Real-Time Water Quality Report

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

Deployment Period
May 13, 2020 to December 21, 2020

Newfoundland Labrador

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 at the Canada Fluorspar mine site near St. Lawrence, Newfoundland and Labrador.

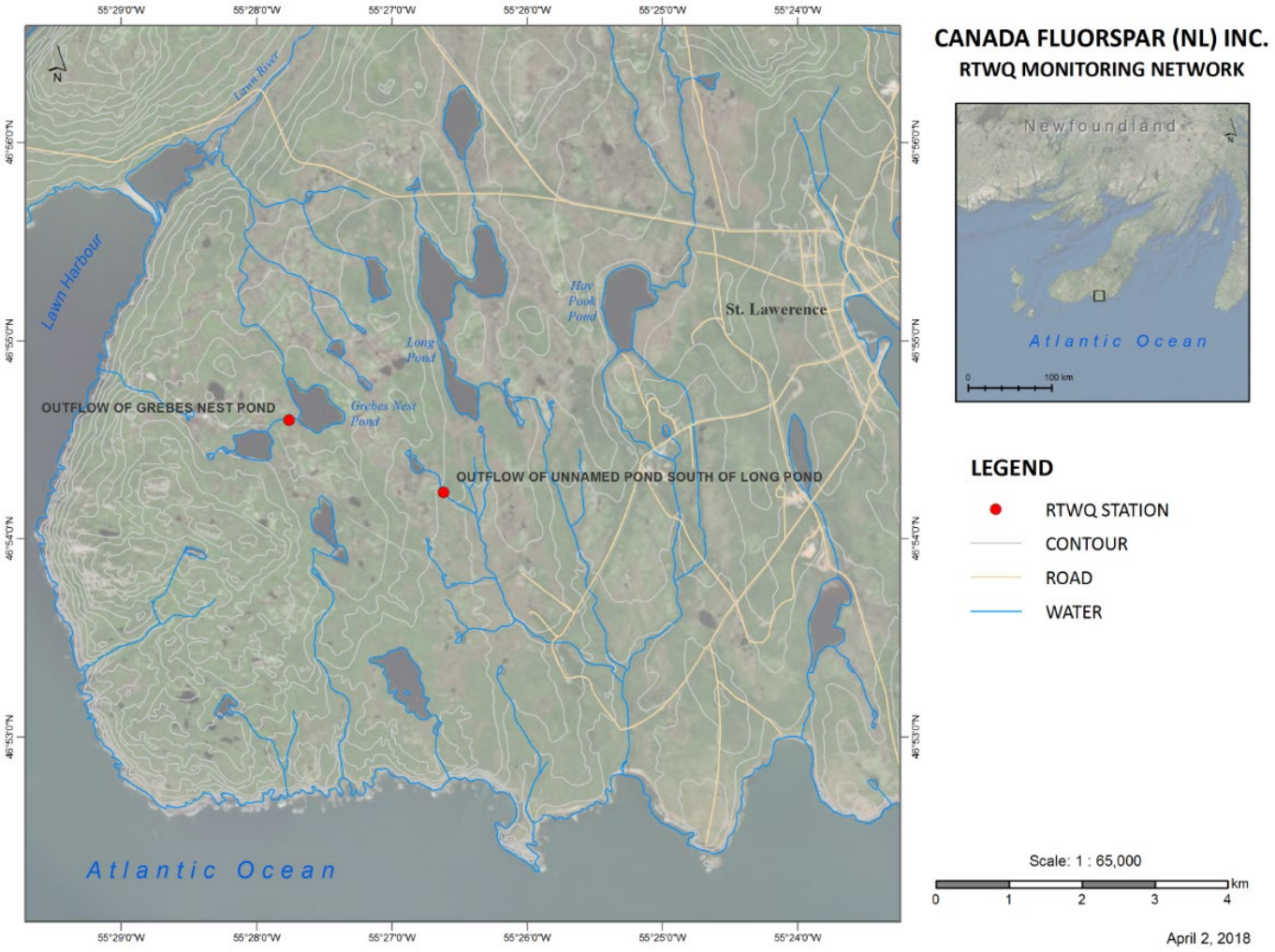


Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

Outflow of Grebes Nest Pond

The Outflow of Grebes Nest Pond station is established northwest of the pit dewatering effluent outfall 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 situated in (Figure 3). The pool depth is approximately 0.5 to 1.0 metres. The GPS coordinates for this site are **N46° 54' 35.9" W055° 27' 45.6"**.

The station hut was placed on the North bank approximately 5 metres from the stream (Figure 2). 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, and to allow the appropriate mitigation measures to be implemented in a timely manner, reducing any adverse effect on the downstream systems.

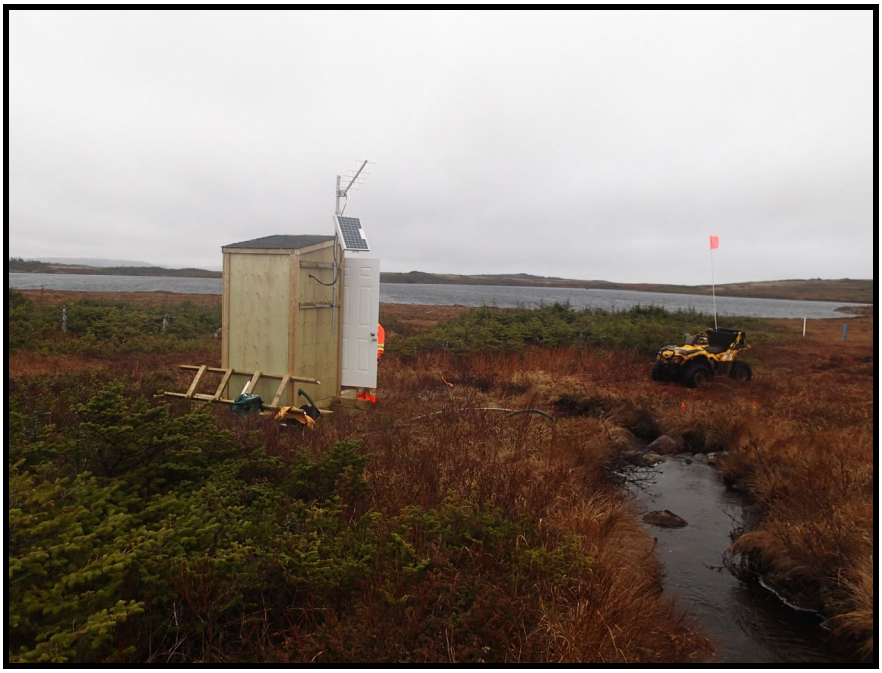


Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest Pond.

Figure 3: Instrument deployed at Outflow of Grebes Nest Pond Real-Time Station

Outflow of Unnamed Pond south of Long Pond

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, allowing the appropriate mitigation measures to be implemented in a timely manner, 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 5). The stream originates from a small unnamed pond and meanders through marshland adjacent to 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 west bank approximately 8 meters from the stream (Figure 4).

Figure 4: Real-Time Water Quality and Quantity Station at Outflow of Unnamed Pond south of Long Pond

Figure 5: Instrument deployed at Unnamed Pond south of Long Pond Real-Time Station.

Station Setup

Water quality parameters are measured at each station using a HOSKIN EXO 2 multiprobe instrument (Figure 6).

Figure 6: HOSKIN EXO 2 used for monitoring water quality parameters.

Six water parameters are measured at each station, including five water quality parameters (water temperature, dissolved oxygen, pH, turbidity and specific conductivity), and one water quantity parameter (stage). Additionally the water quality instrument has the capability to use parameters specific conductivity and water temperature, to calculate the total dissolved solids (TDS) present in the brook as well.

Water quality data is captured on an hourly basis (every 60 minutes) at both stations, while water quantity data is recorded at Outflow of Grebes Nest hourly and Outflow of Unnamed Pond every 15 minutes.

The data for both stations is viewable and downloadable online through WRMD's Real Time Water Quality Monitoring webpage located here: https://www.gov.nl.ca/eccm/waterres/rti/stations/

Data Interpretation

Performance and data records were interpreted for both stations for the following parameters:

• Water Temperature (°C)	• pH (pH units)	• Specific Conductivity(µS/cm)	• Total Dissolved Solids (g/L)
• Dissolved Oxygen (mg/L)	• Dissolved Oxygen (%Sat)	• Turbidity (NTU)	• Stage (m)

A description of each parameter is outlined in Appendix I

The following report discusses the water quality parameters recorded from May 13, 2020 to December 21, 2020. These interpretations aim to point out seasonal trends and any major issues influencing the parameters.

WSC staff play 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 transmission equipment are working properly. WSC is responsible for handling stage and streamflow issues. The raw water quantity data is transmitted via satellite and published online with the water quality data on the Real-Time Station's website. Water quantity data published online or used in the monthly station report has not been corrected or groomed. WSC is responsible for QA/QC of water quantity data. Corrected stage and streamflow data can be obtained upon request to WSC.

WRMD staff with the Department of 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 water quality monitoring equipment at Canada Fluorspar (NL) Inc, and is responsible for maintenance and calibration of the water quality instrument, as well as grooming, analyzing and reporting on the water quality data recorded at the station.

Quality Assurance and Quality Control

To ensure accurate data collection, water quality instruments are subjected to quality assurance procedures in order to mitigate any errors caused by biofouling and/or sensor drift. Quality assurance procedures include: (i) a thorough cleaning of the instrument, (ii) replacement of any small sensor parts that are damaged or unsuitable for reuse, and (iii) the calibration of the sensors using standard solutions. Deployment periods for 2020 are summarized in Table 1.

