Real-Time Water Quality Report

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

Deployment Period
November 22, 2022 to January 17, 2023

Newfoundland Labrador

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 John Fitzpatrick 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.

Decommission of Outflow of Grebes Nest Pond

Due to a change in the water supply for Outflow to Grebes Nest Pond station. It was determined that this brook would not provide consistent water supply to remain a monitoring station. It was decided to decommission Outflow to Grebes Nest station. In replacement, a new site was selected and the hut and all the water quality instrumentation was relocated to an area that has a consistent water supply and the capability to provide an overview of the water quality conditions (Figure 1). The new site was named John Fitzpatrick Pond and this report will cover the water quality data recorded at John Fitzpatrick Pond station.

John Fitzpatrick Pond

John Fitzpatrick station was established May 2022. The site was selected based on the location and consistent water supply throughout the year. Despite an expected small decrease in water level during the summer, this station will provide stable and beneficial water quality data for this site (Figure 1).

The Real Time station is established on the North West bank of John Fitzpatrick Pond, close to the only outflow from the pond. This pond is surrounded by natural habitat on the North East side, and on the south west side bordered by the CFI mine (Figure 1). There are two small brooks that periodically flow into this pond. This station will monitor the water quality and the stage level of the pond. The instrument is deployed, at a depth of approximately 1.0 meters. The GPS coordinates for this site are as follows: N 46° 54’ 47.95” W 055° 27’ 46.97” (Figure 1).

Figure 1: Real-Time Station at John Fitzpatrick Pond

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 2). 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 2).

Figure 2: 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
John Fitzpatrick	Nov 22, 2022	Deployment	Excellent	Good	Good	Excellent	Good
	Jan 17, 2023	Removal	-	-	-	-	-
Unnamed Pond	Nov 22 ,2022	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Jan 17, 2023	Removal	-	-	-	-	-

During the deployment of the field instrument at John Fitzpatrick Pond site, the water temperature, pH, specific conductivity, dissolved oxygen and turbidity all ranked 'Excellent' or 'Good' against the QA instrument data when compared.

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

There is no QA/QC data available for either site for removal.

Issues during the Deployment Period

It was determined by the end of the deployment period that there are potential issues with power at the John Fitzpatrick station. Due to these issues, there are segments of missing data from the John Fitzpatrick dataset for this deployment period.

Please note that the stage data recorded and displayed in this report, 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.

John Fitzpatrick Pond

Water Temperature

Water temperature ranged from -0.21°C to 1.24°C during the deployment period (Figure 3). The average water temperature for this deployment was 3.50°C. Temperatures were much cooler than the previous deployment average of 8.19°C, which is to be expected as the season adjusts to winter temperatures, as can be seen from the decreasing temperature trend line in Figure 3.

Water temperature displayed a natural diurnal pattern, as water temperatures mirror the surrounding air temperatures. Water will be warmer during the daylight hours and then lower during the nighttime (Figure 4).

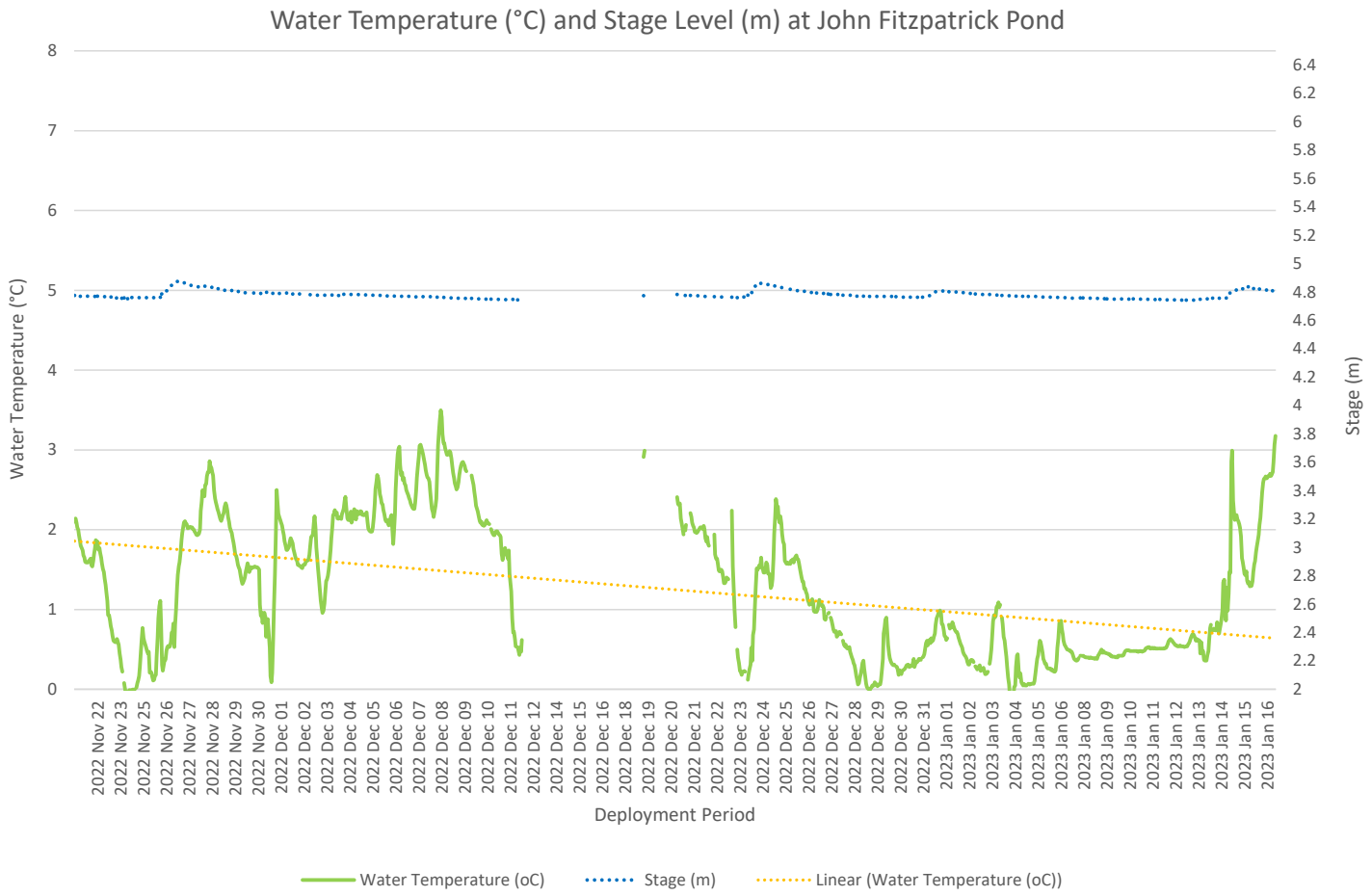


Figure 3: Water temperature (°C)

