Real-Time Water Quality Report

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

**Annual Deployment Period
May 9th, 2023 to January 24th, 2024**

Newfoundland Labrador

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

Prepared by:

Victoria Hollohan
Environmental Scientist
Water Resources Management Division
Department of Environment & Climate Change
4th Floor, Confederation Building, West Block
St. John's NL A1B 4J6
Ph. No.: (709) 729 - 5925
victoriahollohan@gov.nl.ca

Introduction

The Water Resources Management Division (WRMD) maintain real-time water quality (RTWQ) and water quantity monitoring stations on John Fitzpatrick Pond and Outflow of Unnamed Pond south of Long Pond at the Canada Fluorspar Inc. mine site near St. Lawrence, Newfoundland and Labrador. The purpose of these stations is to monitor the impacts of mining activities on surface water downstream of the Tailings Management Facility and open pit mines.

Canada Fluorspar Inc. (CFI) entered a state of cold idle in 2022, halting all mining and production activities at the site. This status persisted throughout 2023. However, around June 2023, the mine restarted following its acquisition by a new owner with the goal to begin production at a later date. In April 2023, WRMD assumed responsibility for water quantity monitoring at each station which involves maintaining the datalogger and bubbler, periodic water level checks and other related duties.
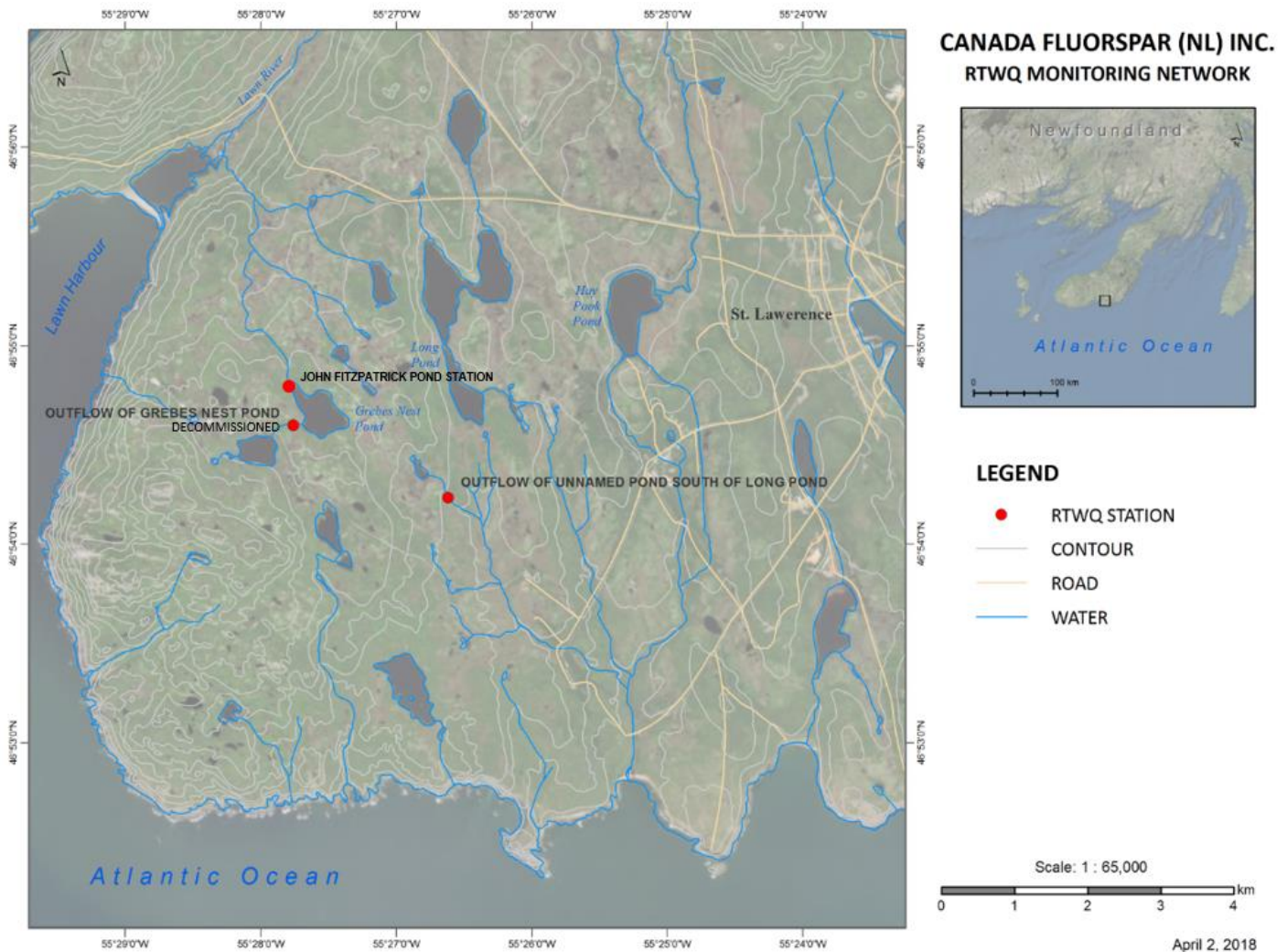

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc.