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, the water quality data is assigned a performance ranking (i.e. poor, marginal, fair, good, excellent) (Table 2). Appendix II details the rankings for each of the instrument sensors deployed at Canada Fluorspar Inc over the course of the year.

For more detailed analyses of a particular time period, date or deployment period, please refer to the individual deployment reports: https://www.gov.nl.ca/eccm/waterres/rti/rtwq/csdr/

Table 1: Water quality instrument deployment start and end dates for 2020 at Canada Fluorspar (NL) Inc

		Deployment	Removal
Canada Fluorspar Real Time Stations	Outflow of Grebes Nest Pond	May 13, 2020	July 2, 2020
	Outflow of Unnamed Pond south of Long Pond	May 13, 2020	July 2, 2020
	Outflow of Grebes Nest Pond	July 2, 2020	August 5, 2020
	Outflow of Unnamed Pond south of Long Pond	July 2, 2020	August 5, 2020
	Outflow of Grebes Nest Pond	August 5, 2020	December 21, 2020 (removed for winter)
	Outflow of Unnamed Pond south of Long Pond	August 5, 2020	December 21, 2020 (removed for winter)

Table 2: 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

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 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 only pumped when water levels reach a certain height in the open pit. Therefore, the lack of consistent flow can result in significant stage level fluctuation across a deployment and have an effect on water quality.

During the first deployment of 2020, Outflow of Unnamed Pond south of Long Pond Station had communication and then transmission issues. The data stopped transmitting from May 19th to June 1st, 2020. Therefore there is a gap in the data displayed on the water quality graphs for Outflow of Unnamed Pond south of Long Pond.

Throughout this report, daily averaged stage data was used for comparison against water quality parameters and corresponding precipitation data from ECCC's weather station in St. Lawrence. **Please note** that the stage data in this document is raw data. It has not been groomed or corrected. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to Water Survey of Canada. **Please note** that the total precipitation and air temperature data from Environment and Climate Change Canada does not warrant the quality, accuracy, or completeness of any information, data or product from these web pages. It is provided "AS IS" without warranty or condition of any nature.

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

Water Temperature

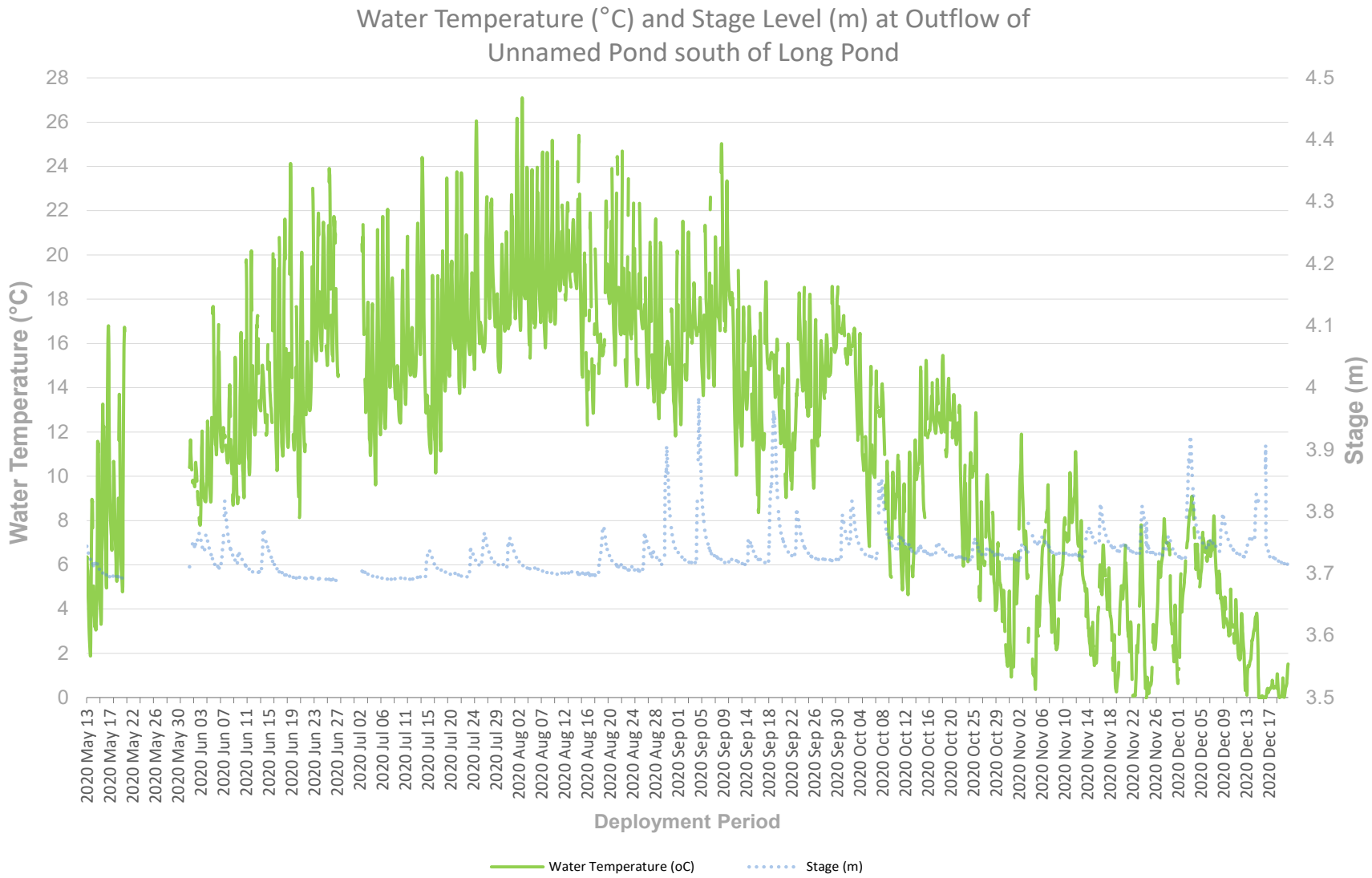
Outflow of Unnamed Pond south of Long Pond station the temperature ranged from -0.02 ^{o}C to 27.1 ^{o}C , while Outflow of Grebes Nest Pond water temperature ranged from 1.93^{o}C and 20.4^{o}C (Table 3).

Both sites displayed evident increases in water temperature as the seasons changed from spring into summer, and decreases in water temperature as summer cooled into fall and winter. Outflow of Unnamed Pond south of Long Pond's median of 12.75^{o}C was higher than that of Outflow to Grebes Nest Pond which was 10.33^{o}C (Table 3).

Water temperatures at both stations display large diurnal variations (Figure 7). This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures (Figure 8). Trends in water temperature corresponded very well with trends in air temperatures, with increases from June through August and decreases after that as fall sets in.

Table 3. Summary of the 2020 Water Temperature data at Fluorspar Real-Time Stations

	Water Temperature (oC)	
	Outflow of Grebes	Outflow of Unnamed
Min	1.93	-0.02
Max	20.4	27.1
Median	10.33	12.75


Water Temperature (°C) and Stage Level (m) at Outflow of Unnamed Pond south of Long Pond
Water Temperature (°C)
Stage (m)
Deployment Period
Water Temperature (oC)
Stage (m)

