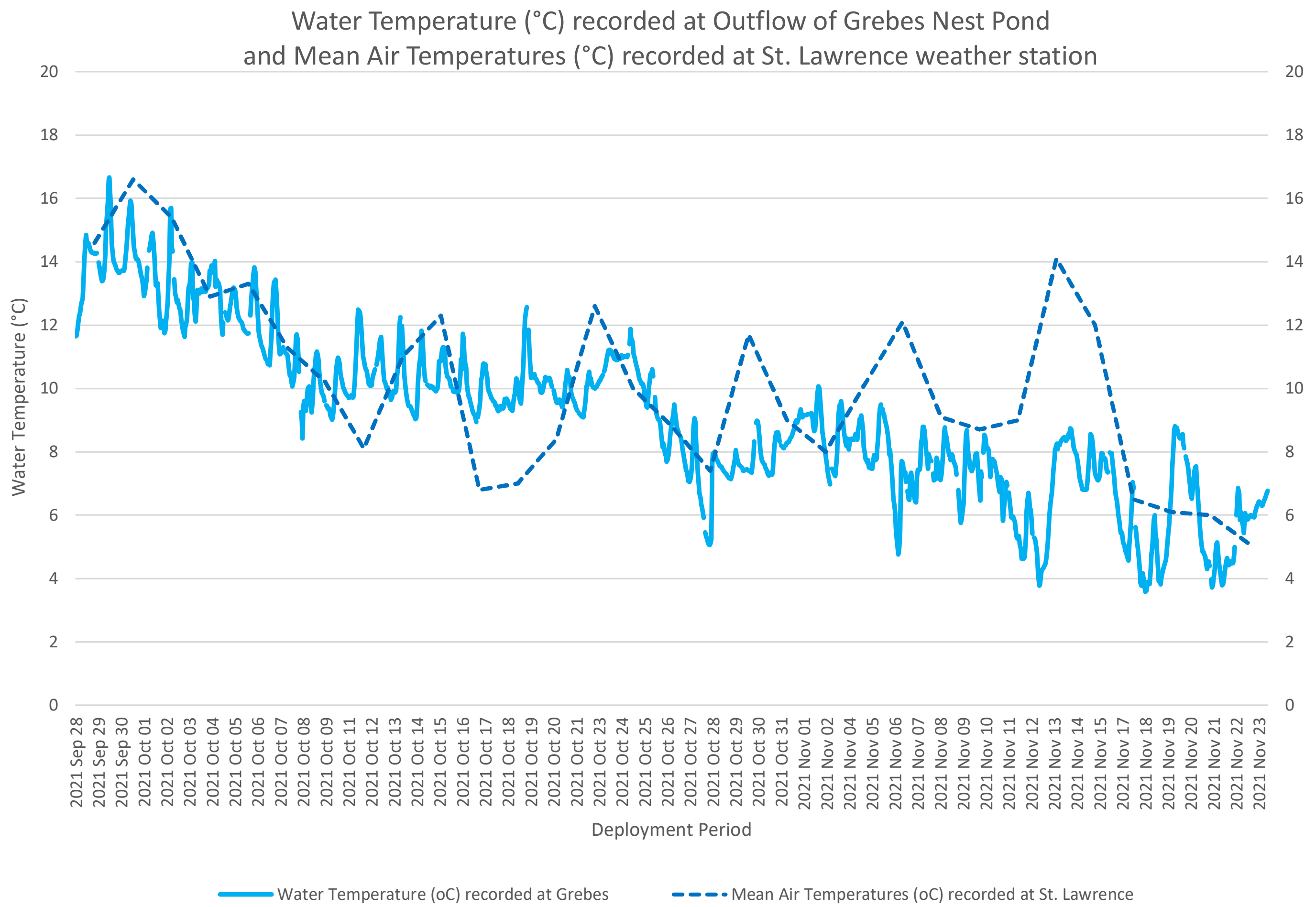

Figure 5: Water temperature (°C) and Mean Air Temperature (°C) at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 7.01 pH units and 7.97 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 in pH across deployment are likely influences by the intermittent stage level (Figure 6). On many days during this deployment, as stage decreases, the pH level also dips for a short period of time. pH levels are highest when stage is also high. This may indicate that a substance in the water during higher stage levels is keeping the pH levels high, and pH then drops when the addition of water into the system stops.

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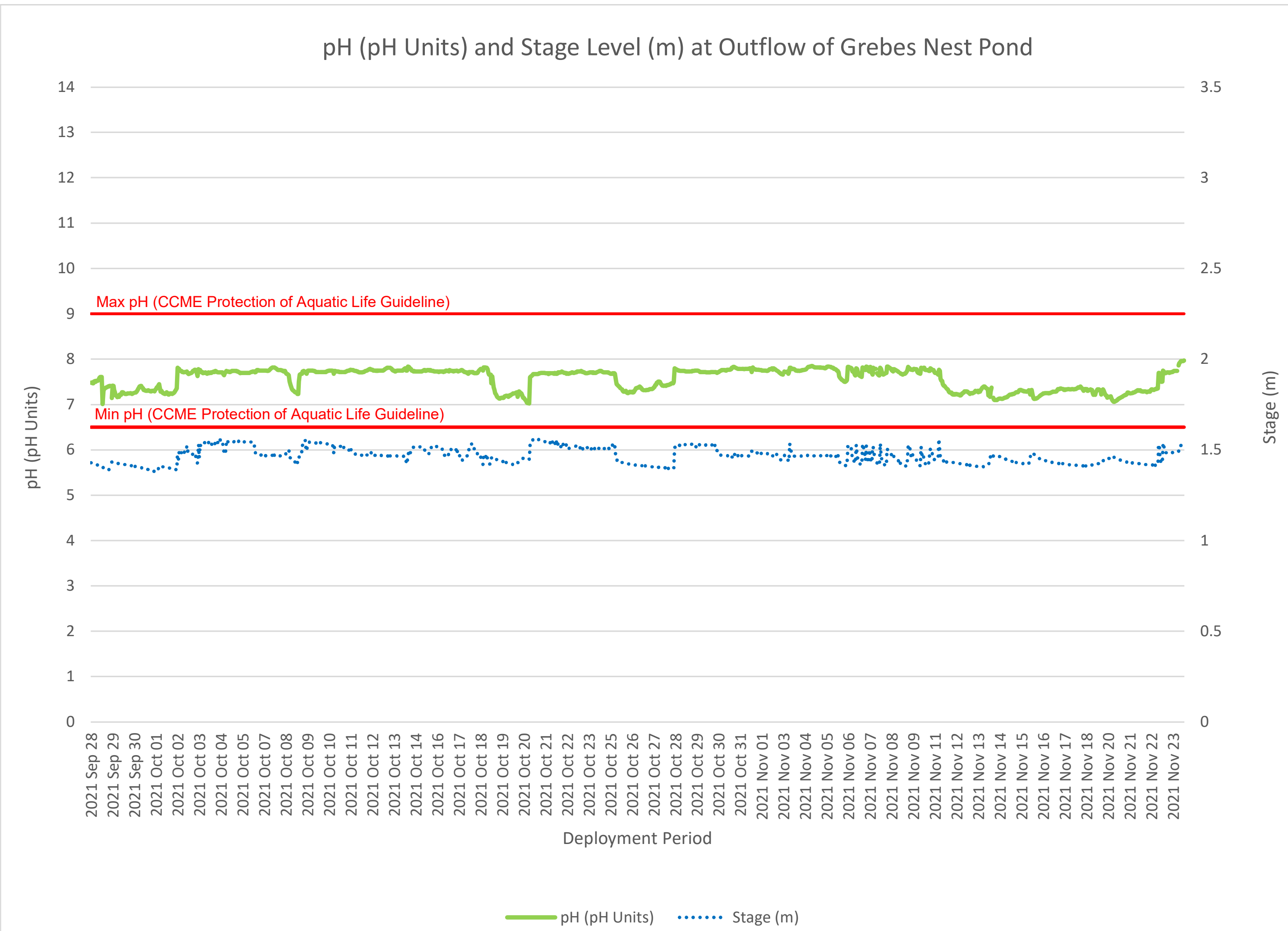