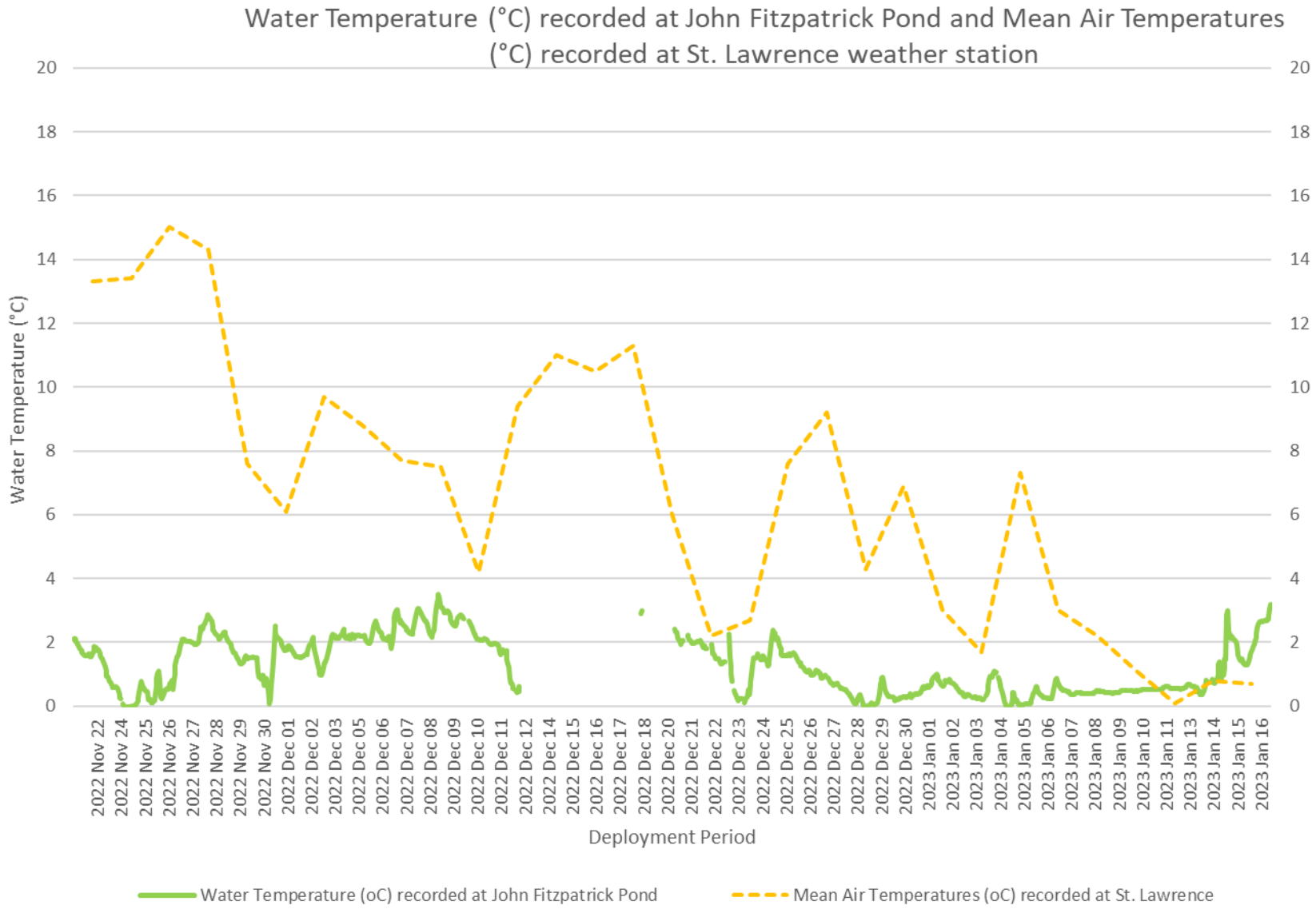


Figure 4: Water Temperature (°C) at John Fitzpatrick Station vs. Mean Air Temperatures (°C) at St. Lawrence Weather Station

pH

Throughout the deployment period, pH values ranged between 6.78 pH units and 7.41 pH units, with an average of 7.30 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 (Figure 5).

Rainwater is often slightly acidic in nature which will in turn decrease the pH of the pond water when it precipitates. Figure 5 illustrates this phenomenon, showing minor pH dips during the deployment period, which align with stage increases caused by precipitation events (see Appendix I). For instance, on December 24th, 2022, a clear example can be observed as the stage rises from 4.763m to 4.858m, and the pH drops from 7.31 units to 6.81 pH units. pH returns to normal background values shortly after the precipitation event ends.

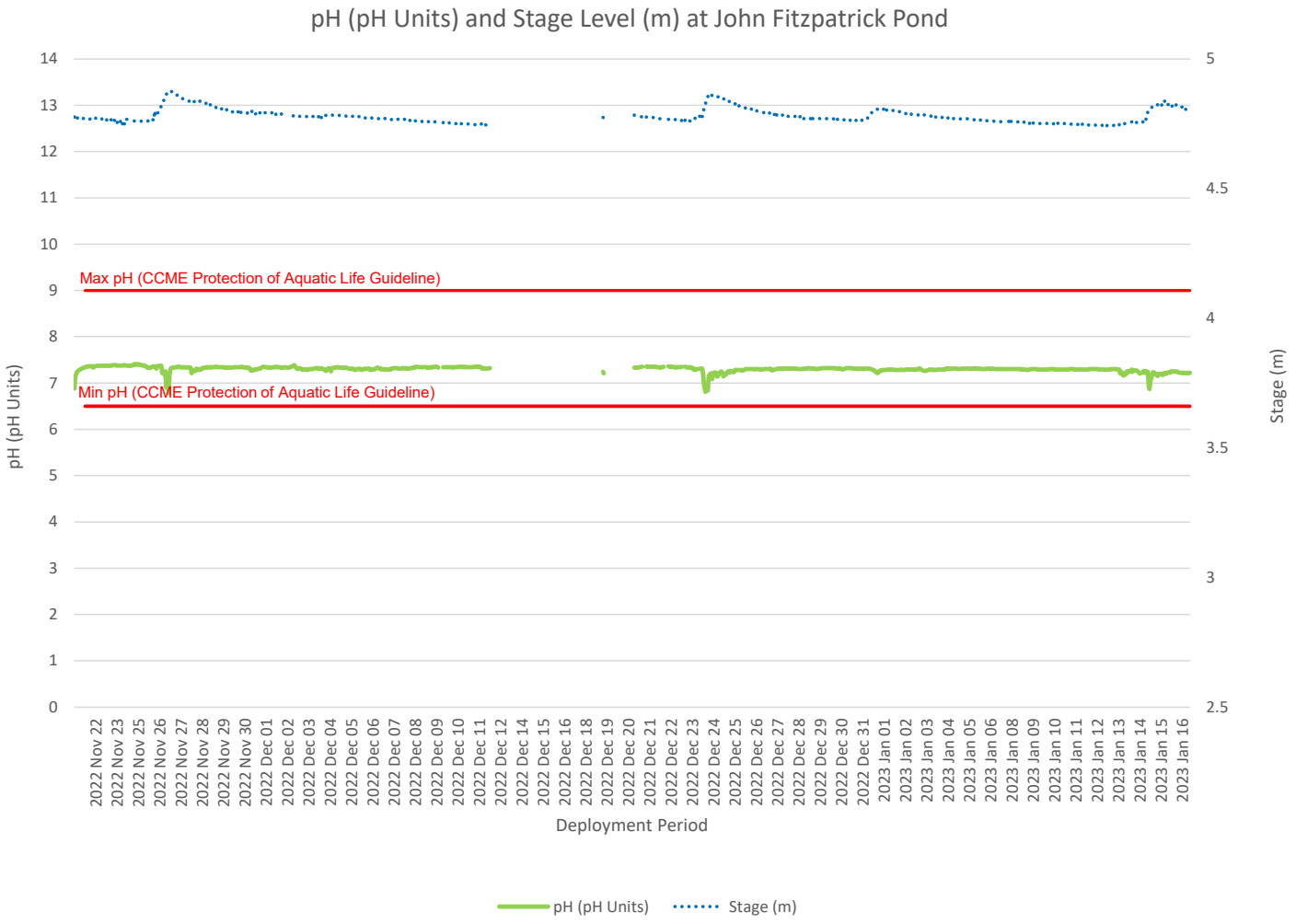


Figure 5: pH (pH units) values

Specific Conductivity

The specific conductivity probe measures the diluted salts and inorganic materials present in the brook. The conductivity levels throughout this deployment were within 92.20 µS/cm and 148.99 µS/cm, with an average of 136.96 µS/cm (Figure 6).

Conductivity in John Fitzpatrick pond will fluctuate with the changes in water level and during any rainfall event. Conductivity was stable throughout the deployment, apart from some minor dips and an abrupt decrease on December 24th, 2022 which coincides with a significant rainfall that also occurred on that date (see Appendix I). The rain dilutes the water column for a short period of time, this reduces the presence of any suspended particles or diluted salts, which in turn decreases specific conductivity.