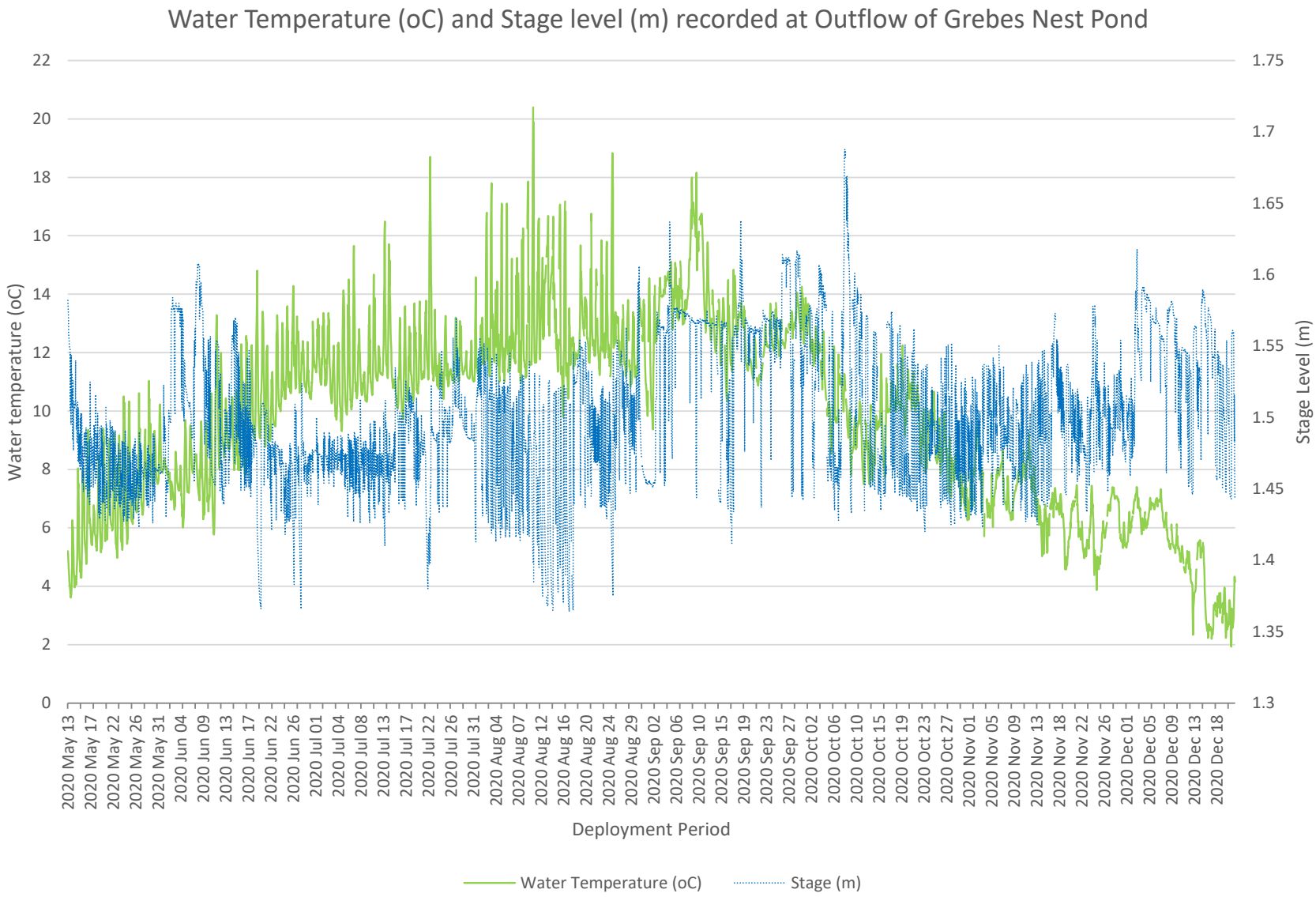


Figure 7. Water temperature recorded at the Real-Time Stations on CFI

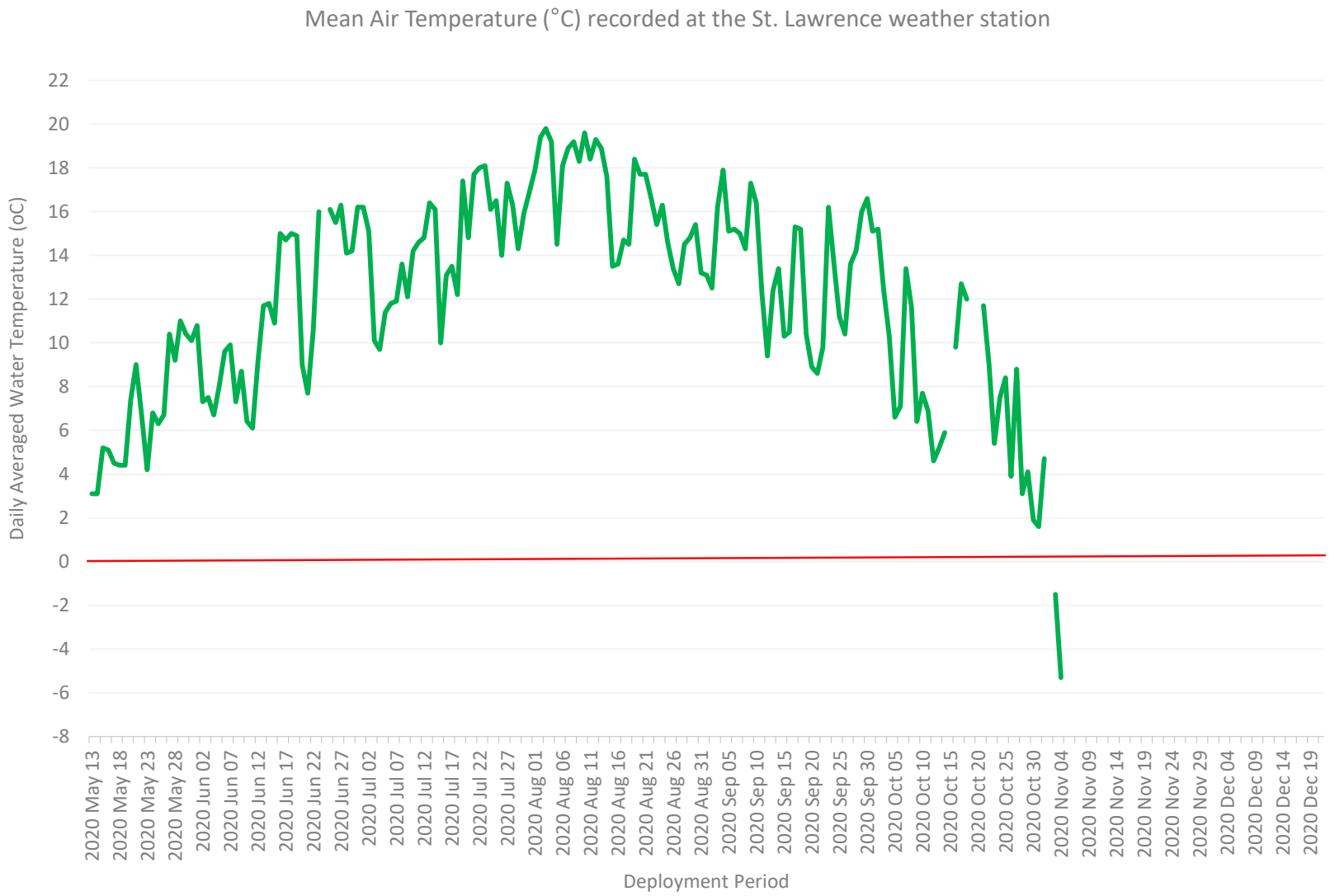


Figure 8: Mean Air temperature (°C) recorded at St. Lawrence Weather Station

pH

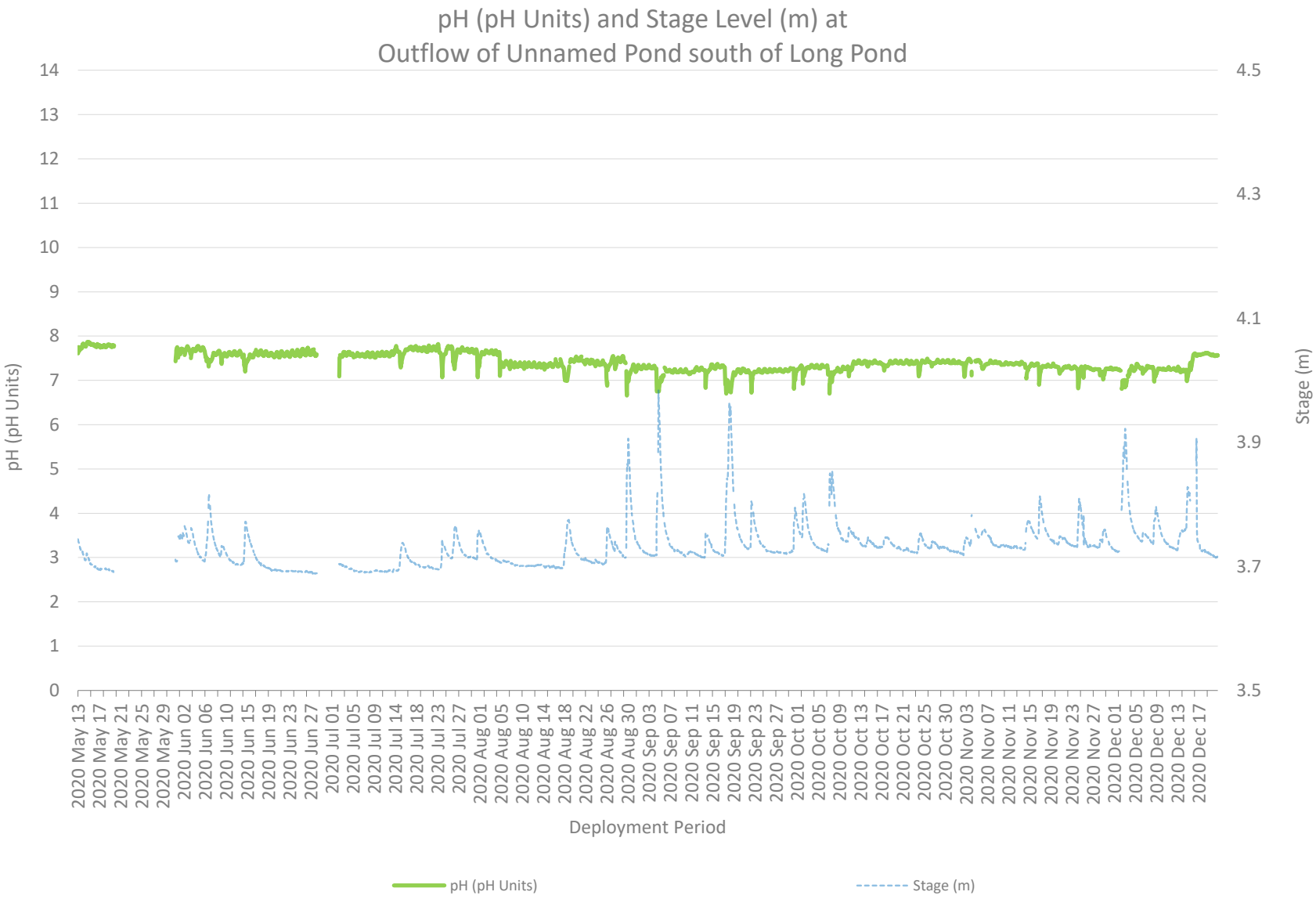
The Outflow of Grebes Nest Pond pH ranged from 7.06 to 8.21 (pH units) while Outflow of Unnamed Pond south of Long Pond station the pH ranged from 6.66 to 7.87 (Table 4).