Decommission of Outflow of Grebes Nest Pond

Due to a change in the water supply, it was determined that Outflow to Grebes Nest Pond would not provide adequate, consistent water supply to remain a monitoring station. A replacement station location was selected and the hut and water quality instrumentation were relocated in May 2022 to John Fitzpatrick Pond, which has consistent water supply and the capability to provide an overview of the water quality conditions.

John Fitzpatrick Pond

John Fitzpatrick Pond RTWQ station was established in May 2022, with an instrument first deployed in June 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 provides stable and beneficial water quality data for the monitoring network (Figure 2).

The Real Time station was established on the northwest bank of John Fitzpatrick Pond, close to the only outflow from the pond. This pond is surrounded by natural habitat on the northeast side and bordered by the CFI mine on the southwest side (Figure 1). There are two small brooks that periodically flow into this pond. This station monitors the water quality and the stage level of the pond. The instrument is deployed, at a depth of approximately 1.0 meter. The GPS coordinates for this site are as follows: **N 46° 54' 47.95" W 055° 27' 46.97"**.

Figure 2: Real-Time station at John Fitzpatrick Pond. Station hut (left) and the instrument deployed in the pond (right)

Outflow of Unnamed Pond south of Long Pond

Outflow of Unnamed Pond south of Long Pond was established in December 2016 and is located downstream of the Tailings Management Facility (TMF). This station provides 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 3). 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: **N 46° 54' 14.1" W 55° 26' 37.5"**. The station hut was placed on the west bank approximately 8 meters from the stream (Figure 3).

Figure 3: Real-Time station at Outflow of Unnamed Pond South of Long Pond Station. The hut (left) and the instrument deployed in the brook (right).

Station Setup

Water quality parameters are measured at each station using an EXO 2 multiprobe instrument (Figure 4).

Figure 4: 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 specific conductivity and water temperature to calculate the total dissolved solids (TDS) present in the brook.

Water quality data is collected on an hourly basis (every 60 minutes) at both stations. Water quantity data is logged at John Fitzpatrick Pond every 5 minutes and at the Outflow of Unnamed Pond every 15 minutes.

The data for both stations is viewable and downloadable online through WRMD's Real Time Water Monitoring webpage located here: Real Time Water Quality Monitoring Stations - Environment and Climate Change (gov.nl.ca)

Data Interpretation

WRMD staff with the Department of Environment & Climate Change (ECC) are responsible for maintenance of the real-time water monitoring equipment, as well as grooming, analyzing, and reporting on the water quality data recorded at the stations. Performance and data records are 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

Water Resources Management Division hydrometric data is quality controlled on a less frequent basis than water quality data due to differences in protocols. **The hydrometric data shown in this report is provisional and has not undergone quality control checks.**

The following report discusses the water quality parameters recorded from May 2023 to January 2024. These interpretations aim to point out seasonal trends and any significant issues influencing the water quality parameters.

Quality Assurance and Quality Control

To ensure accurate data collection, water quality instruments are subjected to quality assurance procedures 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. Approximately every six weeks, the instrument is removed from the waterbody to undergo quality assurance procedures, while a newly cleaned and calibrated instrument is deployed.

During 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. Table 1 below summarizes the deployment periods and comparison rankings for 2023-24. Additionally, grab samples are collected during deployment to compare pH, turbidity, and specific conductivity values against the field sonde. Grab sample – field sonde performance rankings can be found below in Table 2. Based on the degree of difference between the parameters on the Field Sonde and QA/QC Sonde/grab sample, the water quality data is assigned a performance ranking (i.e. poor, marginal, fair, good, excellent) which can be found in Table 3 below.

For more detailed analyses of a particular time period, date or deployment period, please refer to the individual deployment reports: Real Time Water Quality Information – Calibration Schedule and Deployment Reports - Environment and Climate Change (gov.nl.ca)

Canada Fluorspar (NL) Inc, Newfoundland and Labrador

Table 1: 2023-24 Deployment Periods and Field Sonde-QA/QC Sonde Performance Rankings