Figure 6: pH (pH units) values

Specific Conductivity

The conductivity levels were within 146.75 µS/cm and 442.1 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 normally accumulate in the brook, slowly contributing to higher conductivity (Figure 7). Conductivity was very unsettled this deployment period. There are many instances where conductance decreased when stage decreased, which is abnormal. This indicates the source of the stage increase had a higher conductivity than the background water from October 2nd onwards. This also explains some of the oddities in the pH data during this period.

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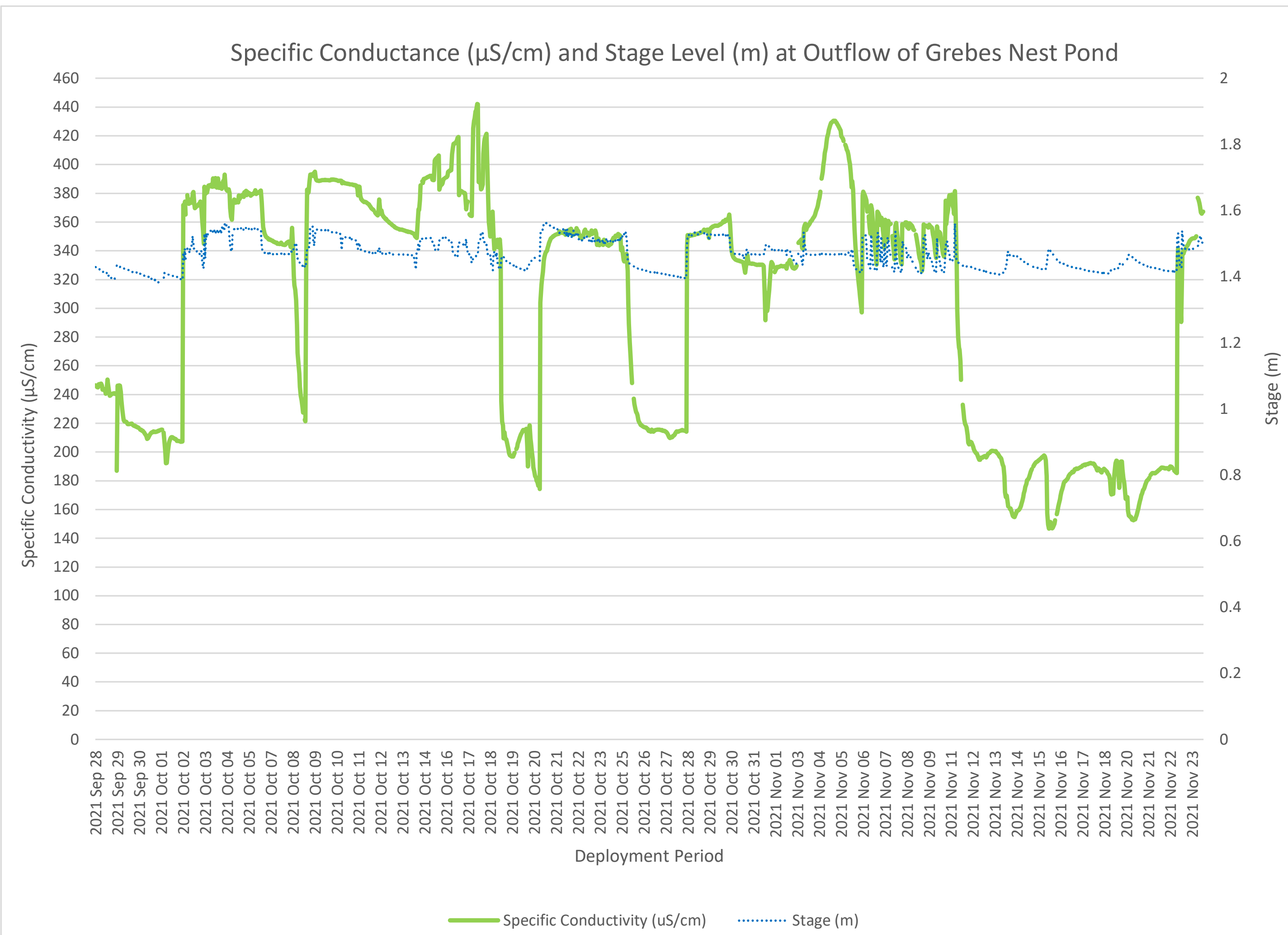

Figure 7: Specific conductivity (µS/cm) values

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 9.22 mg/L to a maximum of 13.14 mg/L. The percent saturation levels for dissolved oxygen ranged within 88.5% Saturation to 105.3% Saturation (Figure 8). Dissolved oxygen concentration increased toward the end of deployment, which would be expected as the water temperatures decrease with the changes into Winter.

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.

From abnormal fluctuations in Figure 8, we can see that dissolved oxygen values were also impacted by water entering the system after Oct 2 which was higher in pH and conductivity. Periods of anormal fluctuations in all parameters occur at the same time.