The pH recorded at Outflow of Grebes Nest Pond remained within the Canadian Council of Ministers of the Environment (CCME) pH guidelines for the protection of aquatic life of 6.5 and 9 pH units. The Outflow of Grebes Nest pond median of 7.9 pH units was similar to the median recorded for the 2019 deployment of 7.6 pH units.

Outflow of Unnamed Pond south of Long Pond is located downstream from a storage area for the mine's tailings. Due to the station's location, there may be external factors affecting the pH. However, pH levels remained relatively consistent at this station throughout the year, remaining within the CCME pH guidelines. The short decreases in pH level at this station were likely a result of precipitation. The pH data returned to background levels after each event as demonstrated on August 30th and September 7th 2020 (Figure 9). The annual median at Unnamed Pond of 7.38 pH units was slightly lower than the median recorded during 2019 of 8.01 pH units (Appendix III). Issues with seepage from the polishing pond could be influencing the pH levels within this brook.

Table 4. Summary of 2020 pH data at Fluorspar Real-Tim+e Stations

	pH(pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.06	6.66
Max	8.21	7.87
Median	7.9	7.38


pH (pH Units) and Stage Level (m) at
Outflow of Unnamed Pond south of Long Pond
pH (pH Units)
Stage (m)
Deployment Period
pH (pH Units)
Stage (m)

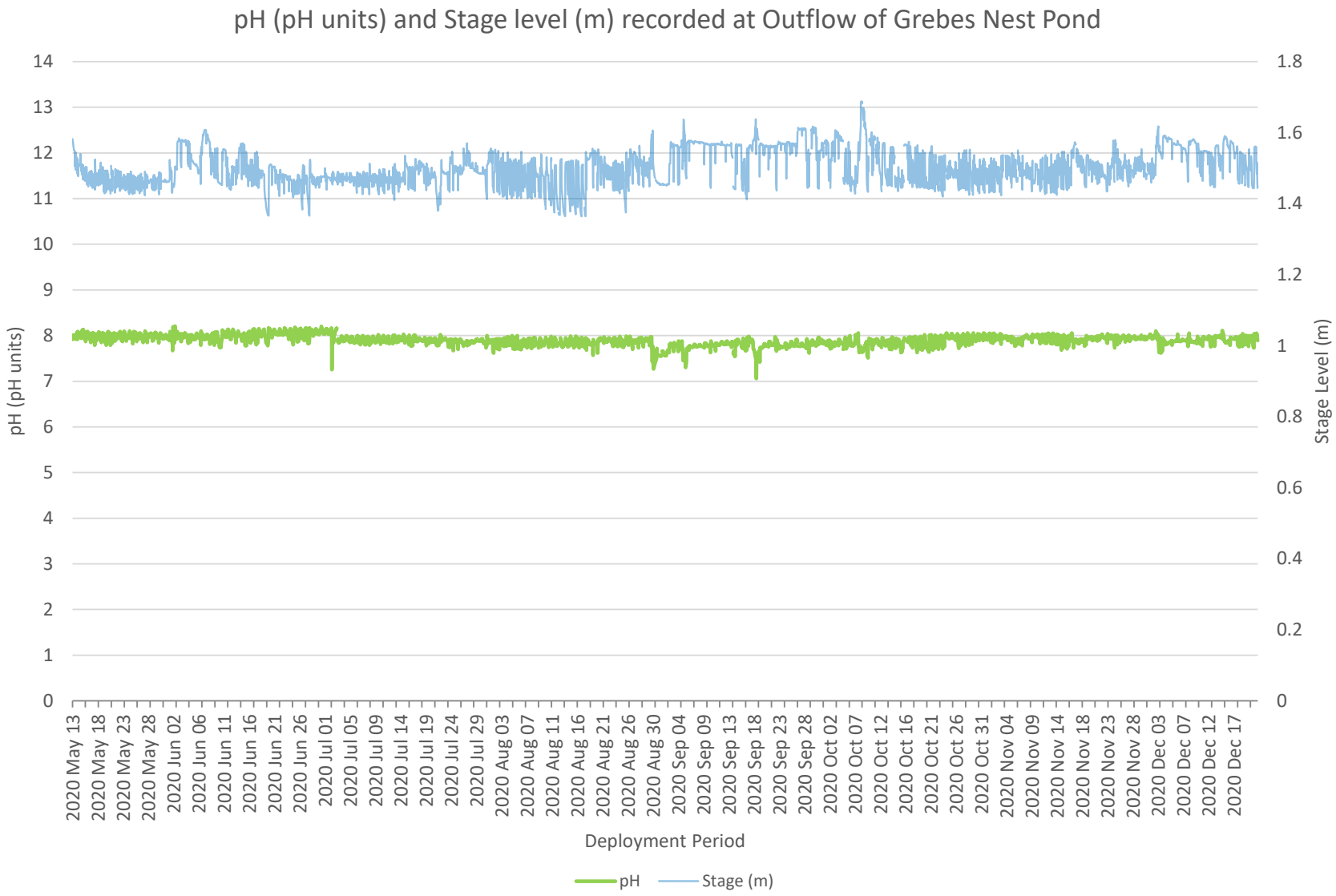


Figure 9: pH (pH units) at the Canada Fluorspar (NL) Inc Real-Time Stations

Specific Conductivity

There is a direct relationship between conductivity and stage. During rainfall events, the water column will become diluted by the added water, lowering the conductivity levels. Then if sediment or materials from the surrounding environment are flushed into the brook, conductivity levels will increase for a short period of time until they are flushed from the system.

Conductivity levels over the deployment year ranged from 86.16 µS/cm to 456 µS/cm at Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond ranged from 66.04 µS/cm to 221.76 µS/cm.

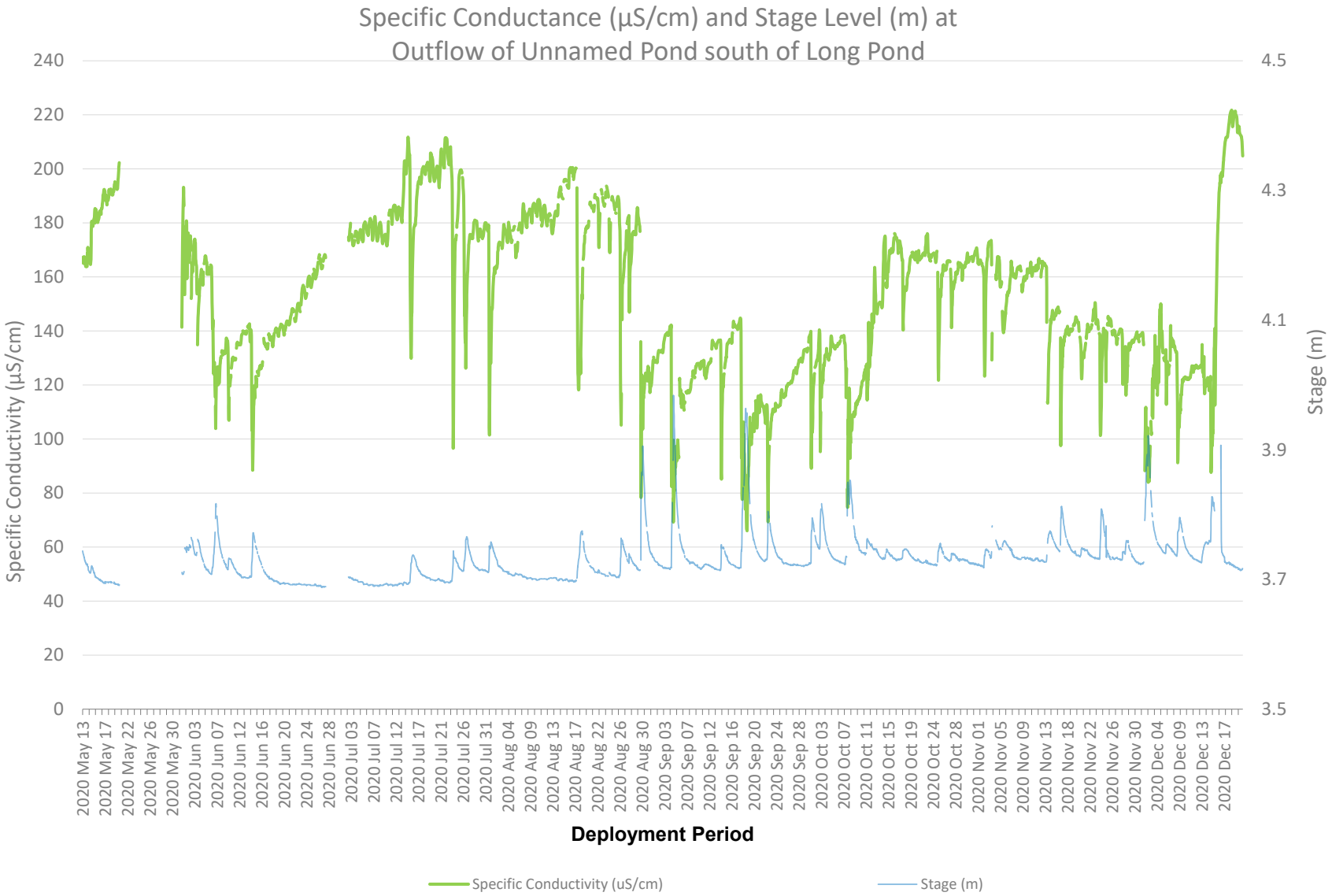
Specific conductivity data recorded at Outflow of Grebes Nest Pond was lower than data recorded in 2019. The median for 2019 was 344.145 µS/cm compared to the 2020 median of 318.74 µS/cm. This was likely a result of improvements with the water supply and pumping schedule on site. There were occasions the brook was not supplemented and this likely resulted in a greater concentration of particle matter. Conductivity remains consistent over the summer period. Decreases in conductivity during August and September were likely a result of rainfall events. Rainfall events flush particles and reduce the conductivity in a brook for a short period of time (Figure 10).