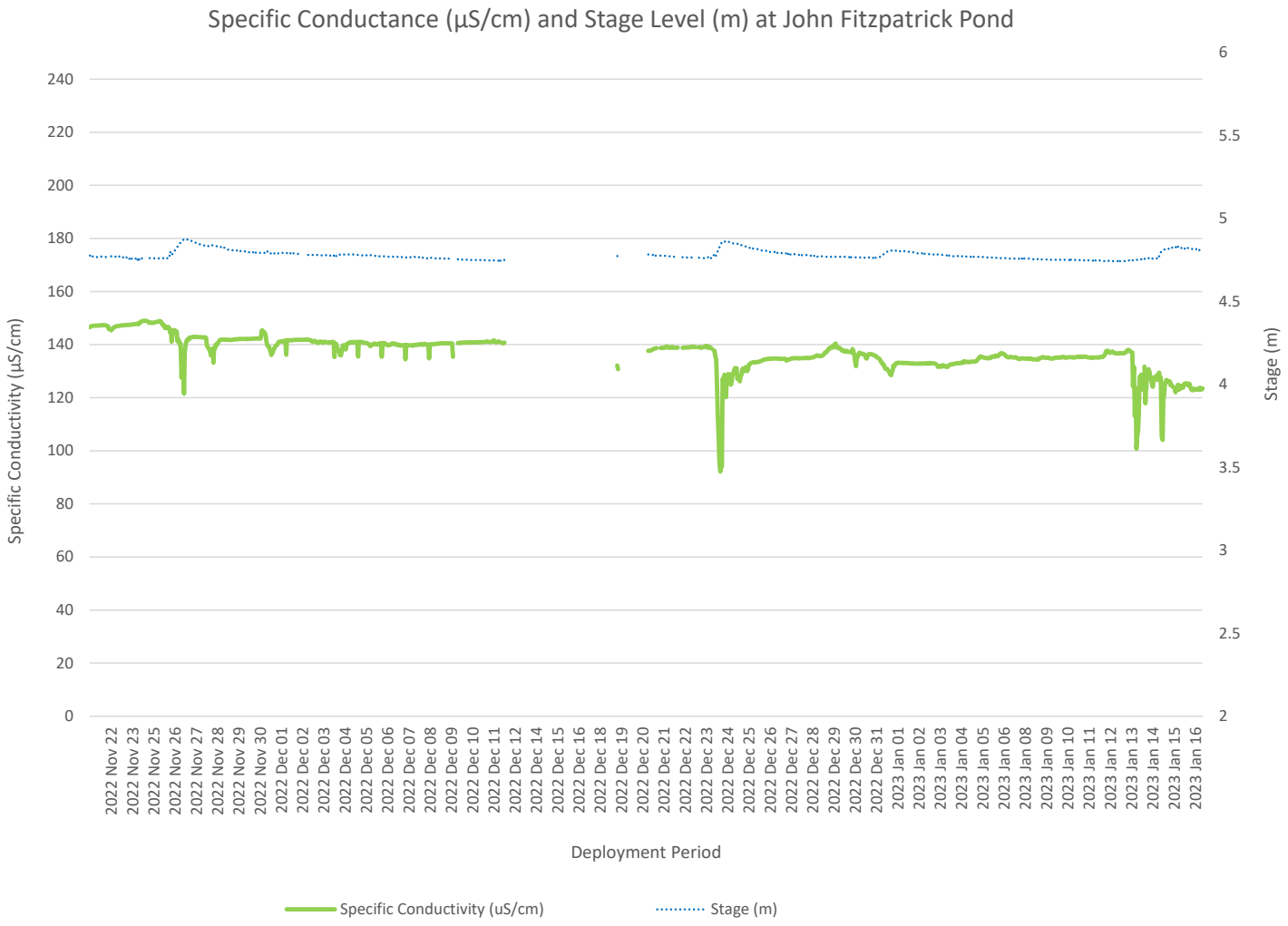


Figure 6: Specific conductivity (µS/cm) values

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 13.42 mg/L to a maximum of 15.40 mg/L. The dissolved oxygen percent saturation levels ranged within 94.5% saturation to 107.4% saturation (Figure 7).

Throughout this deployment period, the dissolved oxygen levels remained relatively constant, experiencing minor fluctuations and a slight but steady rise. Given that we are entering the winter months with colder temperatures, it is anticipated that the dissolved oxygen levels will be higher. This is because cold water has the capacity to hold more dissolved oxygen compared to warm water. As the air temperatures decrease, the water also cools down, leading to an increase in dissolved oxygen levels.

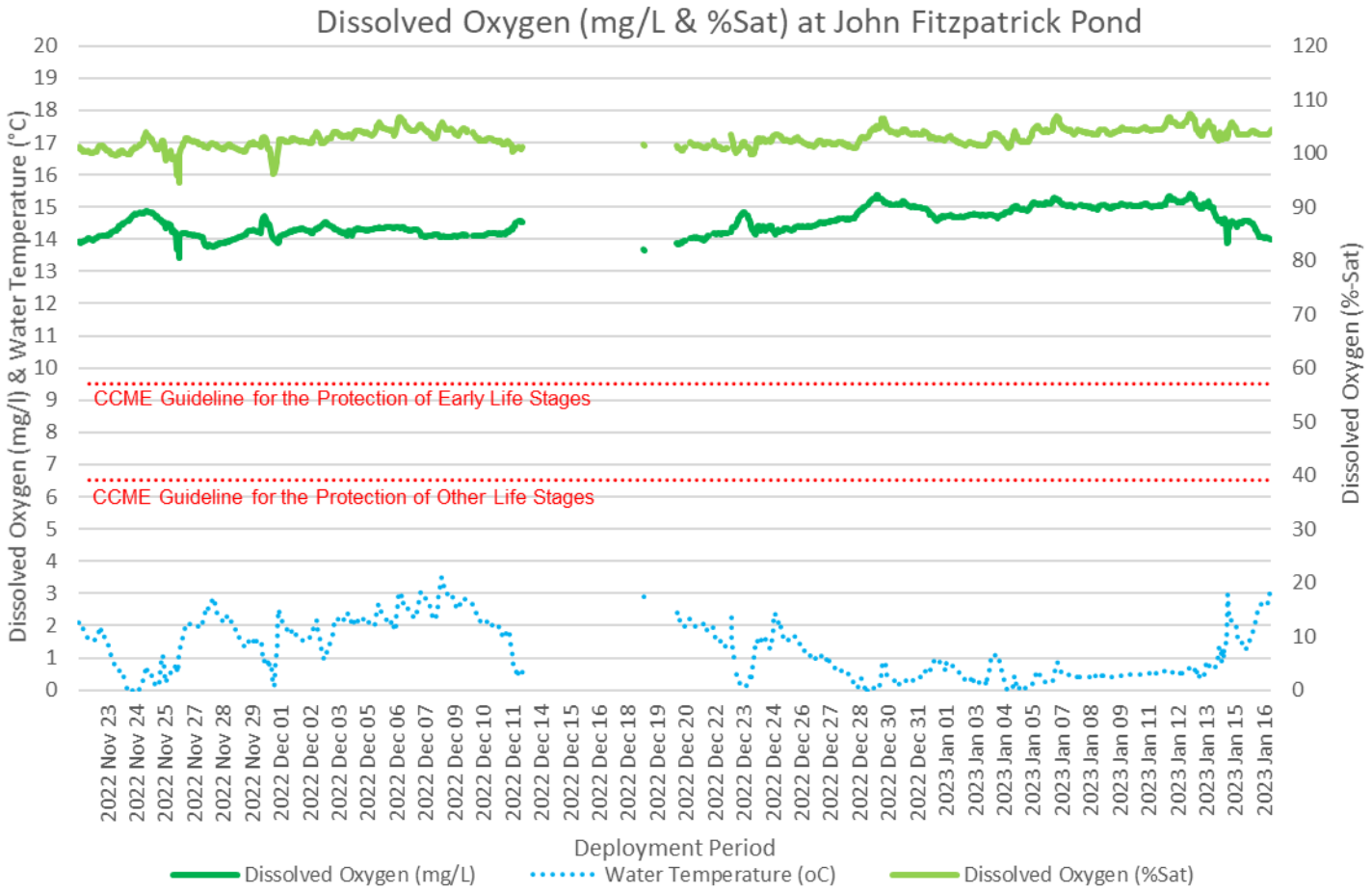


Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment period ranged within 1.3 NTU and 95.5 NTU (Figure 8). The deployment data had an average of 2.6 NTU. A large spike occurred on November 30th, 2022 which was likely a result of increased rain activity in the days prior, and some sediment potentially getting stuck by the sensor. Turbidity values returned to normal values and remained relatively constant other than some small fluctuations. There was a small spike on December 24th, 2022, which coincides with a stage increase and rainfall event on that day (Appendix I).