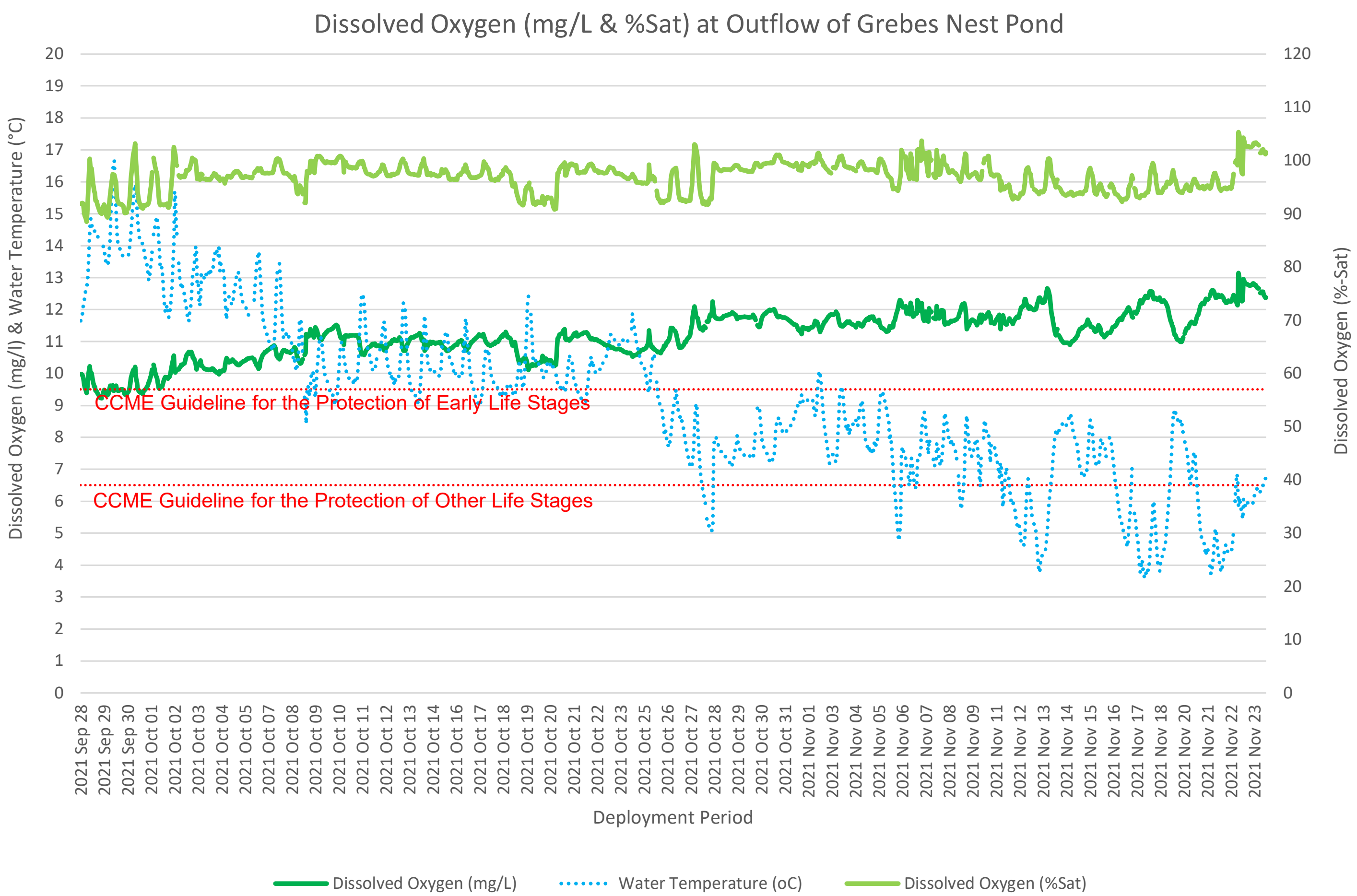

Figure 8: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within 0.8 NTU and 2871.6 NTU (Figure 9). The deployment data had a median of 9.5 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 decreases the water level concentrating sediment particles in the remaining water.

Compared to the other water quality parameters, turbidity was relatively stable during this deployment, with spike occurring during periods of high and low stage levels.

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.

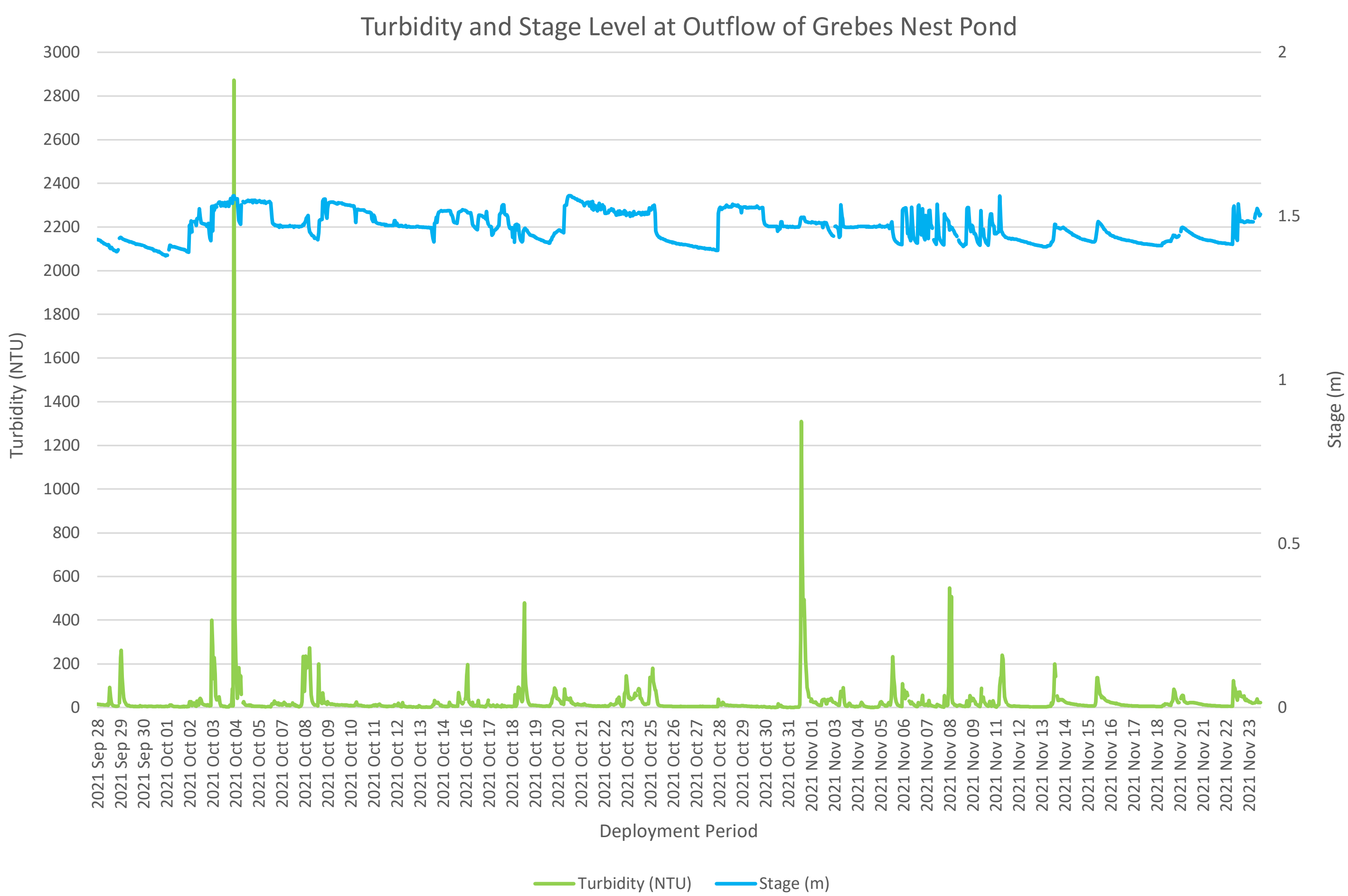

Figure 9: Turbidity (NTU) values.