Conductivity levels at Outflow of Unnamed Pond south of Long Pond values generally displayed conductivity increases at the onset of precipitation, before decreasing quickly and then increasing again (Figure 10). During the summer months, the conductivity at Outflow of Unnamed Pond south of Long Pond remained within the higher range of data. Conductivity levels started to decrease in September, but showed persistent variability between November and December. The highest conductivity levels were recorded at the end of the deployment in December, corresponding with a stage increase. However, due to lack of climate data for that timeframe, it is uncertain if rainfall was a factor in these increases (Figure 10).

Specific Conductivity levels at Outflow of Unnamed Pond south of Long Pond generally decreased in 2020 when compared to 2019 data. The 2019 median was 357.94 µS/cm and the 2020 median was recorded at 154.97 µS/cm. The conductivity data collected at Outflow of Unnamed Pond south of Long Pond indicates an improvement in the quantity of dissolved material entering the brook (Figure 10).

Table 5. Summary of 2020 specific conductivity data at Fluorspar Real-Time Stations

	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	86.16	66.04
Max	456	221.76
Median	318.74	154.97


Specific Conductance (µS/cm) and Stage Level (m) at Outflow of Unnamed Pond south of Long Pond
Specific Conductivity (µS/cm)
Stage (m)
Deployment Period
Specific Conductivity (uS/cm)
Stage (m)

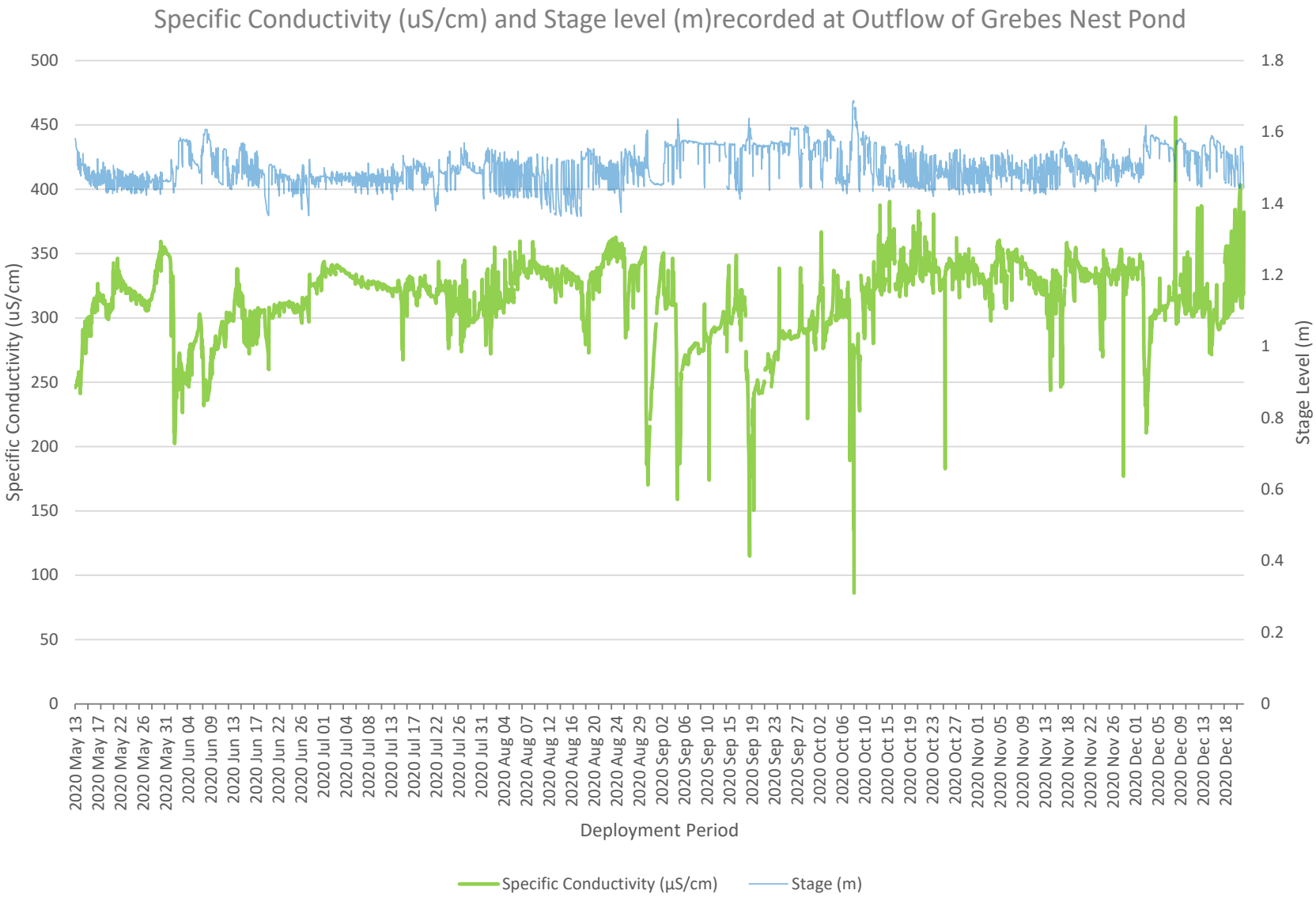


Figure 10: Specific conductivity (µS/cm) at the Canada Fluorspar (NL) Inc Real-Time Stations

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. Both parameters are important and helpful in analyzing the conditions in an ambient water body.

Over the deployment period, the dissolved oxygen concentration ranged from 9.18 mg/L to 13.89 at Outflow of Grebes Nest Pond. The percent saturation levels for dissolved oxygen ranged 86.1% Saturation to 116.7% Saturation. The 2020 median of 10.96mg/L dissolved oxygen for Outflow of Grebes Nest Pond was slightly higher than the median 10.41 mg/L recorded in 2019 (Appendix III).

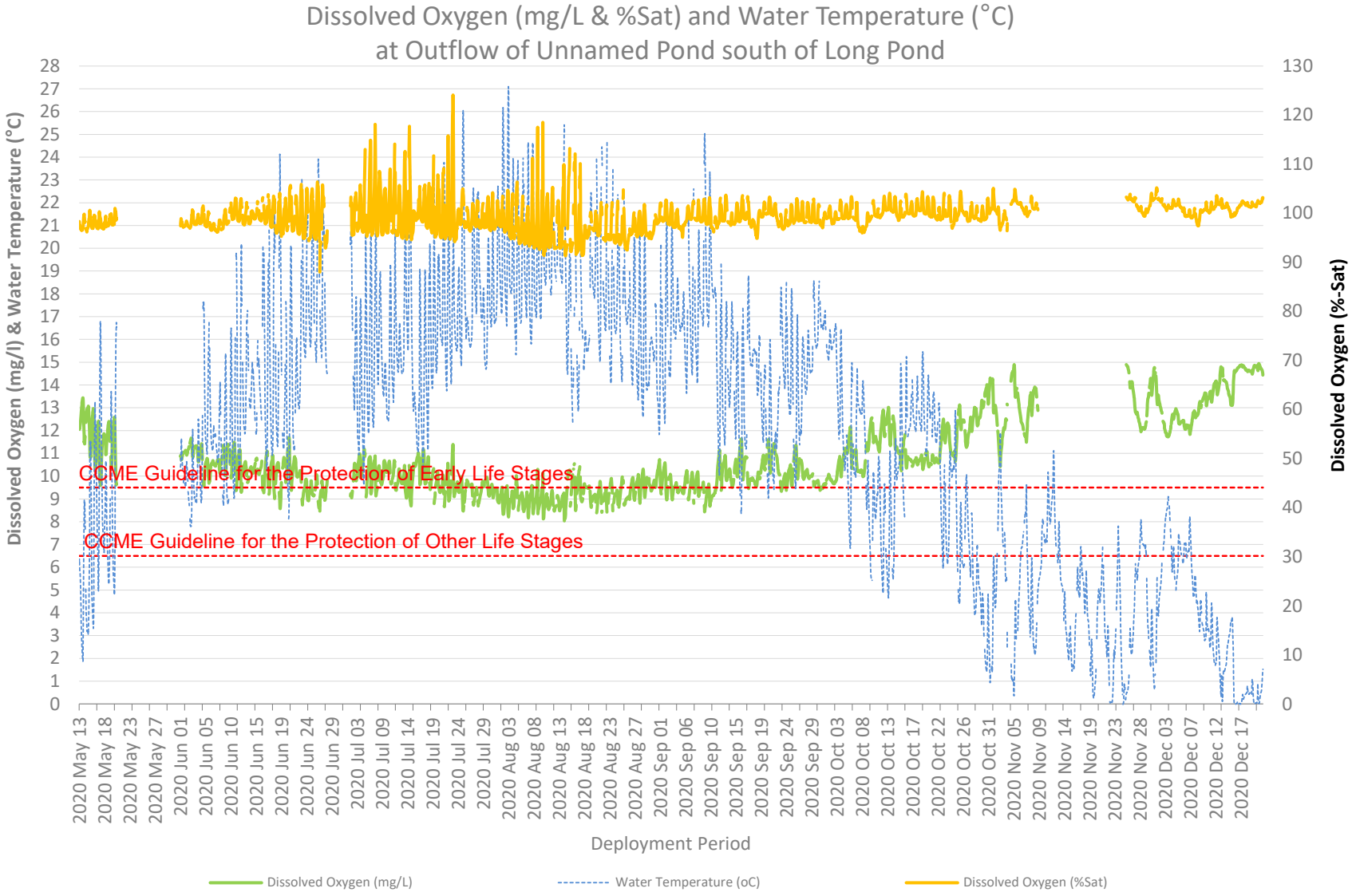
Outflow of Unnamed Pond south of Long Pond dissolved oxygen concentration ranged from 8.04 mg/L to 14.94 mg/L and Saturation ranged from 88 % to 124.1 %. The recorded median dissolved oxygen value for 2020 was 10.38 mg/L, while the median for 2019 was 10.81 mg/L (Appendix III).