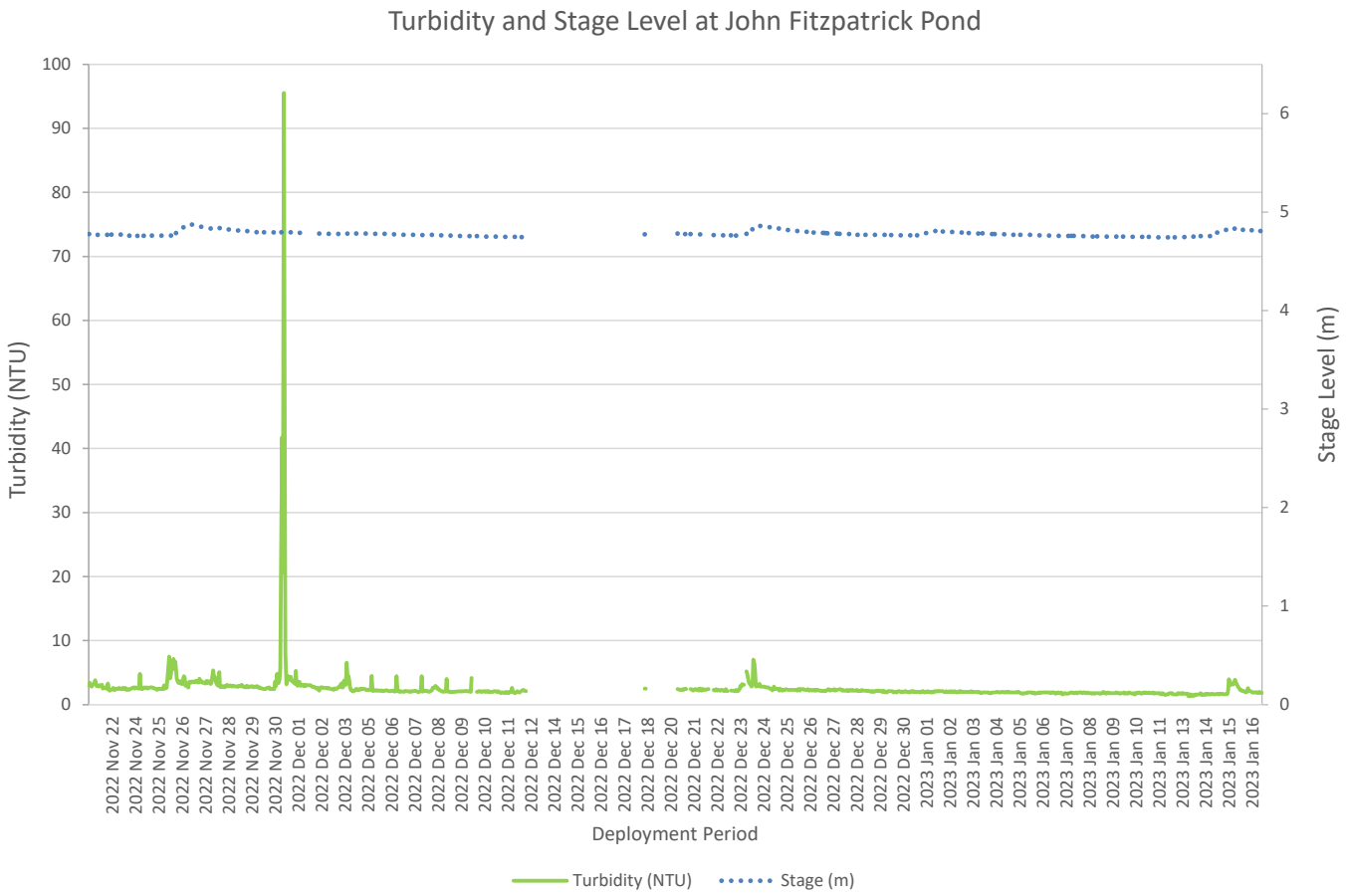


Figure 8: Turbidity (NTU) values.

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 some differences occurring with water quality parameters (i.e. Specific Conductivity, DO, turbidity). Stage ranged between 4.74m to 6.11m, with an average of 4.78m during the deployment. Please note in Figure 9 below, daily averages are used for stage as opposed to continuous data.

Large peaks in stage correspond with the total precipitation events as noted on Figure 9. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. The highest total precipitation was recorded on December 24th, 2022 with a total precipitation of 62.1mm. Stage increases during and peaks shortly after this rainfall event.

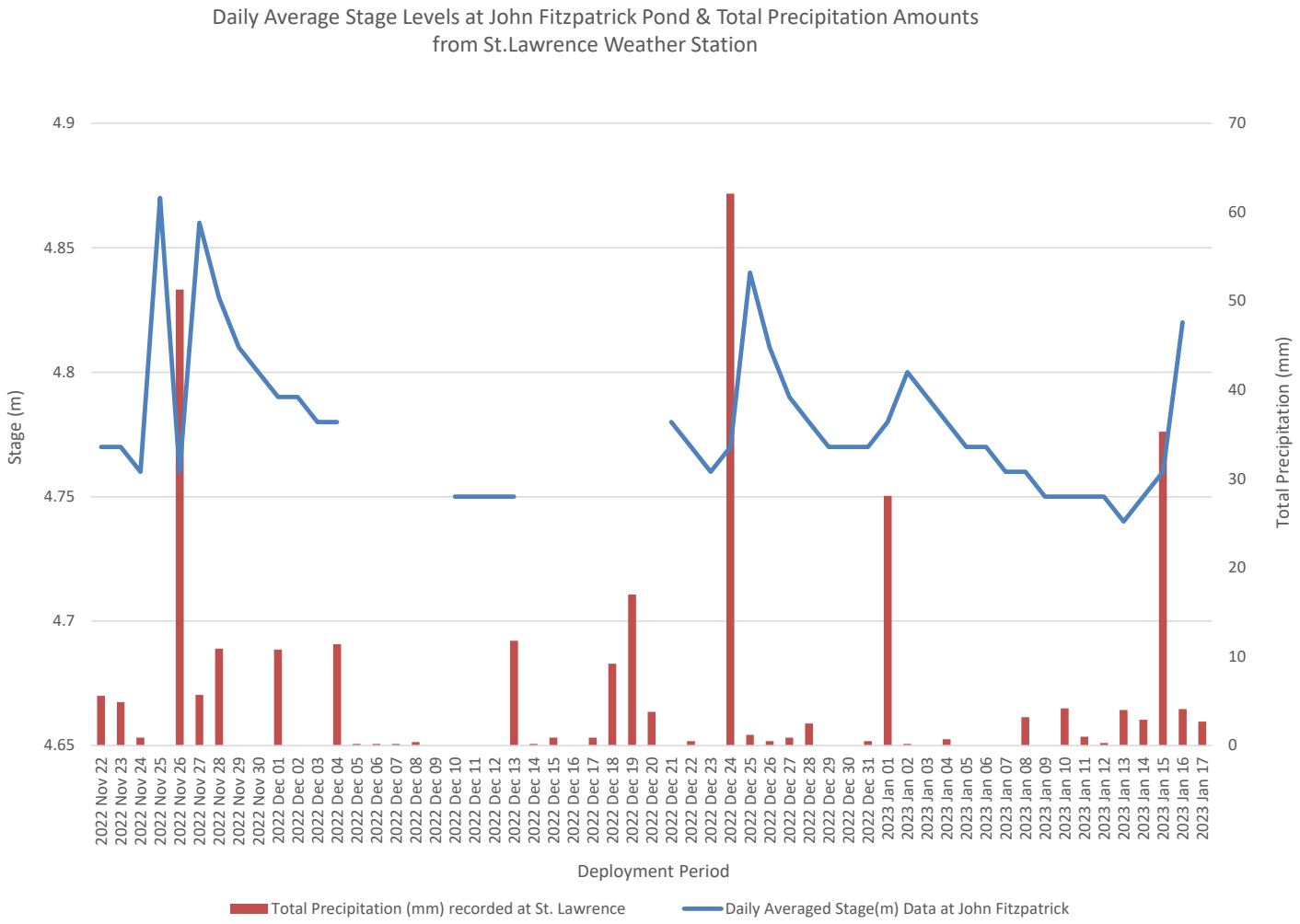


Figure 9: Daily averaged stage values and total precipitation.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranged from -0.17°C to 5.37°C, with an average temperature of 1.47° during the deployment period (Figure 10). Temperatures decreased slightly as the deployment period progressed, as can be seen by the trendline on Figure 10, however temperatures remained relatively stable. 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.