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

Large peaks in stage during this deployment frequently correspond with the precipitation events, but not always. Increases on October 14th and 29th do not appear to be associated with precipitation, and thus must be associated with increased pumping activity. Daily Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. The highest total precipitation was recorded on November 19, 2021 at 27.8mm, corresponding with a stage increase.

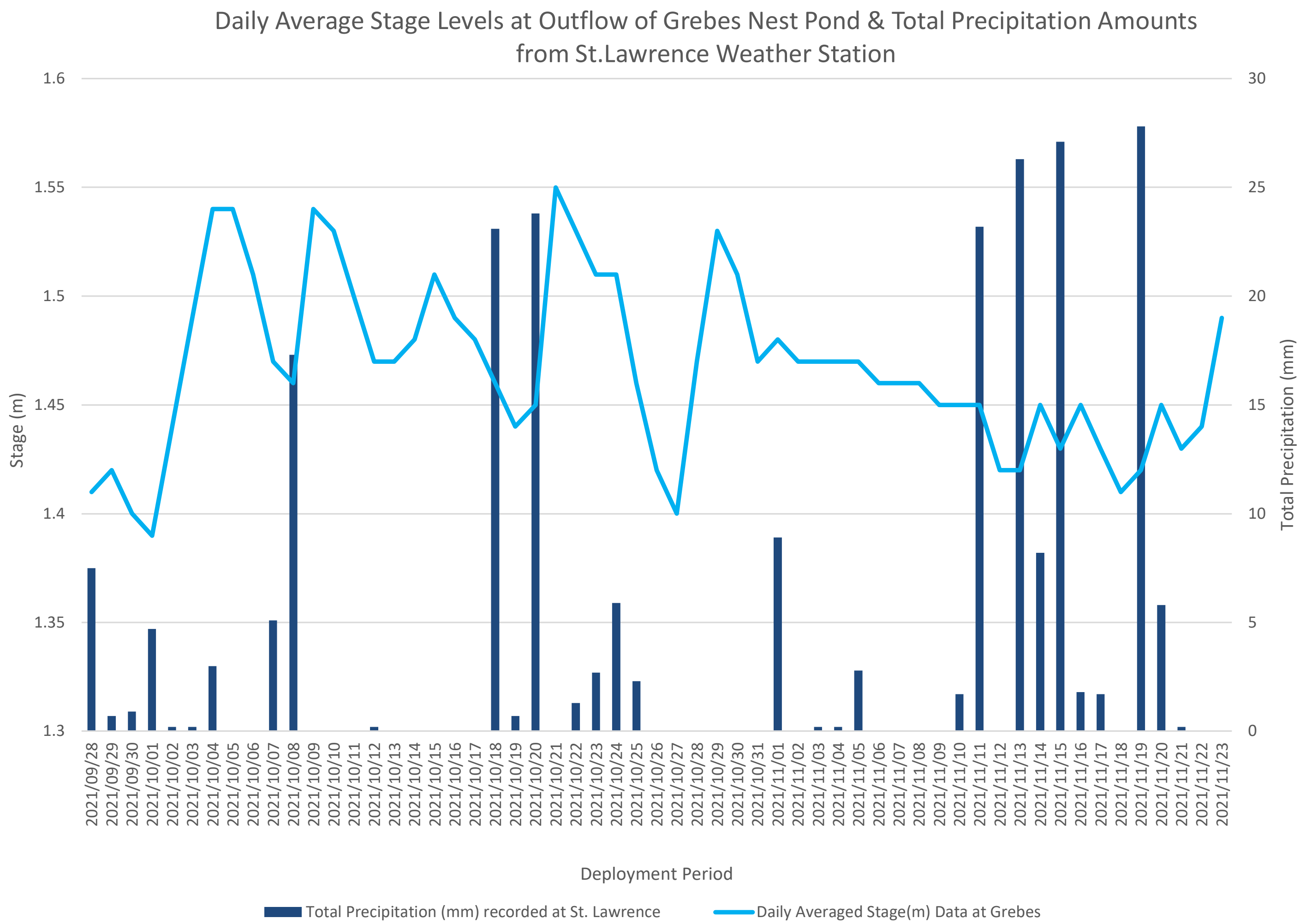

Figure 10: Daily averaged stage values and total precipitation.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranged from 1.91ºC to 19.25ºC during the deployment period (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 12). The water temperatures decrease gradually throughout the deployment, reflecting changes in the season from Fall into Winter.

Outside of the diurnal movement of the water temperature, the data does indicate small fluctuations corresponding to stage changes. As stage increases there is a slight decrease in the water temperature for a short period of time. These stage changes could be a result of precipitation.