Dissolved oxygen levels show diurnal variations for both stations. These diurnal variations are related to daily fluctuations in temperature and photosynthetic cycling of CO^2 by aquatic organisms. Trends in DO corresponded with the inverse of water temperature as colder water has a greater potential to dissolve oxygen compared to warmer water. As a result, DO is generally higher in the spring, fall and winter when water temperatures are cooler.

Dissolved Oxygen for both stations remained above the CCME Guideline for the Protection of Other Life Stages of Aquatic Life (6.5 mg/L) throughout the year and close to or above the guideline for the Protection of Early Life Stages (9.5 mg/L) for the majority of the year (Figure 11).

Table 6. Summary of 2020 Dissolved oxygen data at Fluorspar Real-Time Stations

	Grebes Dissolved Oxygen		Unnamed Pond Dissolved Oxygen	
	mg/L	%Sat	mg/L	%Sat
Min	9.18	86.1	8.04	88
Max	13.89	116.7	14.94	124.1
Median	10.96	97.9	10.38	99.3


Dissolved Oxygen (mg/L & %Sat) and Water Temperature (°C)
at Outflow of Unnamed Pond south of Long Pond
Dissolved Oxygen (mg/l) & Water Temperature (°C)
Dissolved Oxygen (%-Sat)
CCME Guideline for the Protection of Early Life Stages
CCME Guideline for the Protection of Other Life Stages
Deployment Period
Dissolved Oxygen (mg/L)
Water Temperature (oC)
Dissolved Oxygen (%Sat)

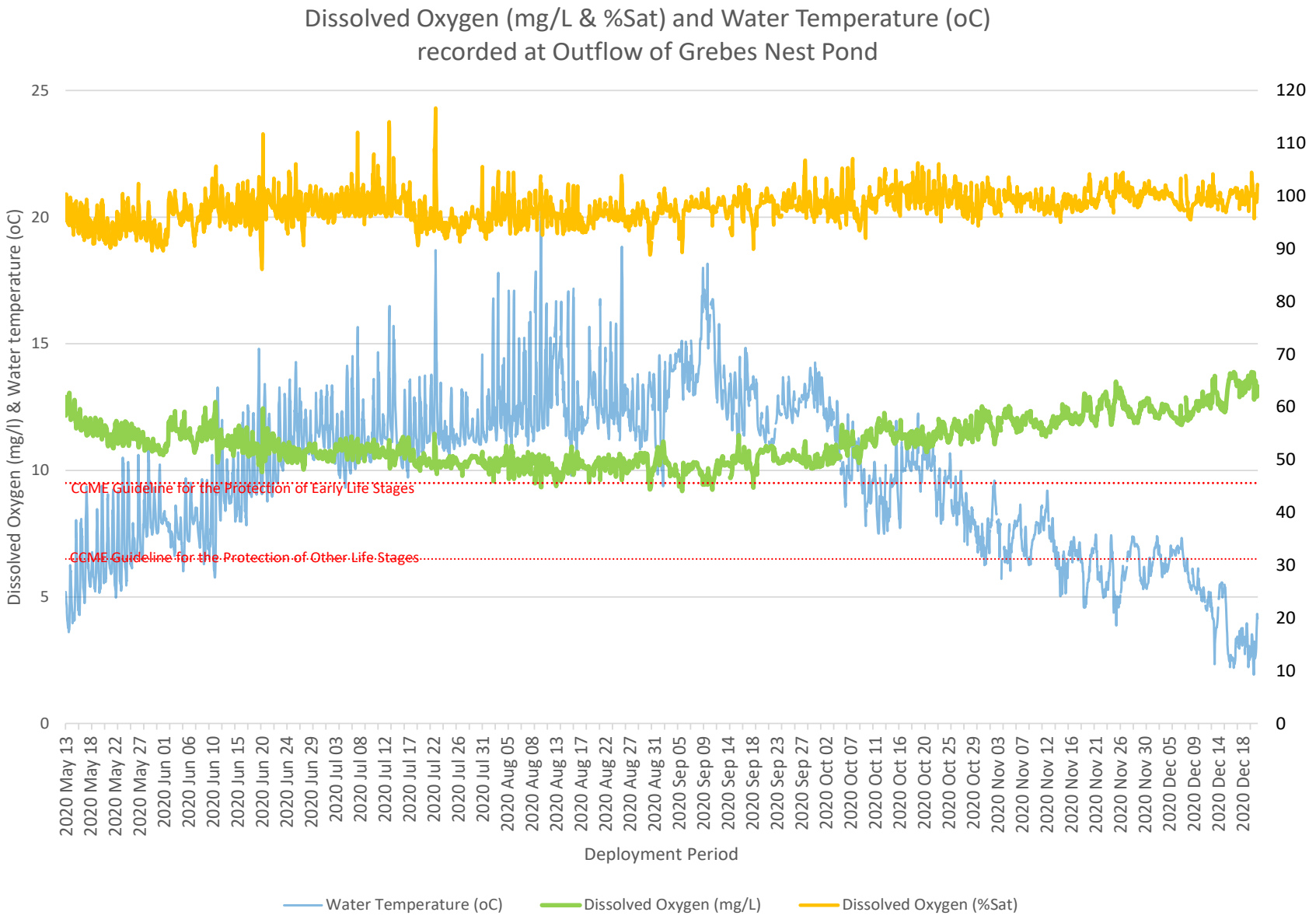


Figure 11: Dissolved Oxygen (mg/L & Percent Saturation) values

Turbidity

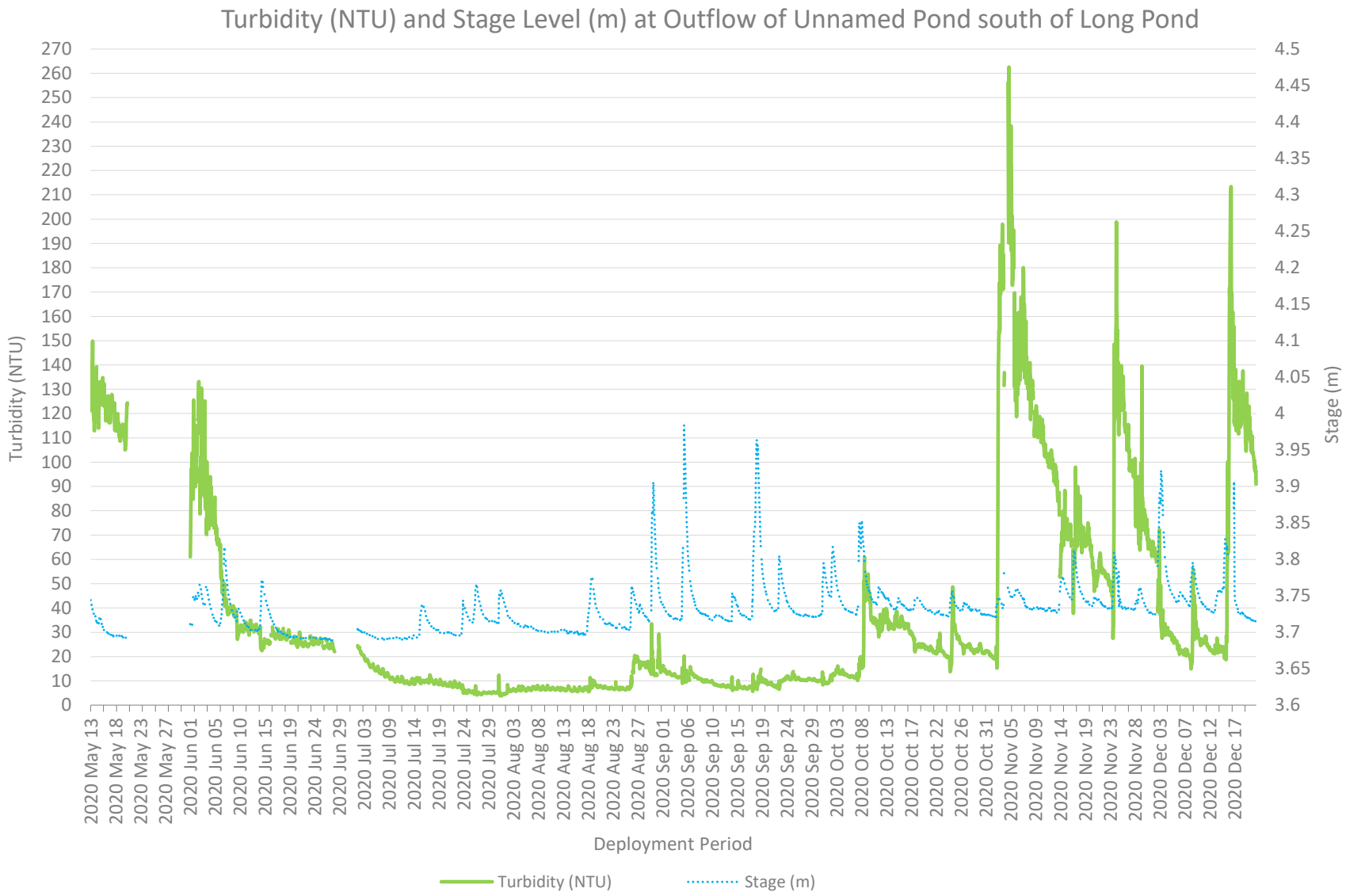
Turbidity levels during the deployment ranged from 0.6 NTU to 4117.1 NTU at Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond ranged 3.9 NTU to 280.6 NTU (Table 7). The medians for both stations were close in range, with Outflow of Unnamed Pond south of Long Pond median at 21.9 NTU, and Outflow of Grebes Nest Pond with a median of 24.35 NTU (Table 7).