Decreases in water temperature correspond with higher stage. These stage changes are likely a result of precipitation. Please note that the stage data in this document is raw data. The data has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

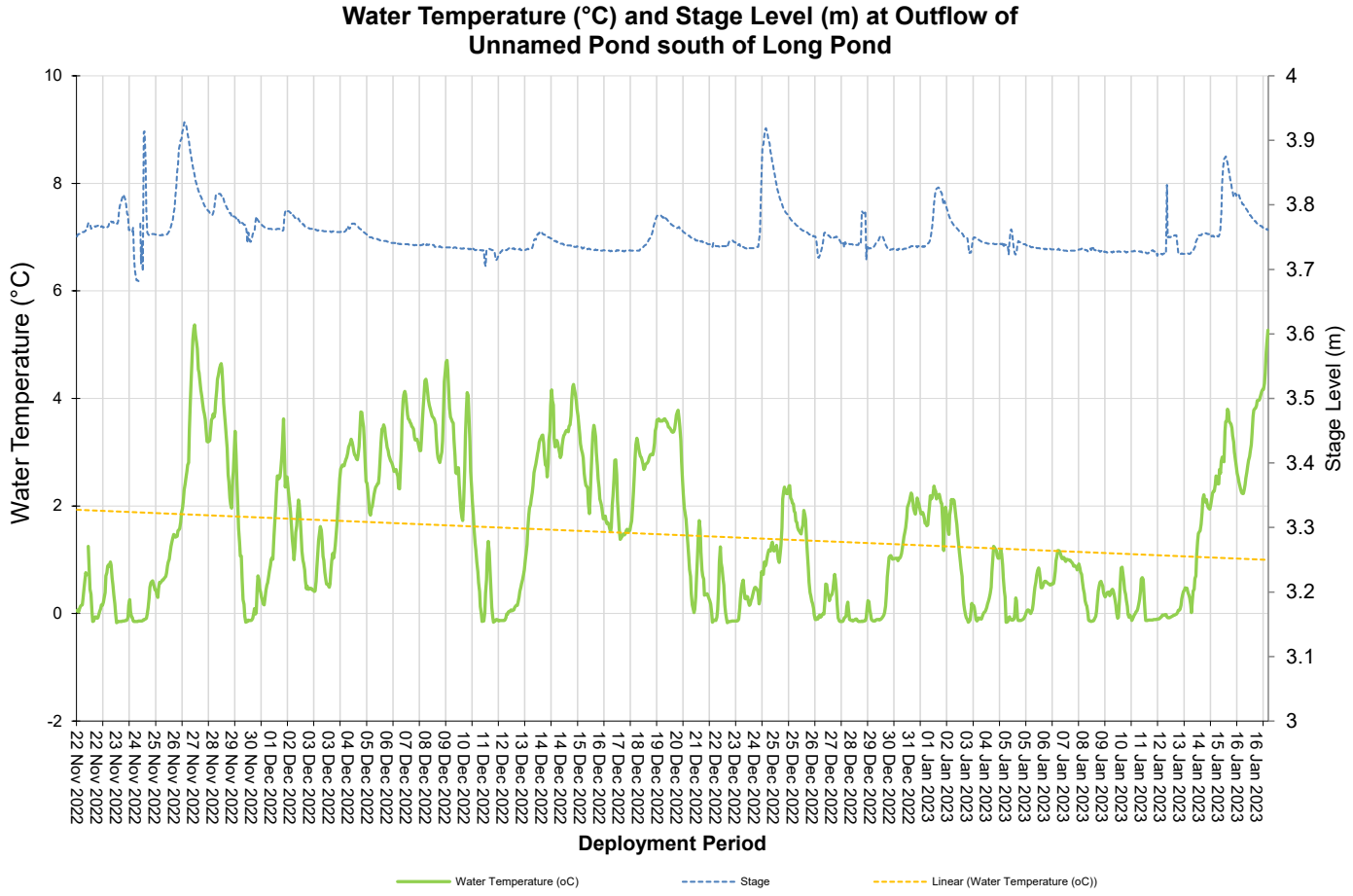


Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

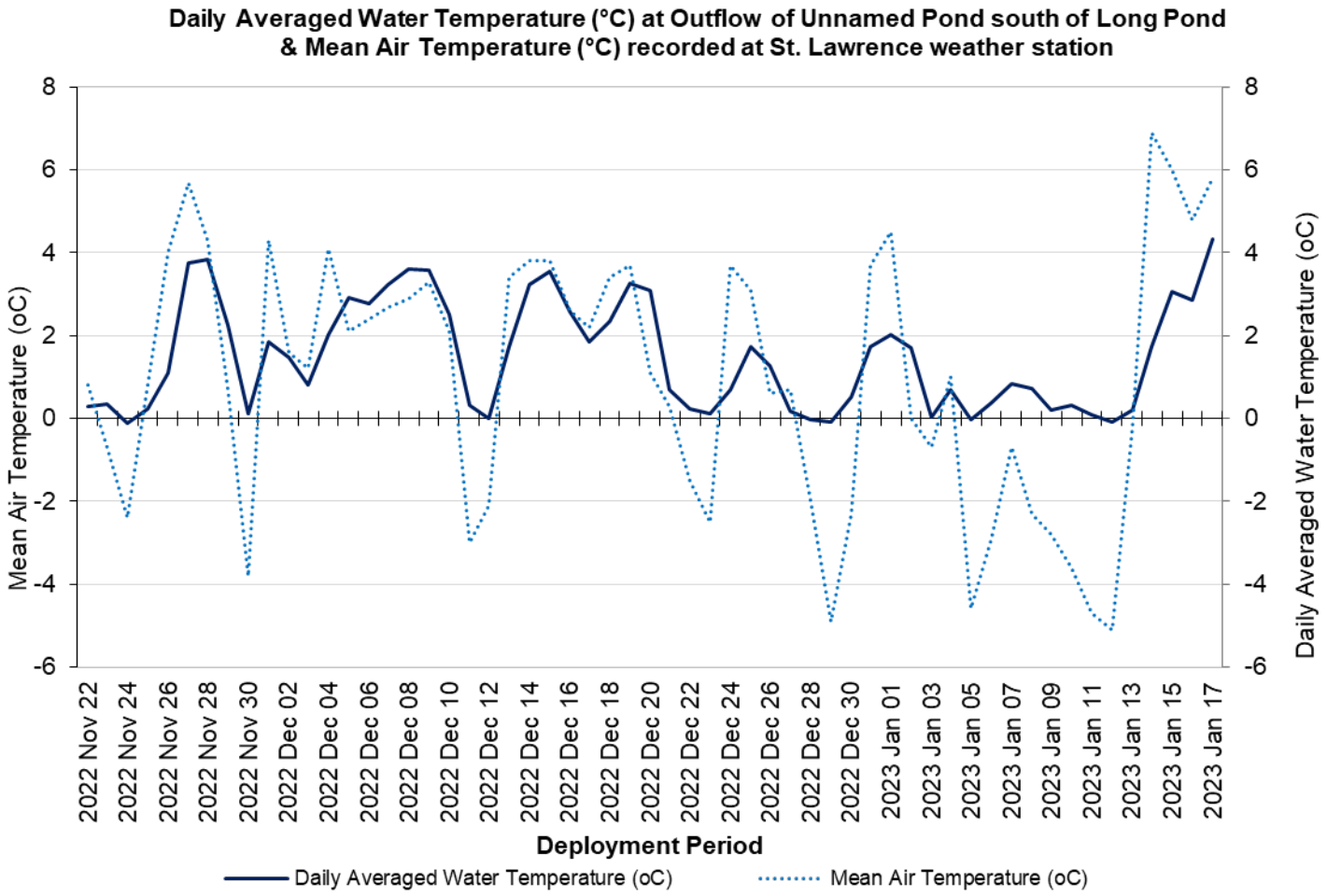


Figure 11: Water Temperature (°C) at Unnamed Pond station vs. Mean Air Temperatures (°C) at St. Lawrence Weather Station

pH

Throughout this deployment period, pH values ranged within 7.08 pH units and 7.83 pH units, with an average of 7.66 pH units (Figure 12). These values remain 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, like on December 24nd, 2022 and January 1st, 2023. pH does return to background levels 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.

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.