Station	Date	Action	2023 Deployment Season Comparison Ranking				
			Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
John Fitzpatrick Pond	May 9, 2023	Deployment	N/A	N/A	N/A	N/A	N/A
	June 14, 2023	Removal	Good	Excellent	Good	Excellent	Excellent
Outflow to Unnamed Pond south of Long Pond	May 10, 2023	Deployment	Excellent	Good	Excellent	Good	Excellent
	June 14, 2023	Removal	Good	Excellent	Excellent	Excellent	Excellent
John Fitzpatrick Pond	June 14, 2023	Deployment	Good	Excellent	Excellent	Excellent	Good
	July 18, 2023	Removal	Good	Excellent	Good	Excellent	Excellent
Outflow to Unnamed Pond south of Long Pond	June 14, 2023	Deployment	Good	Excellent	Excellent	Excellent	Good
	July 18, 2023	Removal	Excellent	Excellent	Excellent	Good	Fair
John Fitzpatrick Pond	July 18, 2023	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	August 22, 2023	Removal	Excellent	Good	Excellent	Excellent	Excellent
Outflow to Unnamed Pond south of Long Pond	July 18, 2023	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	August 22, 2023	Removal	Excellent	Good	Excellent	Excellent	Excellent
John Fitzpatrick Pond	August 22, 2023	Deployment	Excellent	Excellent	Excellent	N/A	N/A
	Sept. 21, 2023	Removal	Excellent	Excellent	Excellent	N/A	N/A
Outflow to Unnamed Pond south of Long Pond	August 22, 2023	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Sept. 21, 2023	Removal	Good	Excellent	Excellent	Excellent	Good
John Fitzpatrick Pond	Sept. 21, 2023	Deployment	Excellent	Good	Good	Excellent	Excellent
	October 24, 2023	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Outflow to Unnamed Pond south of Long Pond	Sept. 21, 2023	Deployment	Excellent	Good	Good	Excellent	Excellent
	October 24, 2023	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
John Fitzpatrick Pond	October 24, 2023	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	December 11, 2023	Removal	Good	Good	Excellent	Good	Excellent
Outflow to Unnamed Pond south of Long Pond	October 24, 2023	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	December 11, 2023	Removal	Good	Fair	Excellent	Excellent	Excellent
John Fitzpatrick Pond	December 11, 2023	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	January 24, 2024	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
Outflow to Unnamed Pond south of Long Pond	December 11, 2023	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	January 24, 2024	Removal	Excellent	Good	Excellent	Excellent	Good

Table 2: 2023 Deployment Season Grab Sample-Field Sonde Performance Rankings

Date	Station	2023 Deployment Season Grab Sample Comparison Ranking		
		pH	Specific Conductivity	Turbidity
May 9, 2023	John Fitzpatrick Pond	N/A	N/A	N/A
May 10, 2023	Outflow to Unnamed Pond south of Long Pond	Good	Excellent	Excellent
June 14, 2023	John Fitzpatrick Pond	Excellent	Good	Excellent
	Outflow to Unnamed Pond south of Long Pond	Good	Good	Good
July 18, 2023	John Fitzpatrick Pond	Good	Excellent	Excellent
	Outflow to Unnamed Pond south of Long Pond	Good	Excellent	Excellent
August 22, 2023	John Fitzpatrick Pond	Good	Good	N/A
	Outflow to Unnamed Pond south of Long Pond	Good	Good	Excellent
September 21, 2023	John Fitzpatrick Pond	Good	Fair	Excellent
	Outflow to Unnamed Pond south of Long Pond	Good	Good	Excellent
October 24, 2023	John Fitzpatrick Pond	Excellent	Excellent	Excellent
	Outflow to Unnamed Pond south of Long Pond	Good	Good	Excellent
December 11, 2023	John Fitzpatrick Pond	Good	Good	Excellent
	Outflow to Unnamed Pond south of Long Pond	Good	Fair	Excellent

Table 3: 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 2023-24 Season

The Outflow of Unnamed Pond South of Long Pond RTWQ station consistently transmitted data without any significant issues throughout the 2023-24 season of deployments.

The John Fitzpatrick Pond RTWQ station encountered transmission problems early in the season. There is no performance data for the initial deployment due to transmission failure. It went offline multiple times during the initial deployment period from May 9th to June 14th, 2023. Troubleshooting was conducted during the instrument switch-out on June 14th, 2023, revealing potential issues with the datalogger or antenna. Despite this, a freshly calibrated instrument was deployed in the pond to internally collect measurements in case of further offline incidents. During the second deployment from June 14th to July 18th, 2023, the station faced additional transmission issues. It was determined on July 18th that the antenna was not functioning properly and was subsequently replaced on the station hut. Since then, the station has been operating and transmitting data consistently. Due to the transmission issues, there are segments of missing stage data from May 9th to July 18th, 2023.

There is no dissolved oxygen or turbidity data for John Fitzpatrick Pond station between August 22nd to September 21st, 2023 due to sensor malfunction.

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

Water Temperature

The John Fitzpatrick Pond water temperature ranged from 0.01°C to 24.80°C while the Outflow of Unnamed Pond south of Long Pond water temperature ranged from -0.06 °C to 28.58 °C. (Table 3).

Water temperatures at both stations display large diurnal variations (Figure 5/6). This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures (Figure 7). Trends in water temperature corresponded well with trends in air temperatures, displaying increases from June through August and decreases as Fall then Winter sets in.