The persistent spikes in turbidity at Outflow of Grebes Nest Pond were likely a result of a sporadic pumping and intermediate rainfall. These factors likely lead to the instrument recording data of potentially stagnant water. The water used to maintain the flow in this brook is sediment laden (Figure 12). Medians for 2019 and 2020 remain within the same range (Appendix III).

Increases in turbidity at Outflow of Unnamed Pond south of Long Pond corresponded with increases in flow as indicated by stage height. These events tend to exhibit an initial high peak before quickly returning to lower levels. However, the data recorded in November indicated that the sensor took some time to return to background levels after large spikes (Figure 12). There were a cluster of precipitation events during November and December and very likely, it contributed to the larger turbidity events, as well as the spike in specific conductivity (Figure 10).

Table 7. Summary for 2020 Turbidity data at Fluorspar Real-Time stations

	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.6	3.9
Max	4117.1	280.6
Median	24.35	21.9


Turbidity (NTU) and Stage Level (m) at Outflow of Unnamed Pond south of Long Pond
Turbidity (NTU)
Stage (m)
Deployment Period
Turbidity (NTU)
Stage (m)

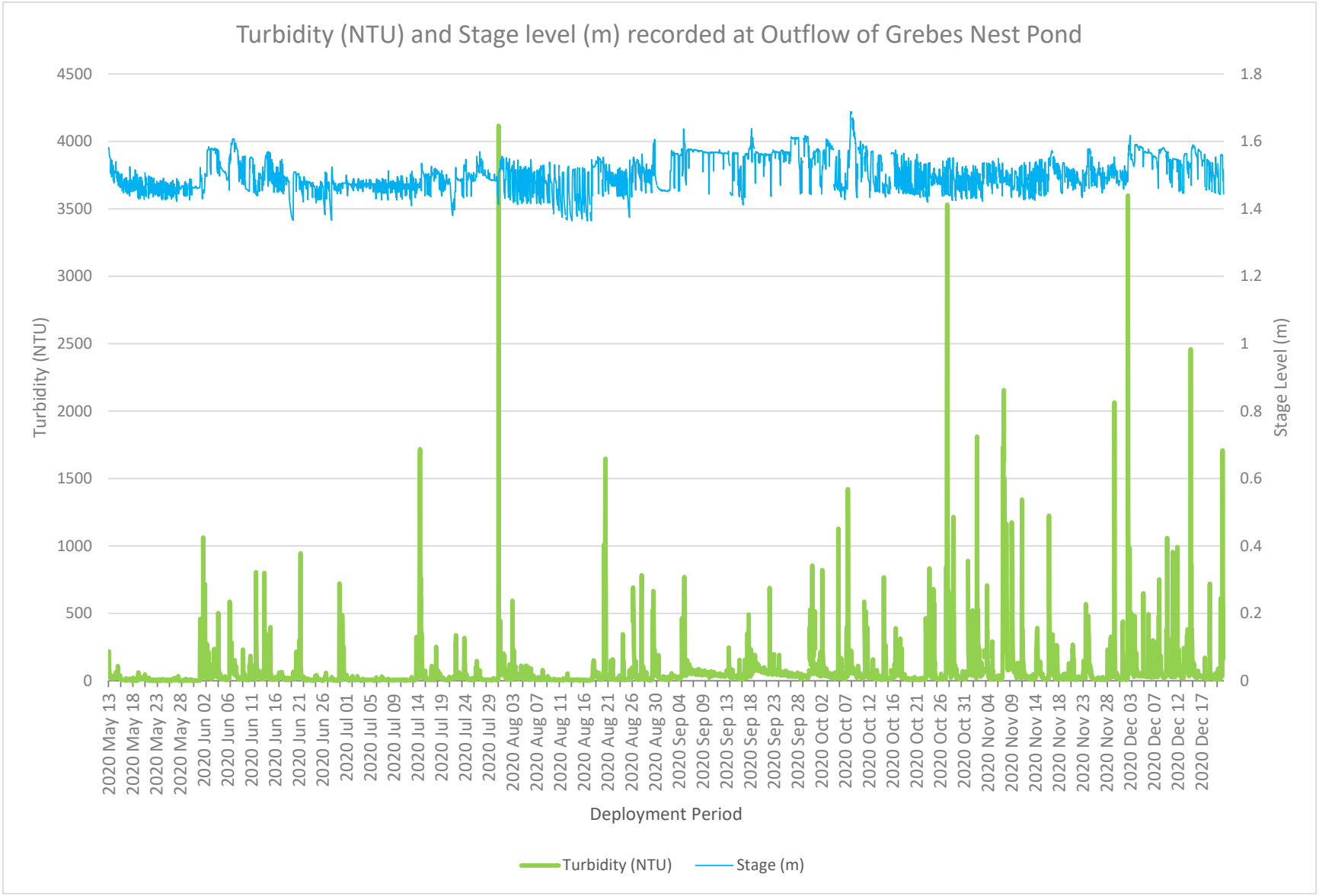


Figure 12: Turbidity (NTU) values at the Canada Fluorspar (NL) Inc Real-Time Stations

Total Precipitation & Daily Averaged Stage Data

Stage is important as it provides an estimation of water level at the station and can explain some of the fluctuations that are occurring in relation to other parameters (i.e. Specific Conductivity, DO, turbidity). Stage will increase naturally during rainfall events (Figure 13) and during any surrounding snow or ice melt as runoff collects in the brooks. However, direct snowfall will not cause stage to rise significantly.

Outflow of Grebes Nest Pond daily averaged stage values ranged from 1.36m to 1.688m (Table 9). Despite the changes in the water supply to Outflow of Grebes Nest Pond, the stage level did not change significantly over the deployment year. Outflow of Unnamed Pond south of Long Pond recorded stage levels ranging from 3.68m to a maximum of 3.984m. Although the stations are not on the same river, both sites had similar peaks in stage during the rainfall events.

Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total Daily Precipitation for the deployment period ranged from 0.0 mm to a maximum of 62.8 mm, which occurred on September 5th 2020.

Table 9. Summary of for 2020 Daily Averaged Stage data at Fluorspar Real-Time stations

	Daily Averaged Stage (m)	
	Outflow of Grebes	Outflow of Unnamed
Min	1.36	3.688
Max	1.688	3.984
Median	1.494	3.727
Mean	1.5011	3.7308