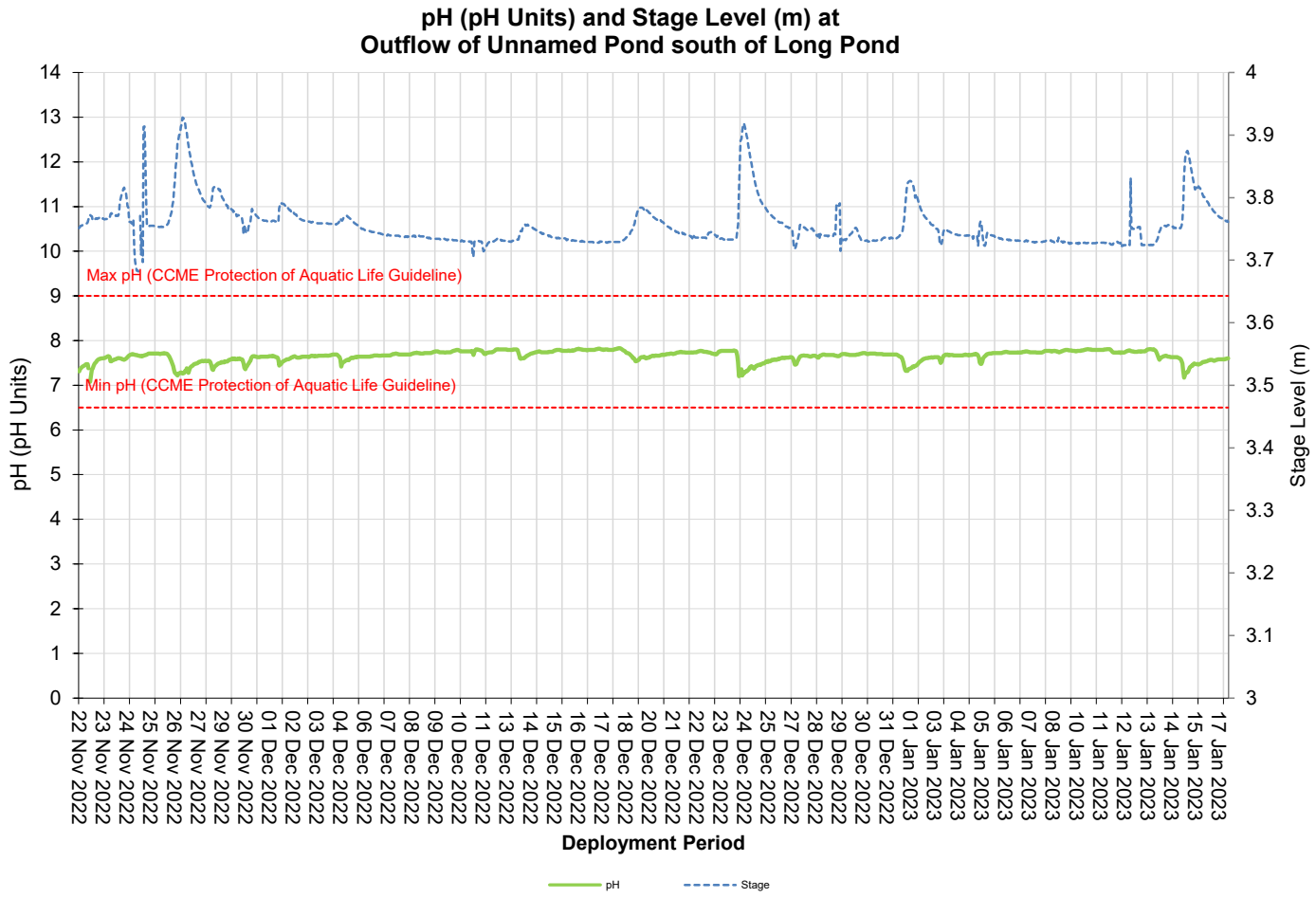


Figure 12: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 137.13 µS/cm and 312.18 µS/cm during the deployment period, with an average conductivity of 234.18 µS/cm (Figure 13).

Changes in stage will influence the conductivity data. The extra volume of water during a stage increase will dilute the particulate matter present in a water column. This is evident on the graph below (Figure 13) where it illustrates how conductivity decreases when stage increases. Stage increases are often a result of precipitation events (Appendix I).

Please note the daily averaged stage data on the graph below, is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

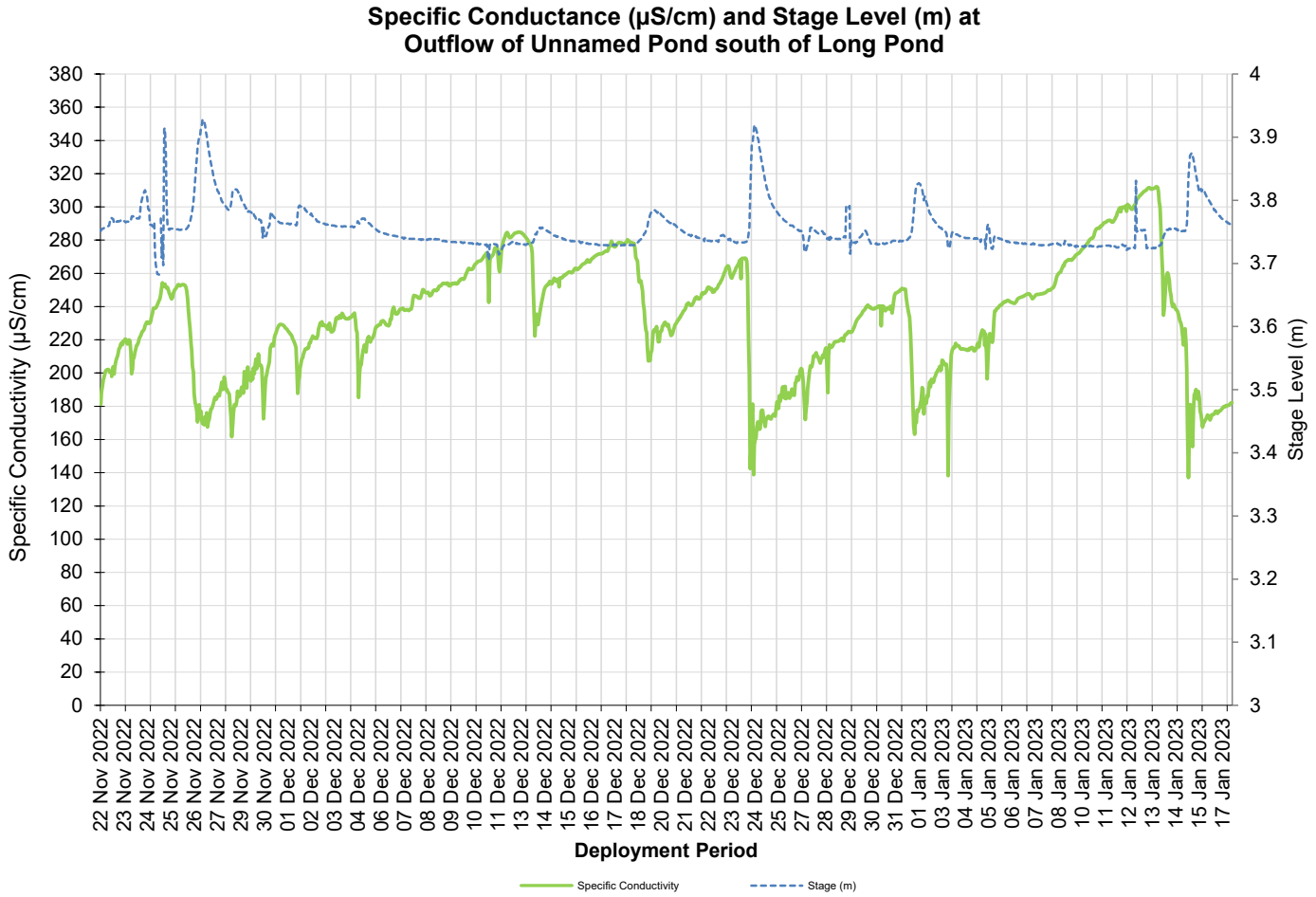


Figure 13: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

Dissolved Oxygen

The water quality instrument directly measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account the water temperature. During this deployment, the dissolved oxygen levels ranged within 12.55 mg/L and 15.12 mg/L for concentration and 97.00 % and 104.70 % for percent saturation. Dissolved oxygen levels were slightly higher this deployment period compared to the last, which is to be expected as temperature decreases in the winter months.

Dissolved Oxygen has a natural diurnal pattern in aquatic environments. Oxygen concentration levels will fluctuate throughout night and day. Cooler night temperatures influence higher dissolved oxygen concentrations and warmer day light temperature create lower concentrations. All other prominent dips/peaks - outside of the diurnal pattern - are a result of fluxes in air temperature or influences from rainfall/runoff (Figure 14).