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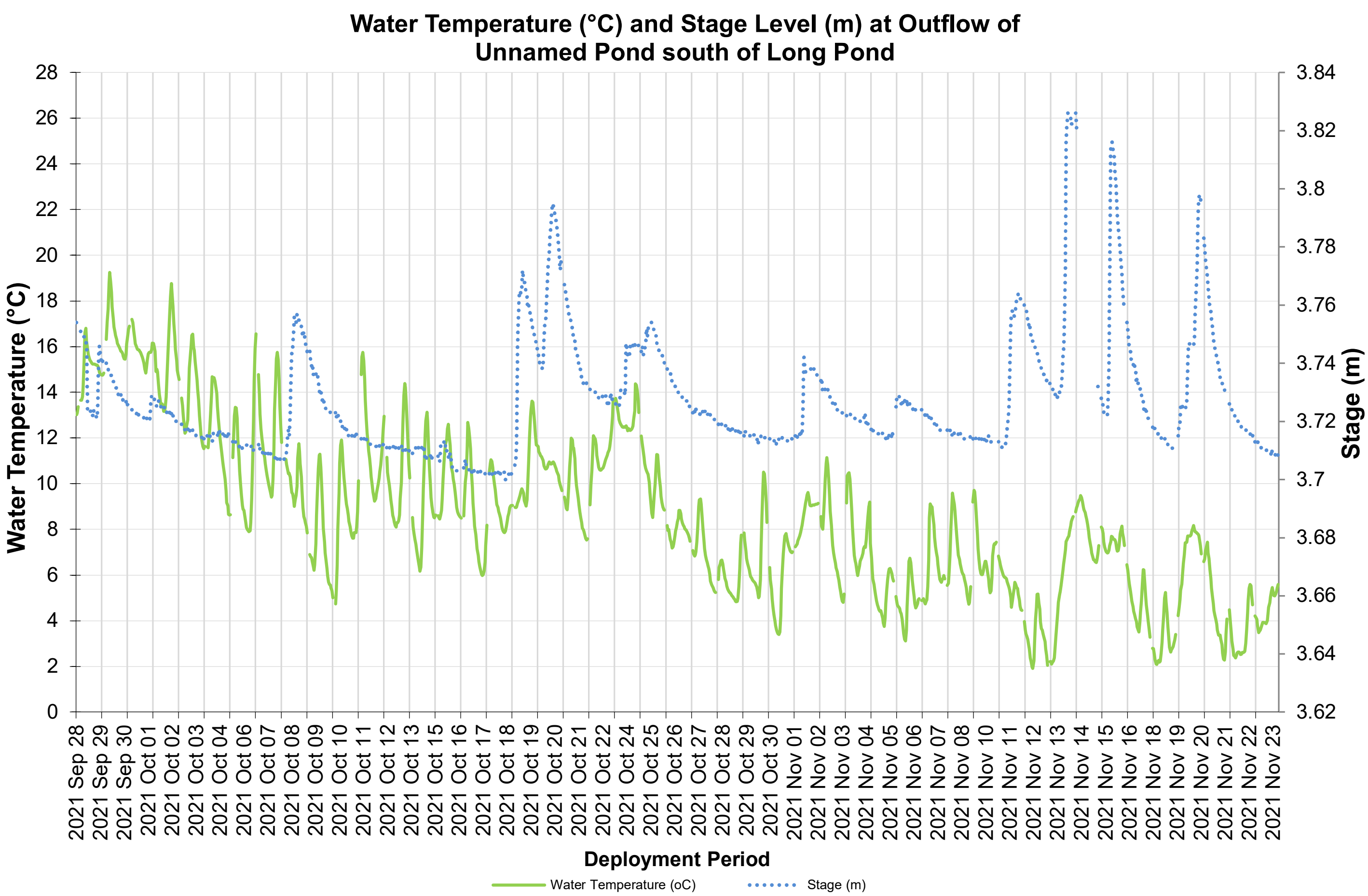

Figure 11: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

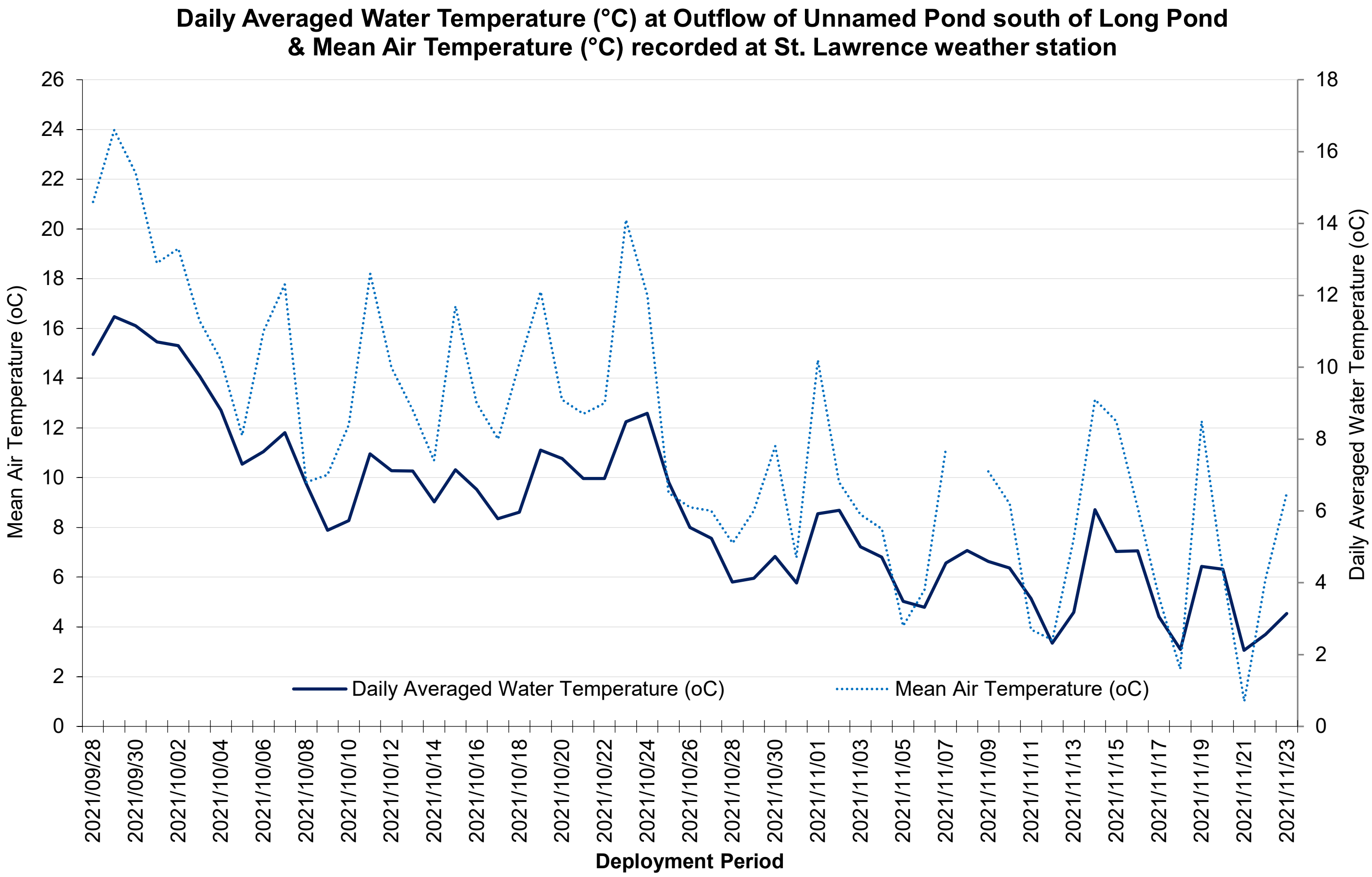

Figure 12: Mean Air Temperature (°C) recorded at St. Lawrence Weather Station

pH

Throughout this deployment period, pH values ranged within 6.84 pH units and 7.64 pH units (Figure 13), 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 13. 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 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.