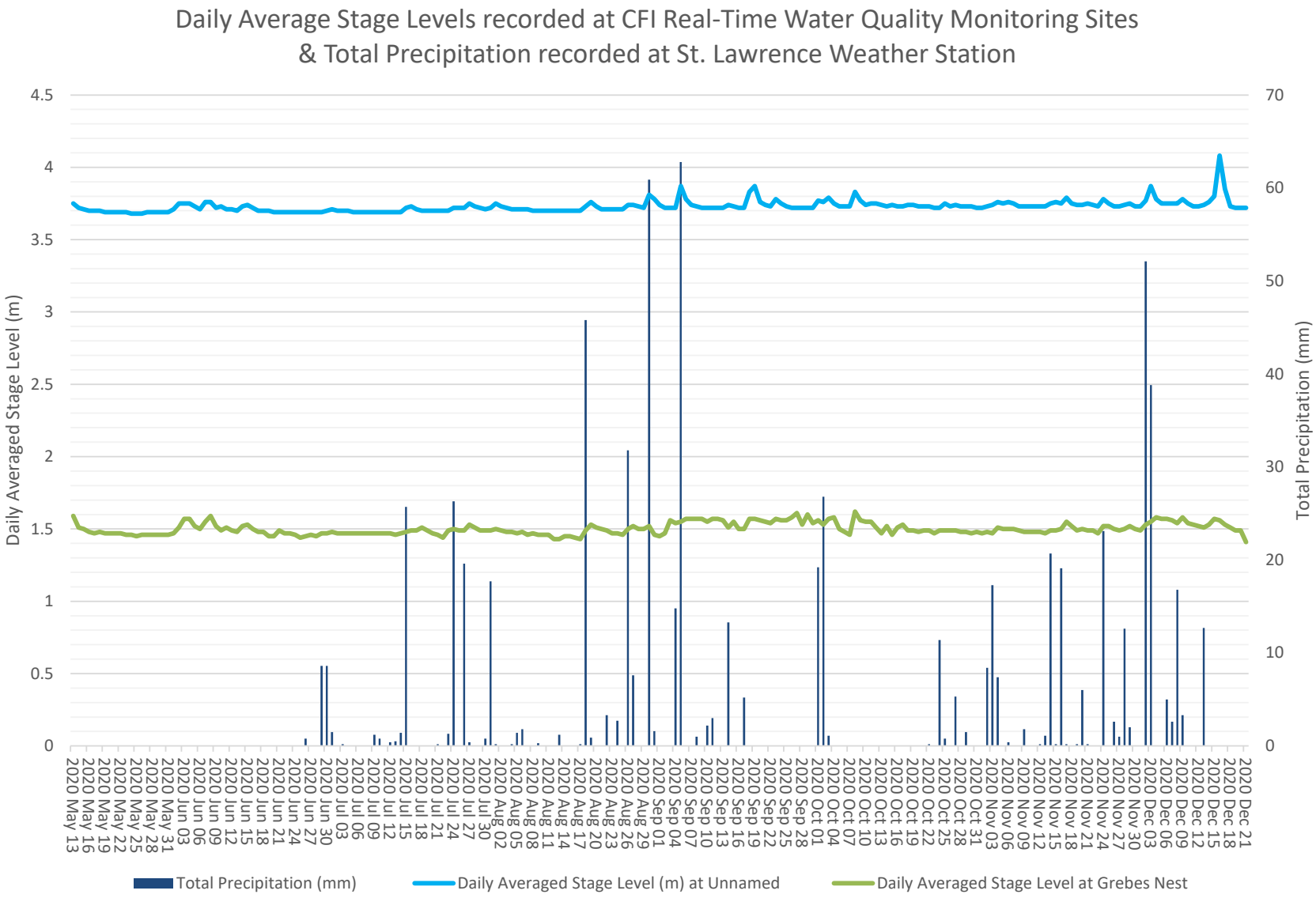


Figure 13: Daily Averaged stage values and total precipitation.

Conclusion

The water quality monitoring instruments for the Fluorspar network were deployed on both Outflow of Grebes Nest Pond and Outflow to Unnamed Pond south of Long Pond on May 13th, 2020 and removed for the winter season on December 21st, 2020.

Water temperature followed the seasonal trend of increasing during the summer and decreasing into the fall. Water temperature corresponded with air temperature. In most cases, weather related events or increases/decreases in water level explain the data fluctuations. With medians for both sites remaining close in range.

For the 2020 deployment, the pH ranges for both sites remained within the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life. There was evidence of more dips in pH at Outflow of Unnamed Pond south of Long Pond. This brook largely influenced by stage fluctuations.

Specific Conductivity data recorded at Outflow of Grebes Nest Pond was lower in 2020 than 2019. This was likely due to an improvement in water supply and better consideration of the pumping schedule. Data recorded at Outflow of Unnamed Pond south of Long Pond site indicated lower conductivity levels in 2020 when compared to 2019 data. The 2019 median was 357.94 µS/cm and the 2020 median was calculated at 154.97 µS/cm. The conductivity data collected at Outflow of Unnamed Pond south of Long Pond indicates an improvement in the quantity of dissolved material entering the brook

Outflow to Grebes Nest Pond continues to have ongoing turbidity spikes. This brook can have intermediate flow issues resulting in the instrument recording data of stagnant water. It is likely the higher turbidity values are the result of low flow and a water supply that has a high silt content. The spikes in turbidity at Outflow of Unnamed Pond south of Long Pond corresponded with increases in flow as indicated by stage height. However, toward the end of the deployment at Unnamed Pond there were significantly larger turbidity events which took longer to return to background levels. A cluster of precipitation events was recorded in November and December and may have contributed to the larger turbidity values and high spike in conductivity as well.

As with many brooks and streams, precipitation and runoff influence the water quality within a water body. Catchment areas for Outflow of Unnamed Pond south of Long Pond and Outflow of Grebes Nest Pond are impacted by anthropogenic changes from the mining activity. Precipitation can increase the transfer of runoff from surrounding construction areas by flushing excess material into waterways. The health of a brook can be determined by how quickly it returns to its background data after a water quality event.

Path Forward 2020

- The water quality instruments will undergo proficiency testing and evaluation during the winter of 2020-2021. ECC will inform Canada Fluorspar of any instrument performance issues.

- ECC staff will deploy real time water quality instruments in spring 2021, when ice conditions allow and perform regular site visits throughout the 2021 deployment season for calibration and maintenance of the instruments.

- If necessary, deployment techniques will be evaluated and modified, ensuring secure and suitable conditions for RTWQ monitoring.

- ECC will continue to work on its Automatic Data Retrieval System, to incorporate new capabilities in data management and data display.

- Ongoing liaison between ECC, ECCC and Canada Fluorspar in order to monitor or respond to emerging issues on a proactive basis. Canada Fluorspar will receive deployment reports and an annual report, summarizing the events of the deployment season throughout the year.

APPENDIX I

WATER QUALITY PARAMETER DEFINITIONS

Dissolved Oxygen

The amount of Dissolved Oxygen (DO) (mg/l) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (Allan 2010).

pH

pH is the measure of hydrogen ion activity and affects: (i) the availability of nutrients to aquatic life; (ii) the concentration of biochemical substances dissolved in water; (iii) the efficiency of hemoglobin in the blood of vertebrates; and (iv) the toxicity of pollutants. Changes in pH can be attributed to industrial effluent, saline inflows, precipitation or aquatic organisms involved in the photosynthetic cycling of CO_2 (Allan 2010).

Specific conductivity

Specific conductivity (µS/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25˚C. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

Stage

Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature

Essential to the measurement of most water quality parameters, temperature (^oC) controls most processes and dynamics of limnology. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth (Allan 2010; Hach 2006).

Total Dissolved Solids

Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

Turbidity

Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Allan 2010; Hach 2006; Swanson and Baldwin 1965).

APPENDIX II

INSTRUMENT PERFORMANCE RANKINGS

2020 Instrument Performance Rankings

Station	Date	Action	2020 Deployment Season Comparision Ranking				
			Temperature	pH	Specific Conductivity	Dissolved Oxgyen	Turbidity
Outflow of Grebes Nest Pond	May 13, 2020	Deployment	Good	Good	Excellent	Excellent	Poor
	July 2, 2020	Removal	Good	Good	Excellent	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	May 13, 2020	Deployment	Marginal	Good	Excellent	Excellent	Excellent
	July 2, 2020	Removal	Fair	Good	Excellent	Excellent	Excellent
Outflow of Grebes Nest Pond	July 2, 2020	Deployment	Good	Good	Excellent	Excellent	Poor
	August 5, 2020	Removal	Good	Good	Excellent	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	July 2, 2020	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	August 5, 2020	Removal	Excellent	Excellent	Excellent	Good	Excellent
Outflow of Grebes Nest Pond	August 5, 2020	Deployment	Good	Good	Excellent	Excellent	Poor
	December 21, 2020	Removal	Good	Good	Excellent	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	August 5, 2020	Deployment	Poor	Excellent	Excellent	Good	Excellent
	December 21, 2020	Removal	Excellent	Poor	Good	Fair	Marginal

APPENDIX III

COMPARISON STATISTICS ACROSS DEPLOYMENTS AT CANADA FLUORSPAR INC

Comparison Statistics from 2017		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.15	-0.154
Max	21.2	26.57
Median	3.772	7.2
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	5.11	4.57
Max	7.41	7.73
Median	5.82	6.1
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	29.1	43.7
Max	227.09	229.71
Median	59.1	87.1
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.06	8.2
Max	14.34	15.16
Median	12.35	11.74
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	67.2	88
Max	115.1	105.6
Median	95	98.4
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.35	0.16
Max	1314.4	133.9
Median	1.49	8.8

Comparison Statistics from 2018		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.03	-0.017
Max	22.586	25.642
Median	9.34	10.43
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.71	7.07
Max	7.81	8.37
Median	7.3	7.81
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	87.79	105.7
Max	649.3	535.34
Median	244.44	234.8
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	4.92	7.11
Max	15.18	14.76
Median	10.025	11
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	52.5	63.7
Max	114.8	105.8
Median	89.3	98.7
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	4.23	0
Max	1341.9	76.8
Median	60.3	13.2

Comparison Statistics from 2019		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	2.41	-0.04
Max	22.58	26.88
Median	9.54	11.62
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.21	7.31
Max	8.13	8.44
Median	7.6	8.01
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	190.2	182.12
Max	586.91	507.59
Median	344.145	357.94
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.36	7.98
Max	13.27	14.59
Median	10.41	10.81
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	70.7	90.8
Max	131	103.6
Median	90.6	98.4
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.4	6.5
Max	3548.1	166
Median	24.3	48.6

Comparison Statistics from 2020		
	Water Temperature °C	
	Outflow of Grebes	Outflow of Unnamed
Min	1.93	-0.02
Max	20.4	27.1
Median	10.33	12.75
	pH (pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	7.06	6.66
Max	8.21	7.87
Median	7.9	7.38
	Specific Conductivity (µS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	86.16	66.04
Max	456	221.76
Median	318.74	154.97
	Dissolved Oxygen (mg/L)	
	Outflow of Grebes	Outflow of Unnamed
Min	9.18	8.04
Max	13.89	14.94
Median	10.96	10.38
	Dissolved Oxygen (%Sat)	
	Outflow of Grebes	Outflow of Unnamed
Min	86.1	88
Max	116.7	124.1
Median	97.9	99.3
	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	0.6	3.9
Max	4117.1	280.6
Median	24.35	21.9