Table 4: Summary of the 2023 Water Temperature data at CFI Real-Time Stations

	Water Temperature (°C)	
	John Fitzpatrick	Outflow of Unnamed
Min	0.01	-0.06
Max	24.80	28.58
Median	12.25	11.99

Figure 5: Water temperature (°C) recorded at John Fitzpatrick Pond RTWQ station throughout 2023

Water Temperature (°C) at Outflow of Unnamed Pond south of Long Pond RTWQ Station
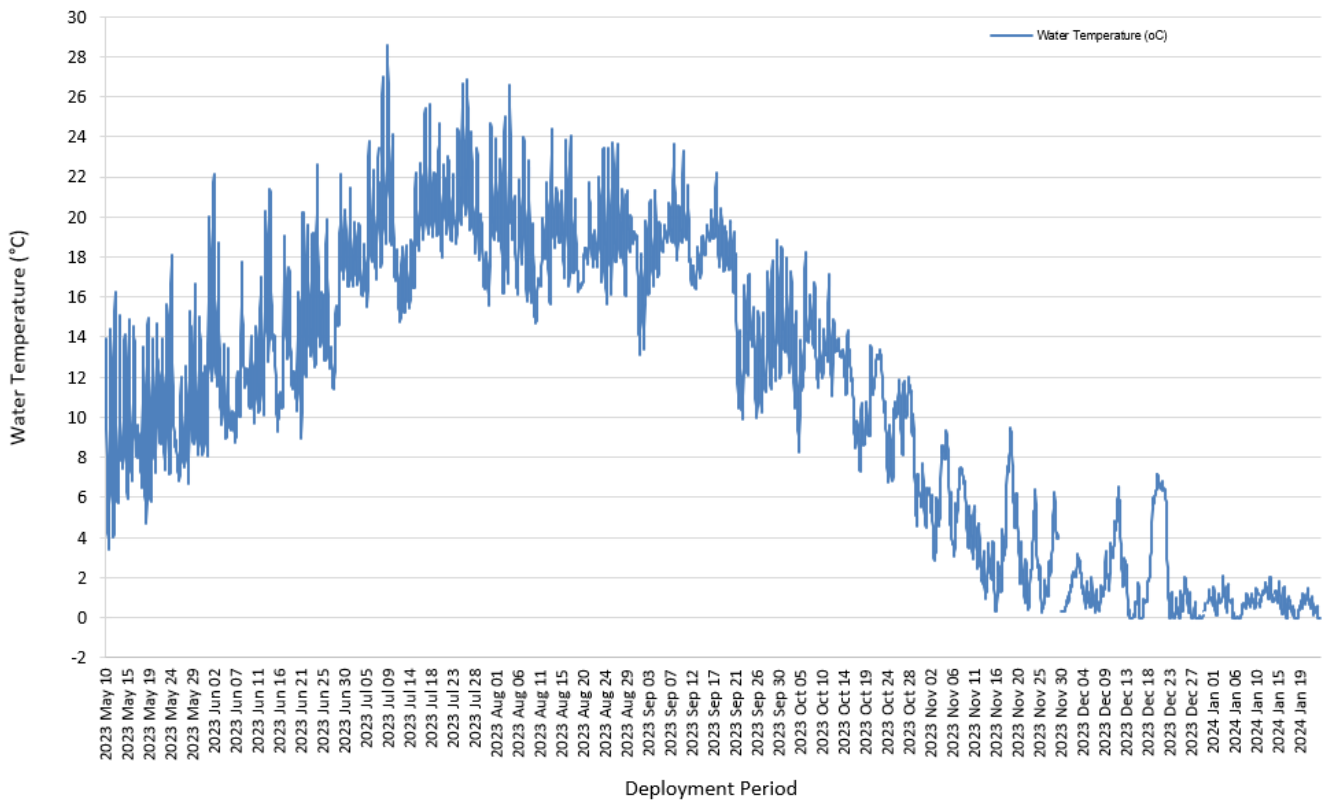

Figure 6: Water temperature (°C) recorded at Outflow of Unnamed RTWQ station throughout 2023

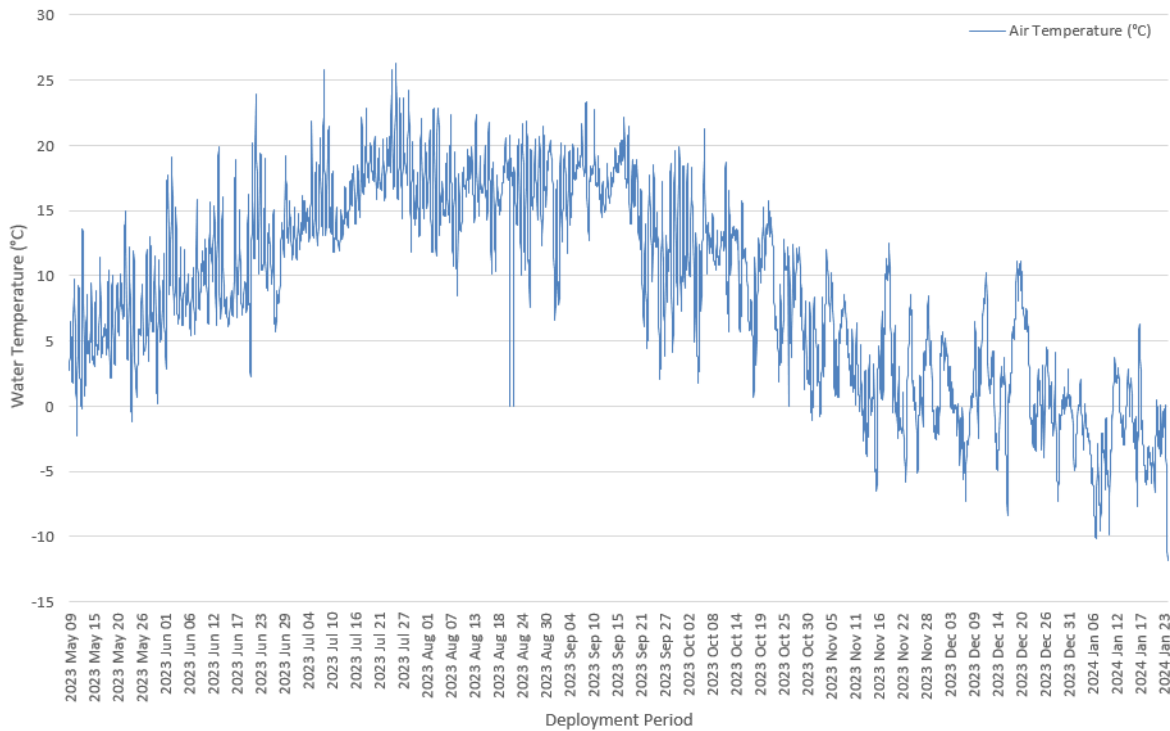## Hourly Air Temperature (°C) Recorded at St. Lawrence Weather Station