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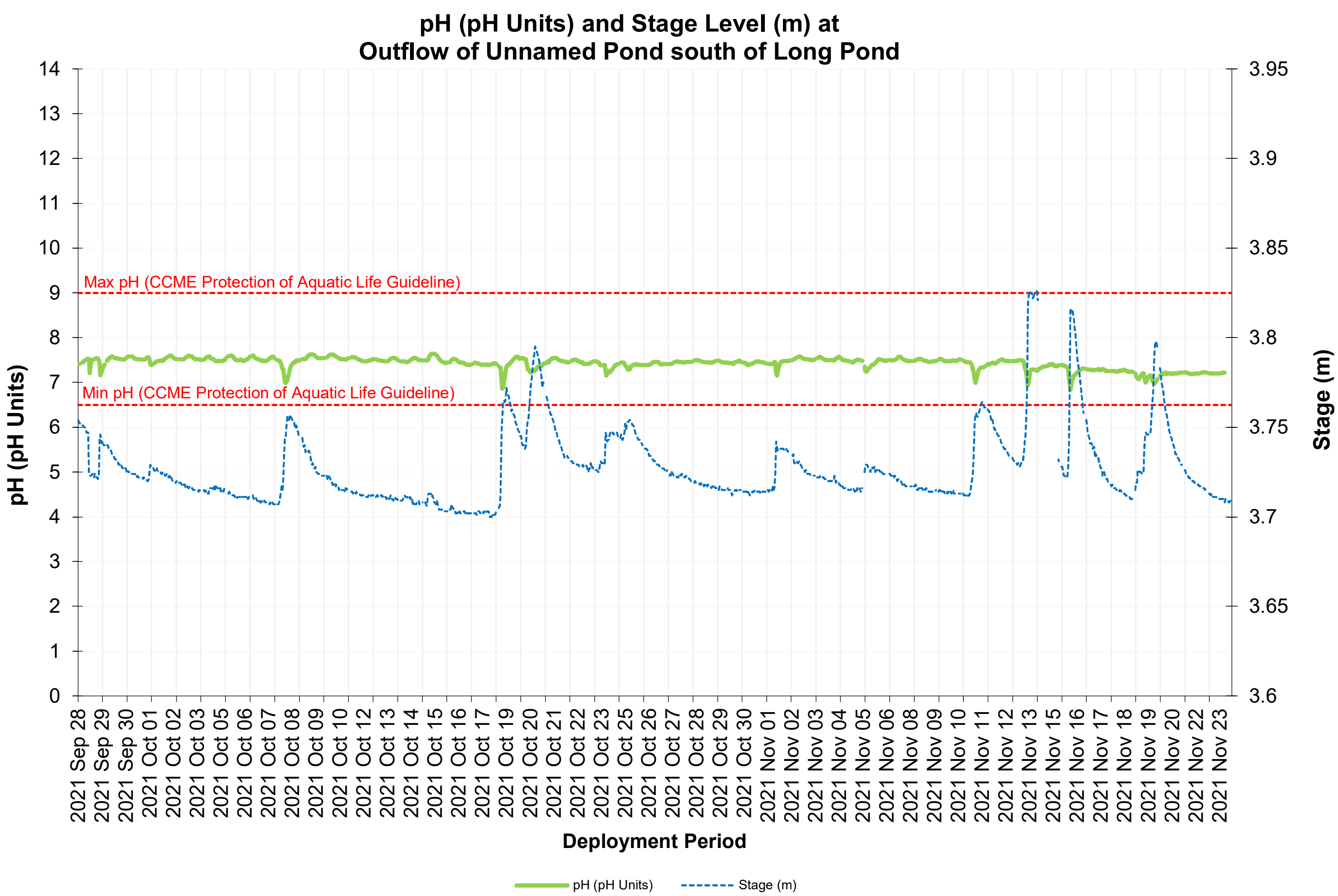

Figure 13: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 83.24 µS/cm and 169.41 µS/cm during deployment (Figure 14). The deployment period had a median of 145.12 µS/cm.

Changes in stage will influence the conductivity data (Figure 14). The extra volume of water during a stage increase will dilute the particulate matter present in a water column. This relationship between fluctuations in stage and conductivity can be noted on Figure 14.

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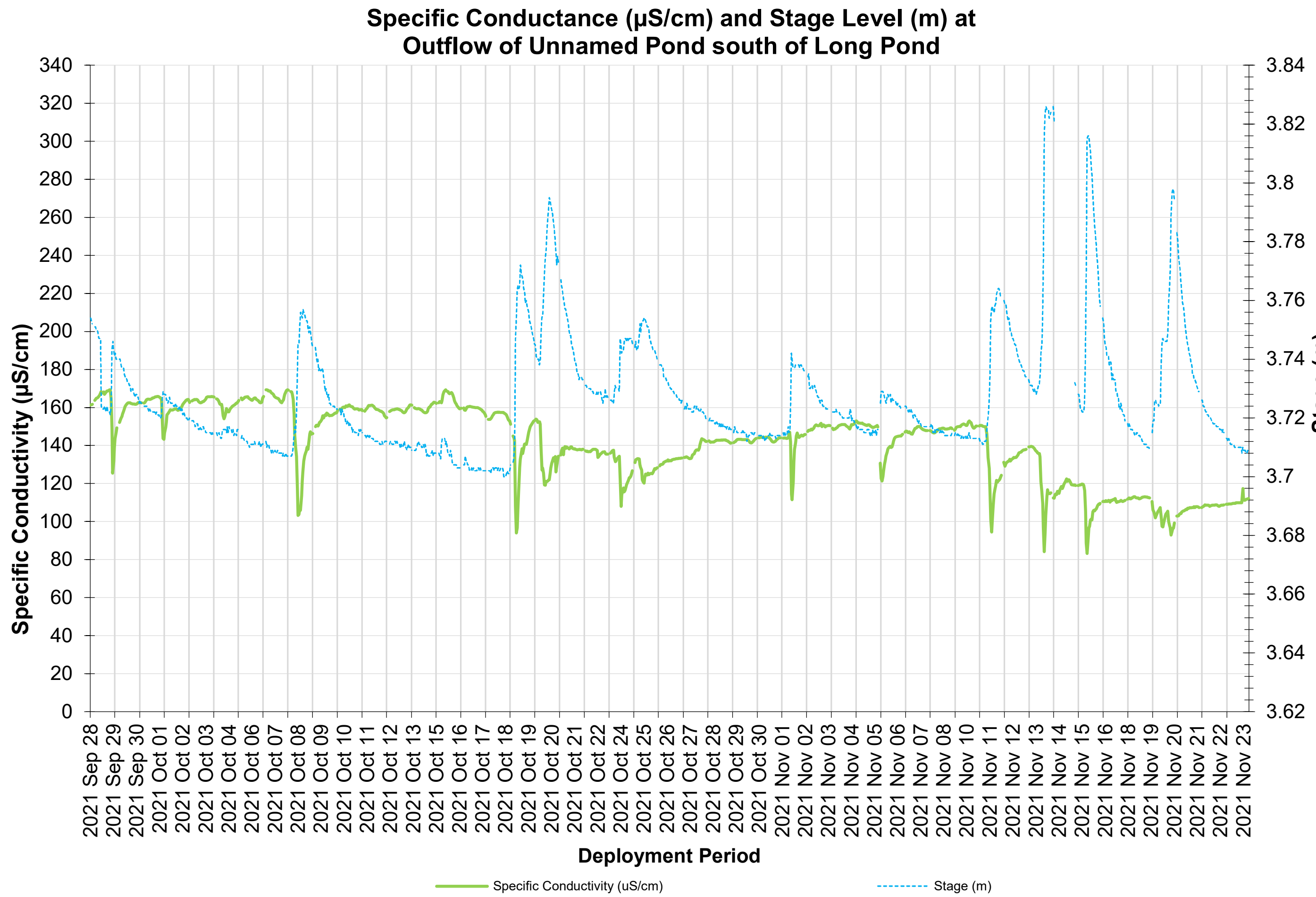