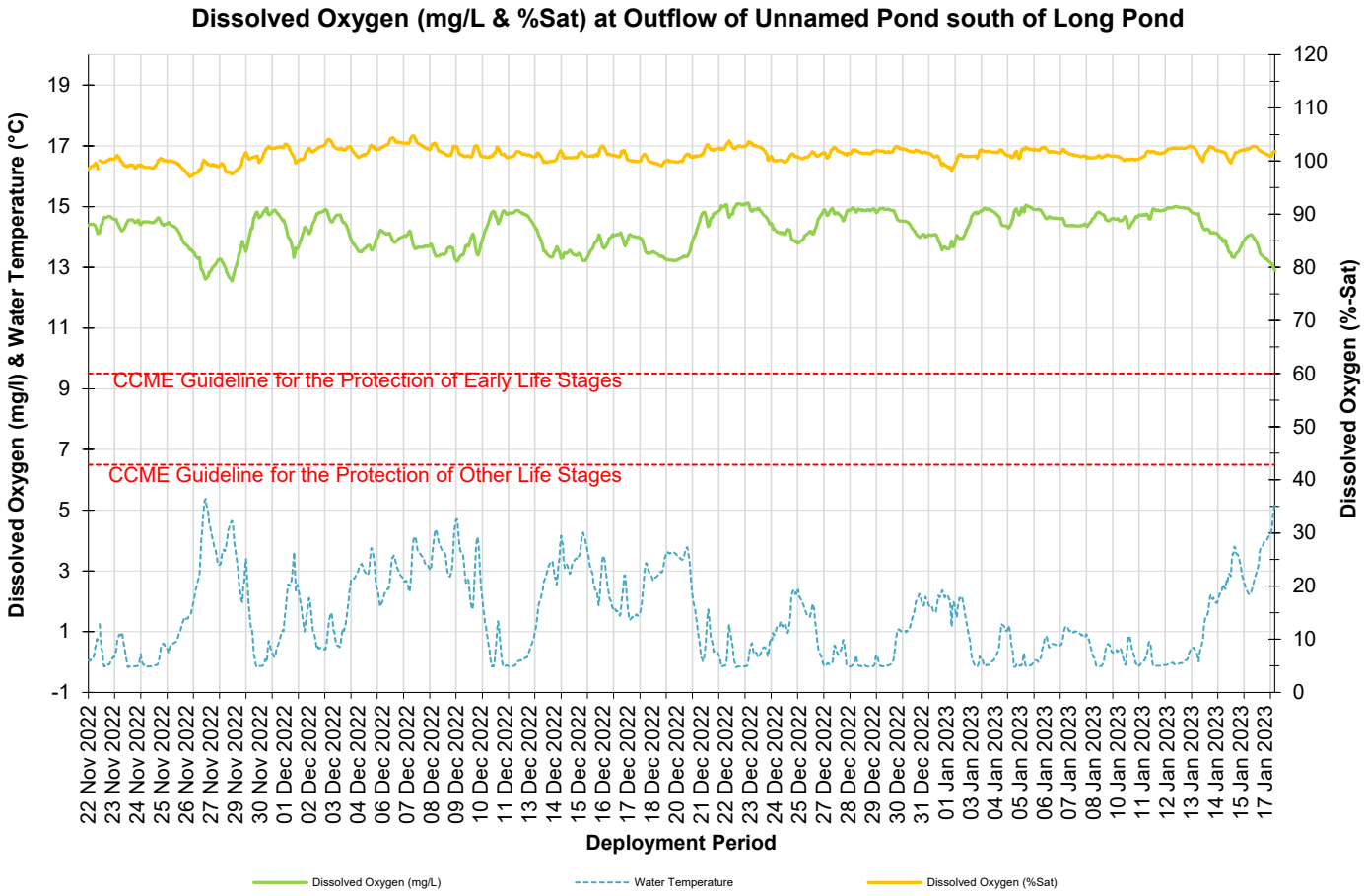


Figure 14: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 2.5 NTU and 15.30 NTU, with an average turbidity of 3.97 NTU (Figure 15). Turbidity levels were high at the beginning of the deployment period, during increased levels of precipitation (Appendix I). By the end of November, turbidity levels decreased and remained relatively consistent throughout the deployment period. Turbidity peaks consistently with stage increases, indicating a precipitation event. There were noticeable increases on December 24th, 2022 and January 1st, 2023.

Please note the daily averaged stage data on the graph below, is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

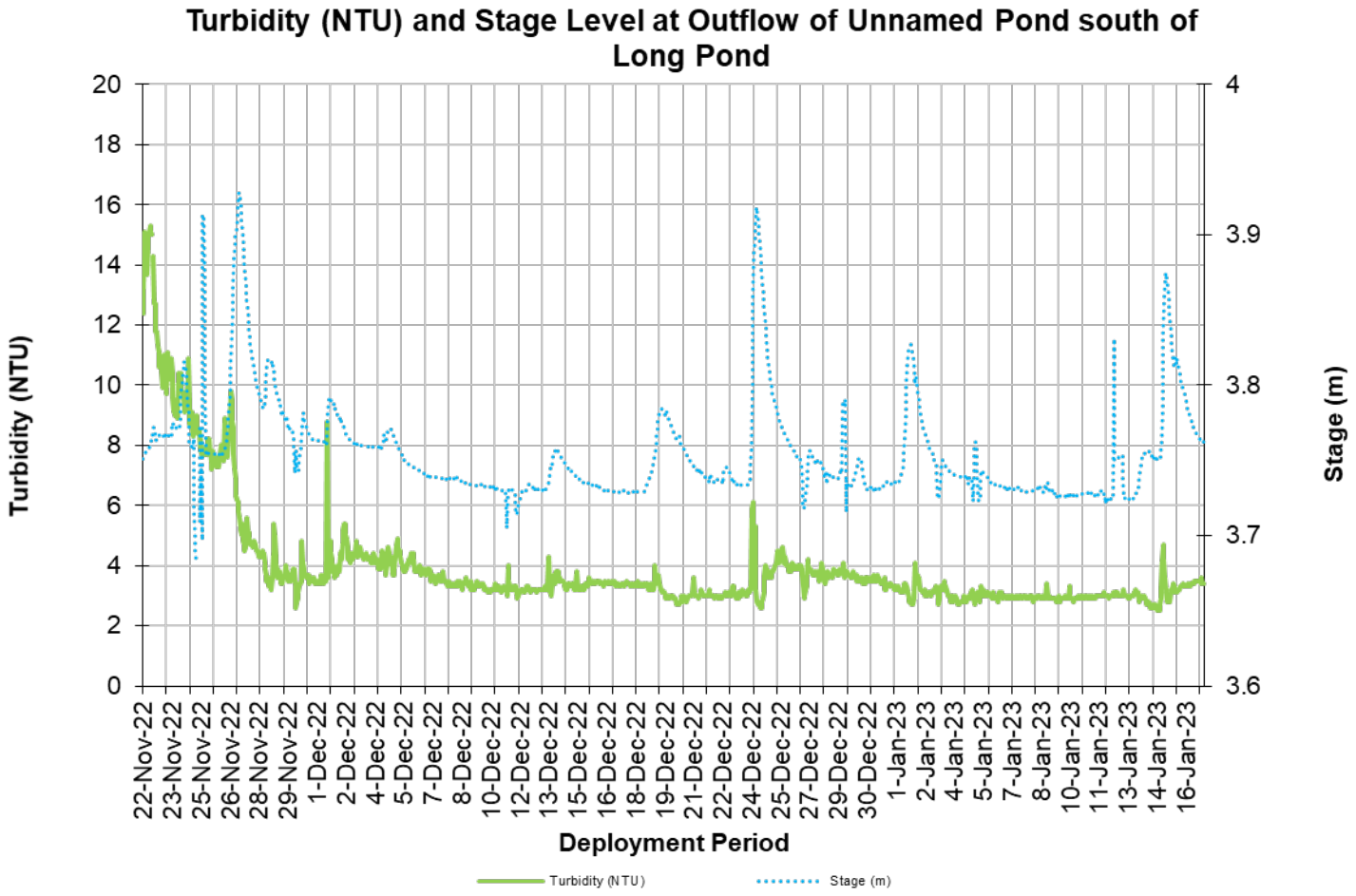


Figure 15: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

Please note the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

Stage is an estimation of water level at the station and can explain fluctuations occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage at Outflow of Unnamed Pond south of Long Pond ranged between 3.68m to 3.93m during the deployment, with an average stage of 3.76 m. Please note that the graph below (Figure 16) uses daily averages and not continuous data for the stage values.