Figure 7: Hourly Air Temperature (°C) recorded at St. Lawrence Weather Station throughout 2023

pH

John Fitzpatrick Pond pH ranged from 7.03 to 8.0 pH units while at the Outflow of Unnamed Pond South of Long Pond station, the pH ranged from 6.78 to 8.10 pH units (Table 4). The Outflow of Unnamed typically experiences larger fluctuations due to it being a small brook that is easily influenced by environmental factors. John Fitzpatrick Pond had a median of 7.75 pH units which is slightly higher than the 2022 median of 7.61 (see Appendix II), which can likely be related to pumping of the open pit mines flowing into the pond. Outflow of Unnamed had a median of 7.78 pH units, which is similar to the 2022 median of 7.71.

pH at both stations was relatively consistent throughout the deployment season, remaining within the CCME Guidelines for the Protection of Aquatic Life of 6.5 – 9.0 pH units. There were several incidences where pH dipped down below background levels which can often be attributed to an increase in stage levels (Figure 8/9). Stage increases are typically the result of precipitation events.

Table 5: Summary of 2023 pH data at CFI Real-Time Stations

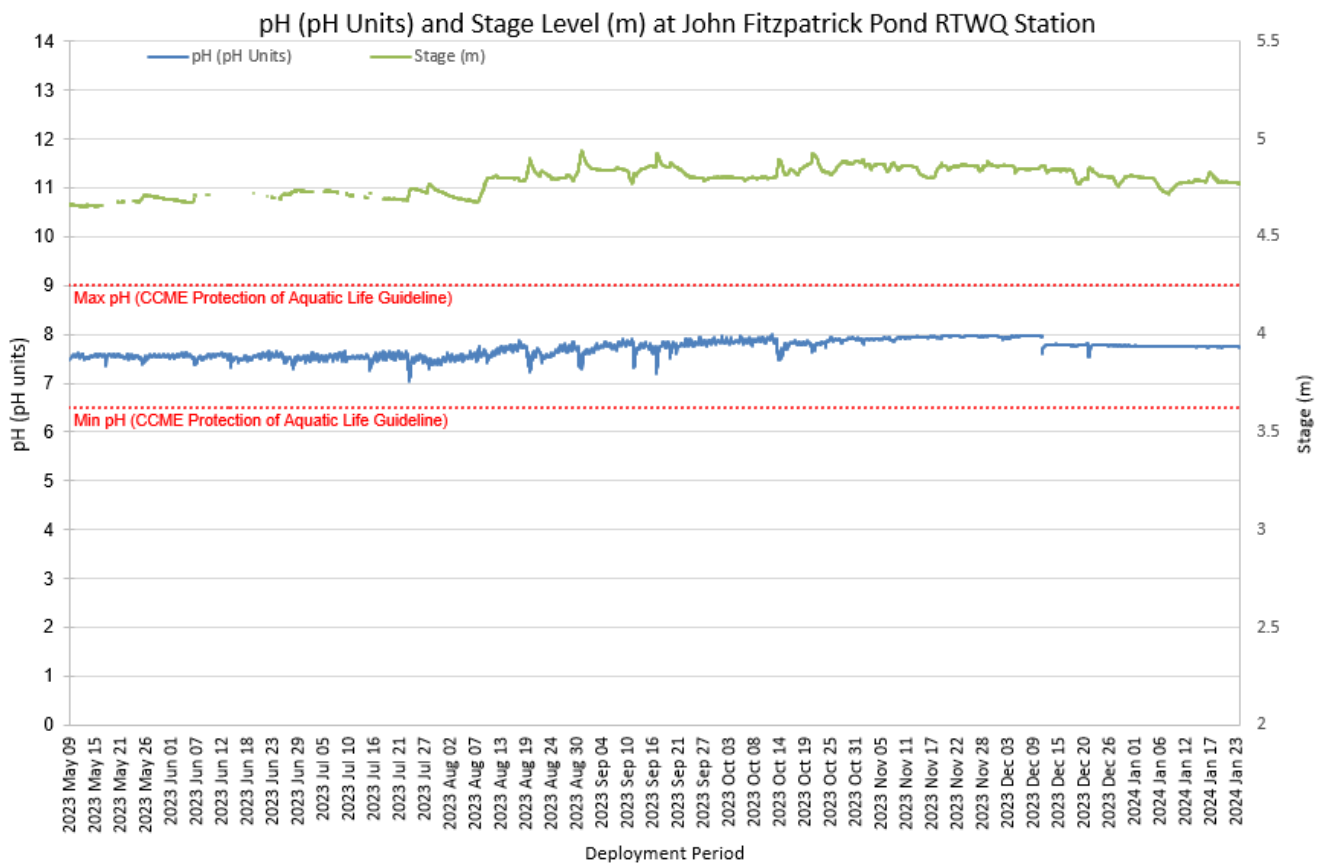|	pH (pH units)	
	John Fitzpatrick	Outflow of Unnamed
Min	7.03	6.78
Max	8.0	8.10
Median	7.75	7.78