Figure 14: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

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 9.29 mg/L and 14.25 mg/L for concentration and 93.6 % and 104.6 % 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 15. All other prominent dips/peaks - outside of the diurnal pattern - are a result of fluxes in water temperature or influences from rainfall/runoff.

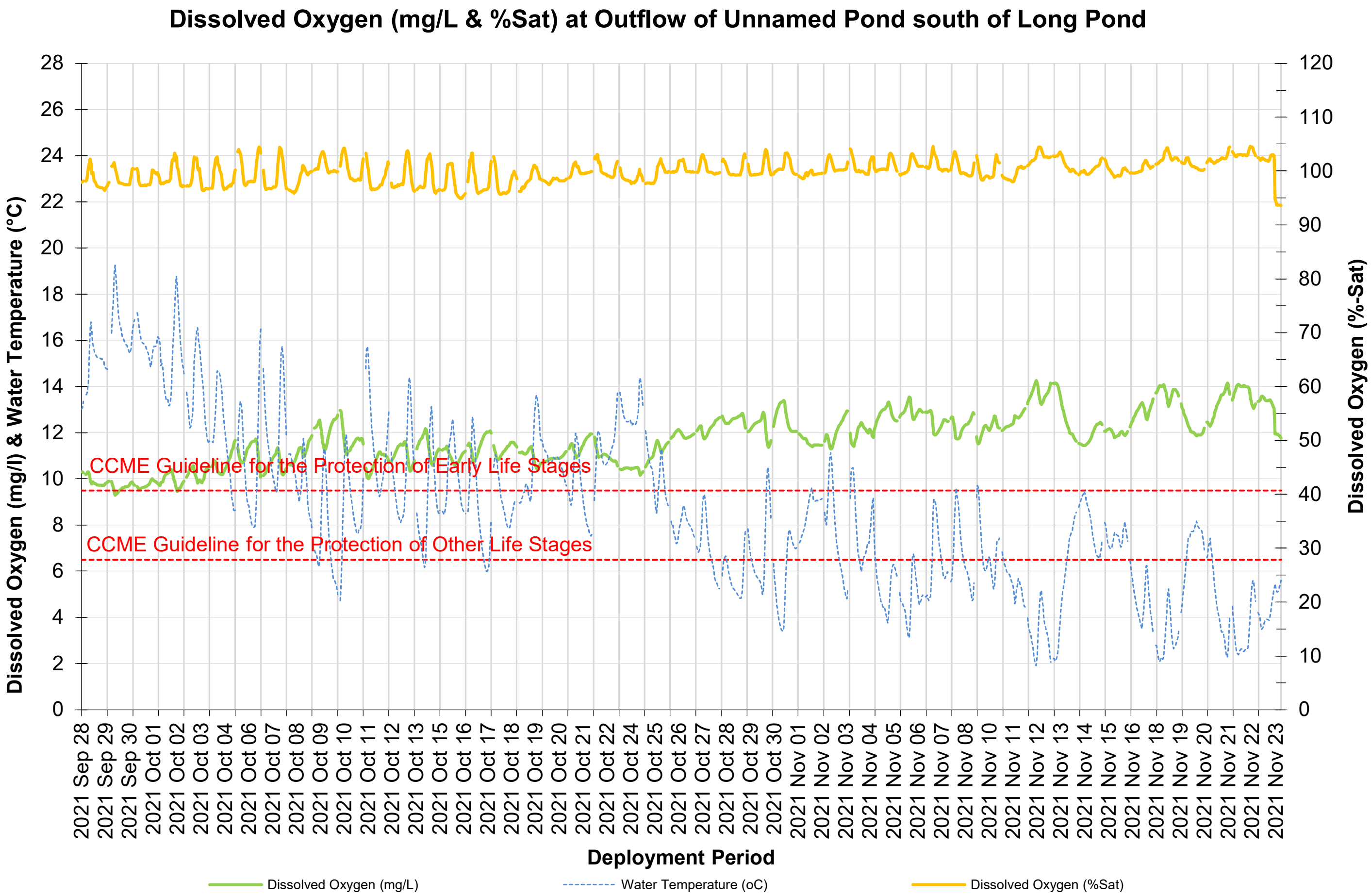

Figure 15: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 3.1 NTU and 58.9 NTU (Figure 16). The deployment data had a median of 15.9 NTU, indicating a slight increase in turbidity levels compared to previous deployment.

Turbidity remained below 60 NTU, throughout the deployment. On November 1st there was a spike to 58.9 NTU, which occurred during an increase in stage. Turbidity conditions continued to remain relatively low during this deployment which was likely a result of the work CFI have completed on reducing the runoff from the settling ponds upstream. However, the water is still constantly turbid.