Large peaks in stage correspond with the total precipitation events as noted on Figure 16. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. The highest total precipitation was recorded on December 24th, 2022 at 62.1 mm.

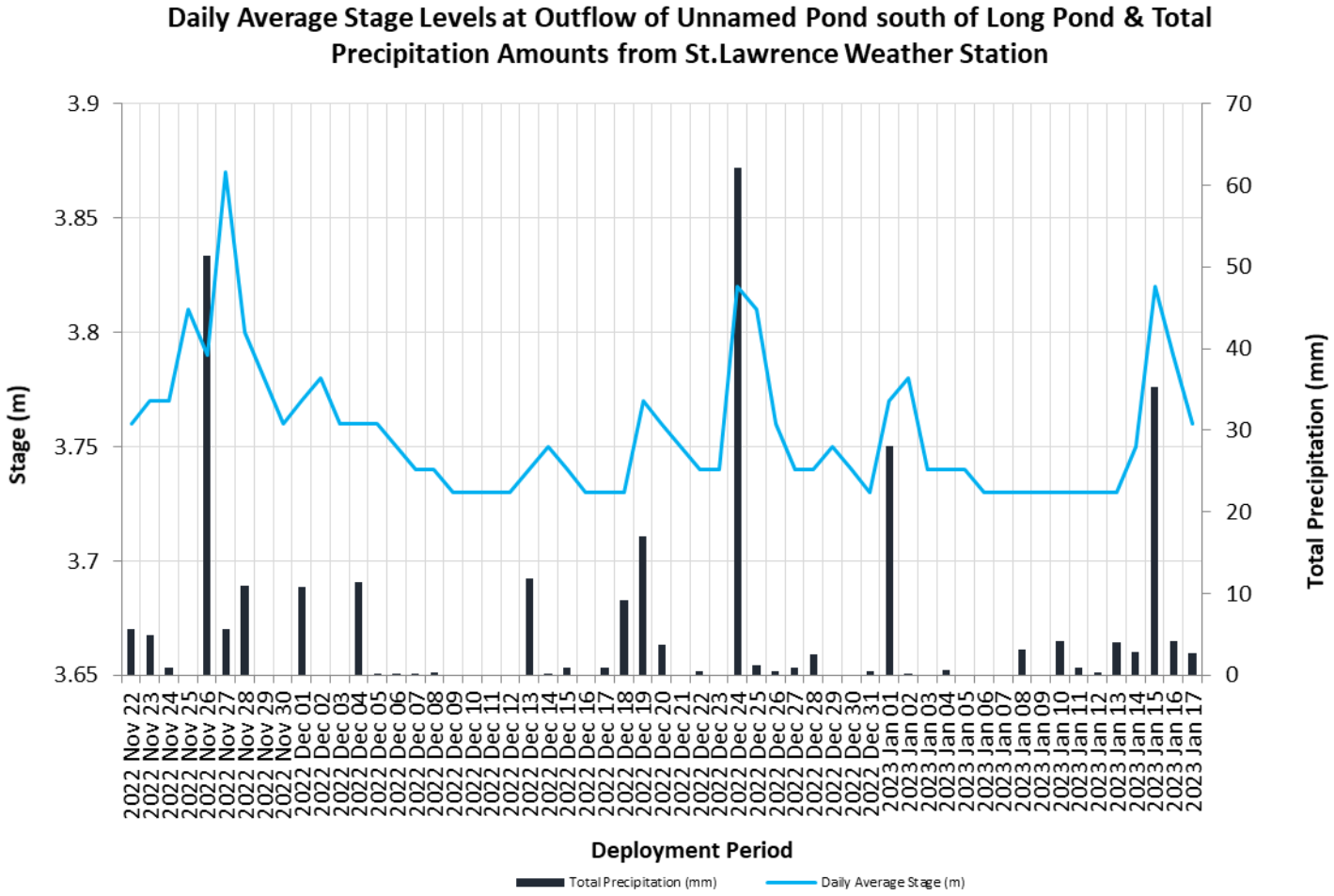
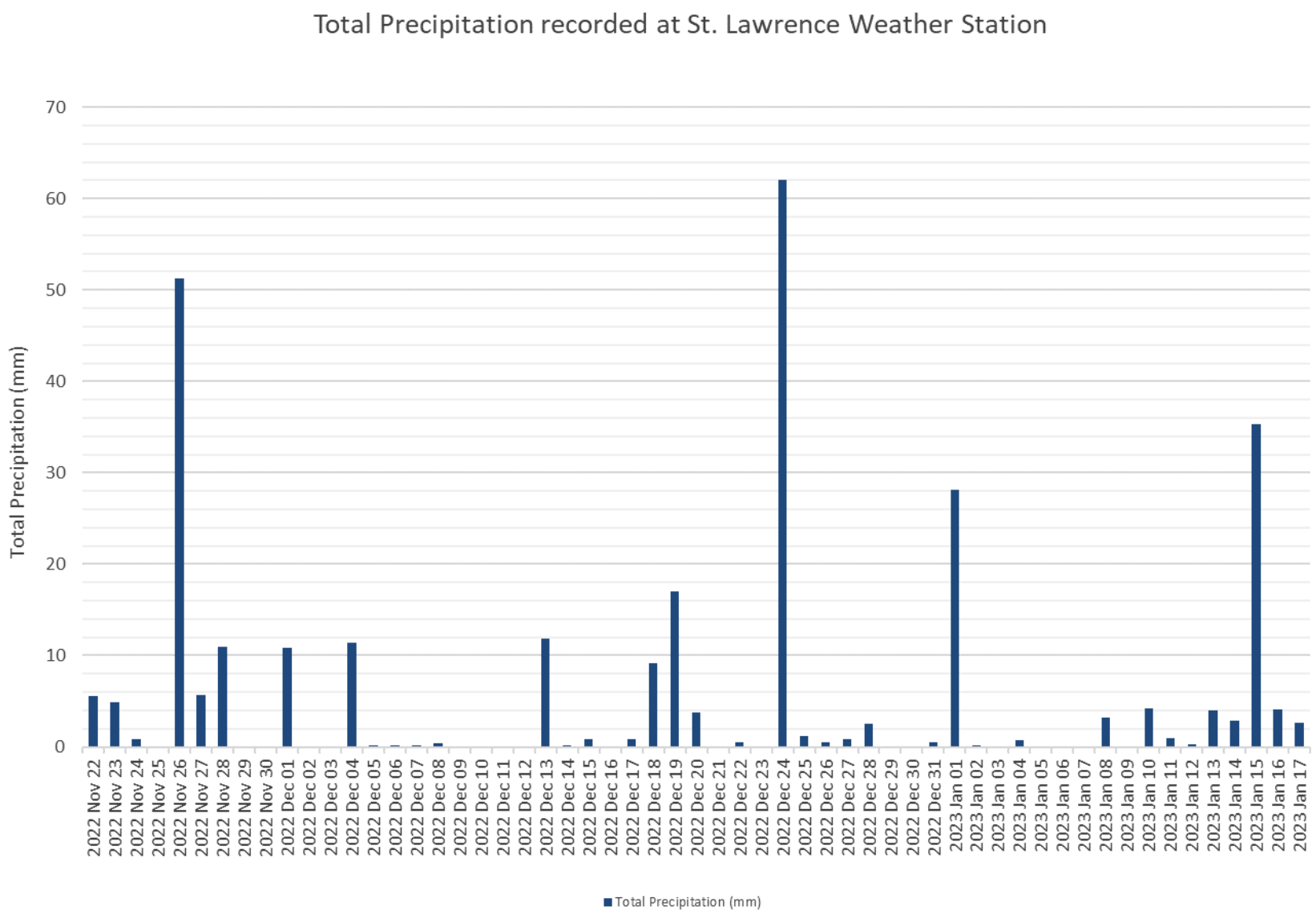


Figure 16: Daily averaged stage values and total precipitation.

APPENDIX I

Total Precipitation recorded at Environment Canada, St. Lawrence Weather Station


Total Precipitation recorded at St. Lawrence Weather Station
Total Precipitation (mm)
70
60
50
40
30
20
10
0
2022 Nov 22
2022 Nov 23
2022 Nov 24
2022 Nov 25
2022 Nov 26
2022 Nov 27
2022 Nov 28
2022 Nov 29
2022 Nov 30
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Total Precipitation (mm)