Figure 8: pH and Stage Level (m) recorded at John Fitzpatrick Pond RTWQ Station throughout 2023
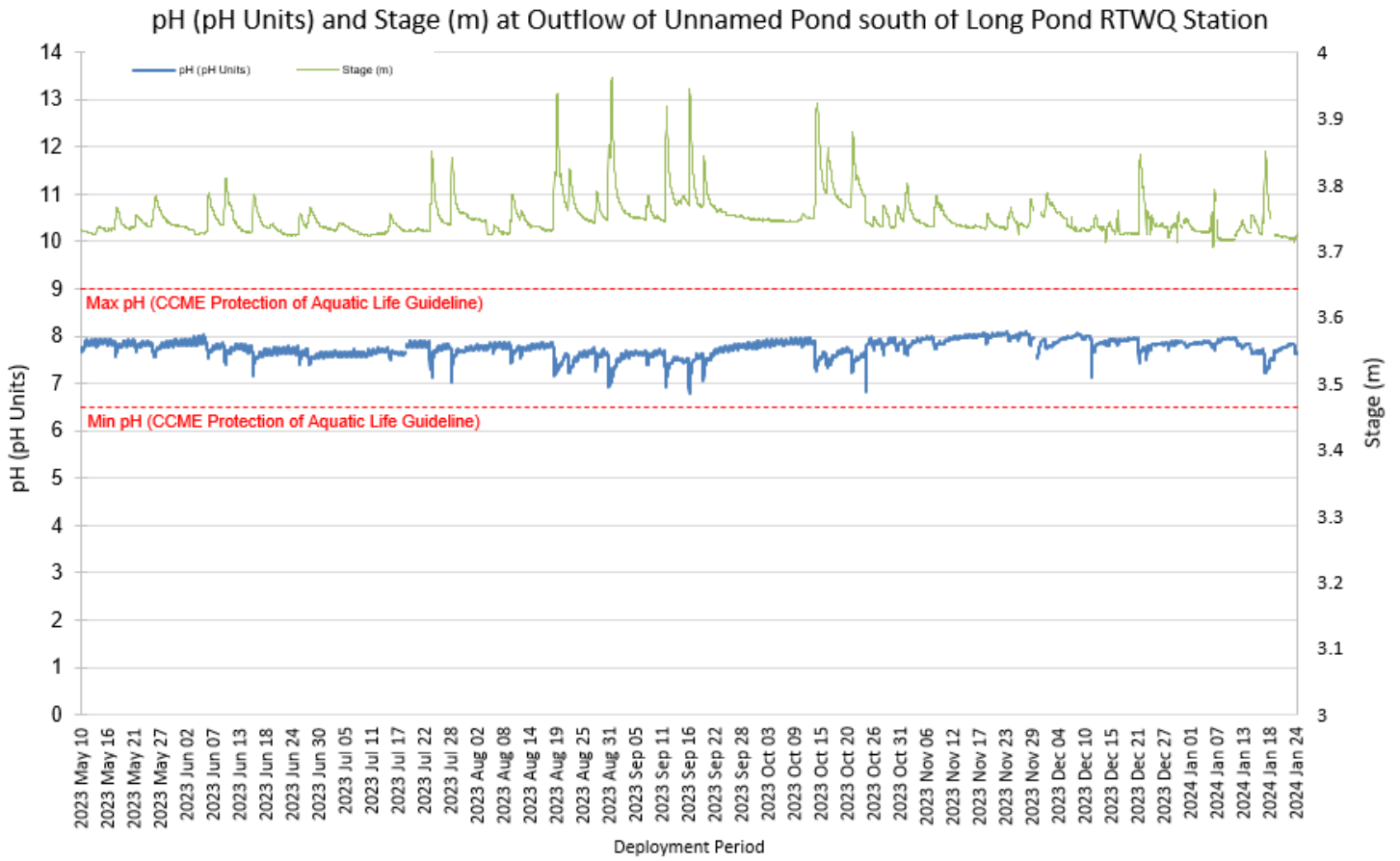
Figure 9: pH and Stage (m) recorded at Outflow of Unnamed Pond South of Long Pond RTWQ Station throughout 2023