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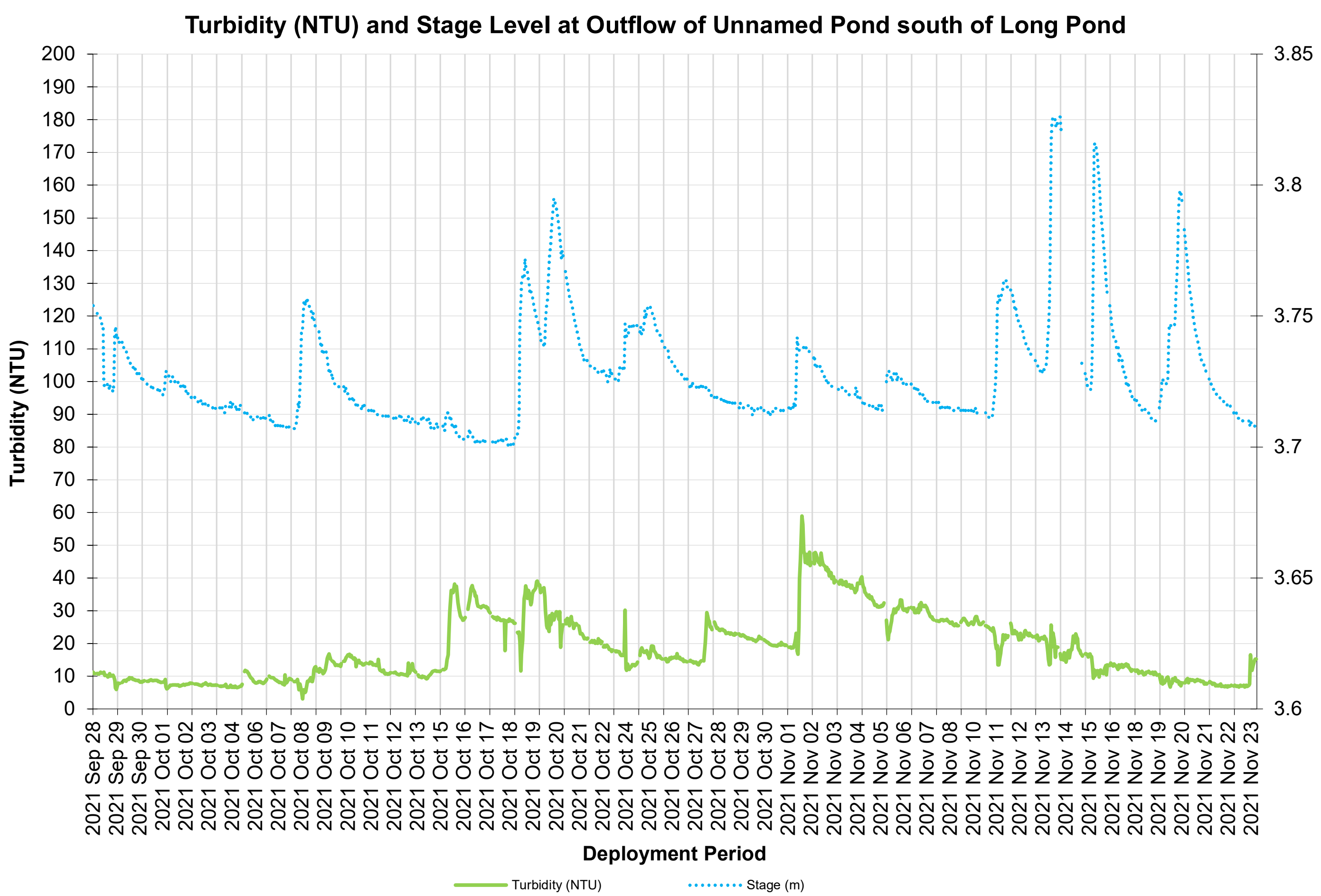

Figure 16: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

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Large peaks in stage correspond with the total precipitation events as noted on Figure 17. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. The highest total precipitation was recorded on November 19th 2021 at 27.8 mm, this event also corresponded with a stage increase.

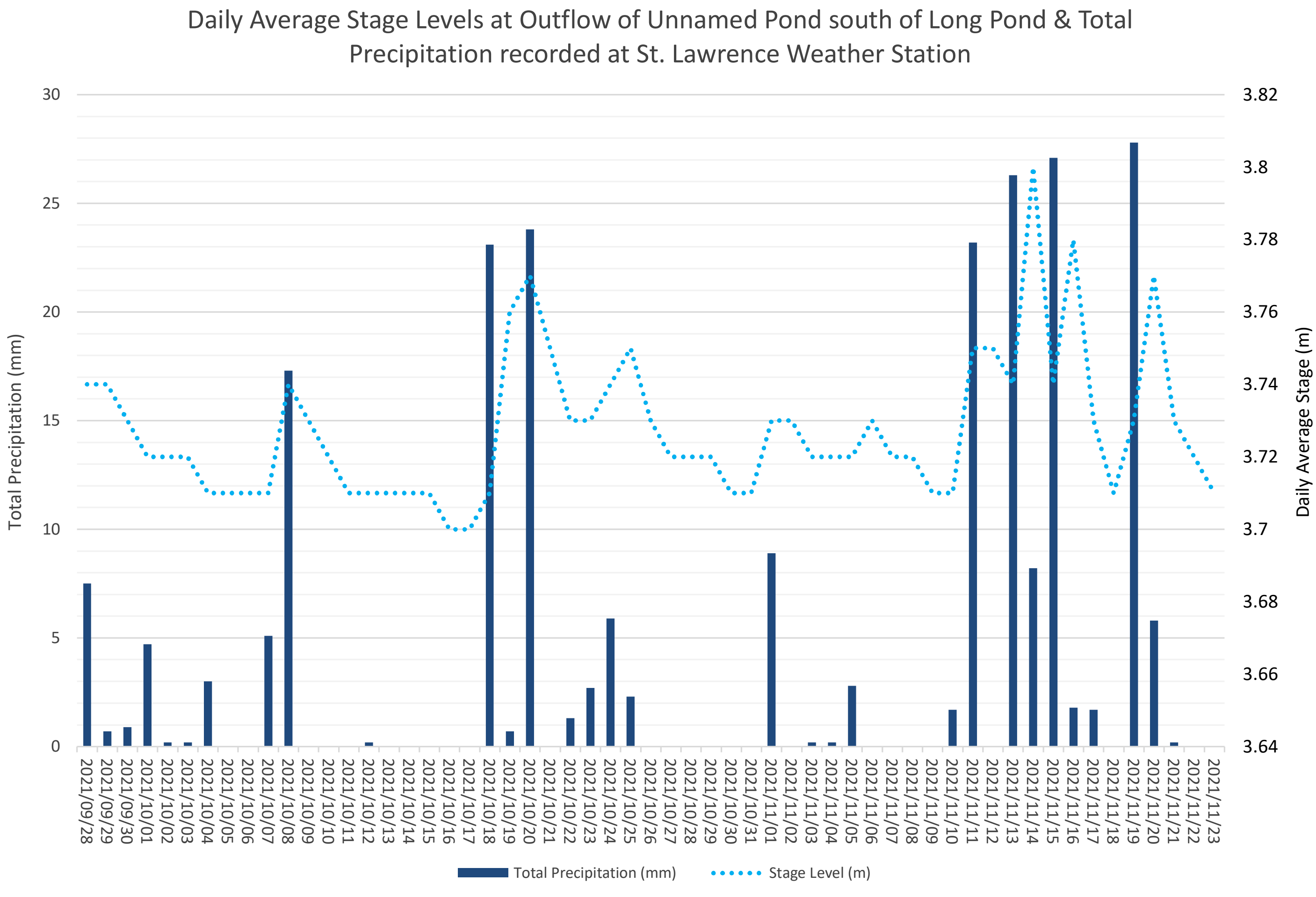

Figure 17: Daily averaged stage values and total precipitation.