Specific Conductivity

During the 2023 deployment season, conductivity levels ranged from 98.4 μS/cm to 272.52 μS/cm at John Fitzpatrick Pond and 88.88 μS/cm to 365.26 μS/cm at Outflow of Unnamed Pond south of Long Pond (see Table 5). There is a direct relationship between conductivity and stage. Generally during rainfall events, the additional water dilutes the minerals and material present in the water column, lowering the conductivity levels. However, if sediment or materials from the surrounding environment are flushed into the brook, conductivity levels may rise.

Specific conductivity recorded at John Fitzpatrick Pond had a median of 197.1 μS/cm, slightly elevated from the 2022 median of 165.6 μS/cm. Conductivity overall displayed an increasing trend beginning in August and coincides with increasing stage. This can be attributed to the pumping of the open pit mines into John Fitzpatrick Pond.

Specific conductivity recorded at Outflow of Unnamed Pond south of Long Pond had a median of 242.8 μS/cm, which is comparable to the 2022 median of 248.9 μS/cm. This station is located downstream from the Tailings Management Facility so typically any leaks from the TMF will cause noticeable increases in the conductivity levels. The fluctuations in conductivity observed throughout 2023 likely stem from precipitation events leading to increases in water levels. Significant drops coincide with spikes in water levels, followed by a gradual return of conductivity levels to their baseline (refer to Figure 11).

Table 6. Summary of 2023 specific conductivity data at the CFI Real-Time Stations

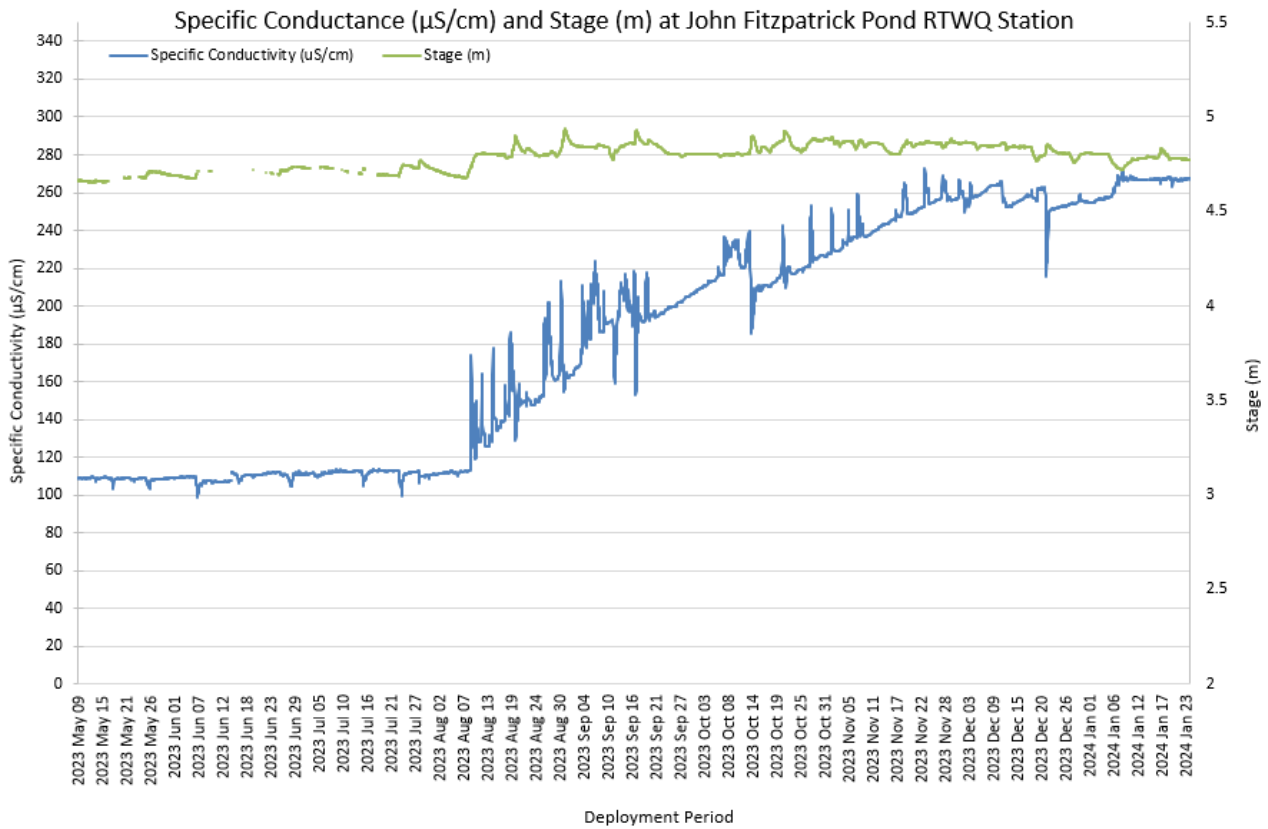|	Specific Conductivity (μS/cm)	
	John Fitzpatrick	Outflow of Unnamed
Min	98.40	88.88
Max	272.52	365.26
Median	197.06	242.84

Figure 10: Specific conductivity (µS/cm) recorded at John Fitzpatrick Pond Real-Time Station during 2023
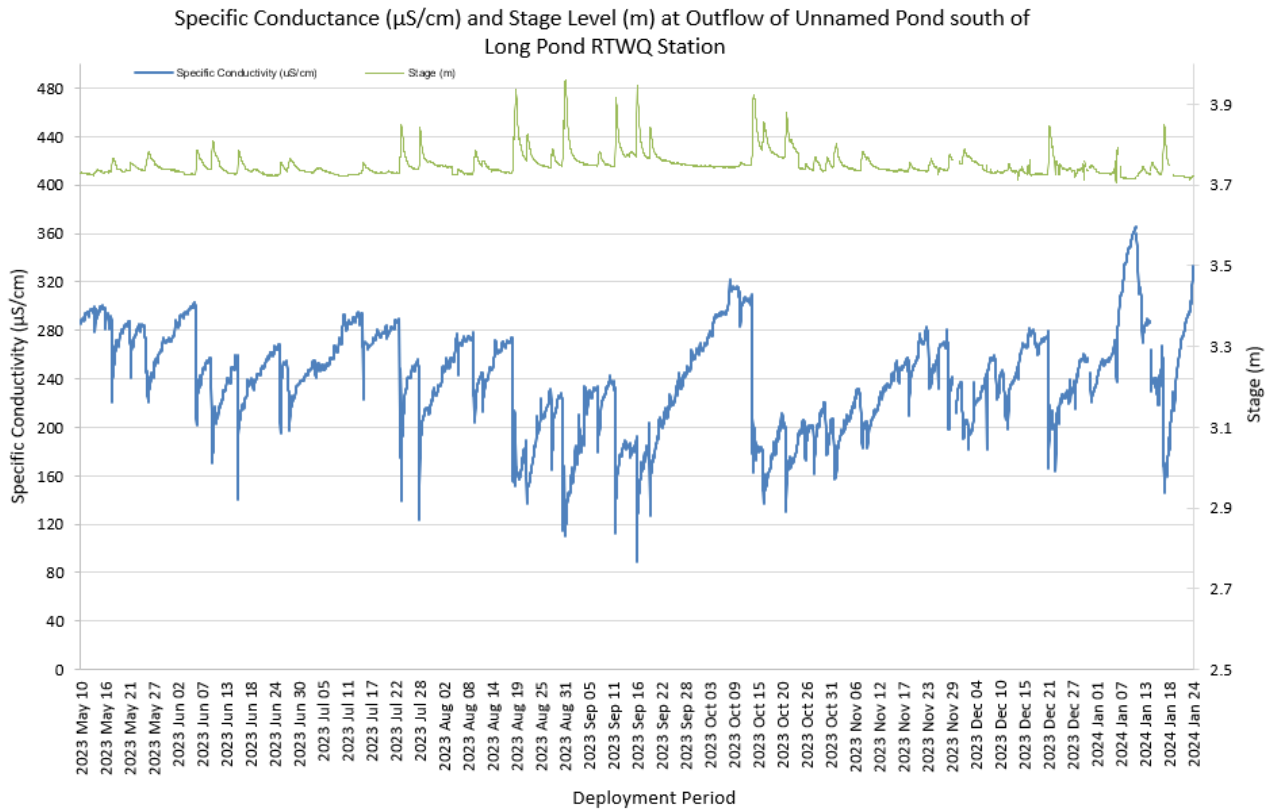

Figure 11: Specific conductivity (µS/cm) at the Outflow of Unnamed Pond South of Long Pond Real-Time Station during 2023

Dissolved Oxygen (DO)

Over the 2023 annual deployment period, the dissolved oxygen concentrations ranged from 8.01mg/L to 15.28mg/L at John Fitzpatrick Pond, with percent saturation levels ranging between 88.3% to 114.7%. Outflow of Unnamed Pond south of Long Pond dissolved oxygen concentrations ranged from 7.44 mg/L to 14.9 mg/L and percent saturation ranged from 89.3 % to 109.8 % (see Table 6). DO 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 a portion of the year.

There is no dissolved oxygen data for John Fitzpatrick Pond station between August 22nd to September 21st, 2023 due to sensor failure.

Dissolved oxygen levels exhibited natural daily fluctuations at both locations due to changes in temperature and the photosynthetic activity of aquatic organisms regarding CO_2. The patterns observed in DO align with the inverse relationship with water temperature; colder water tends to hold more dissolved oxygen compared to warmer water.

Table 7. Summary of 2023 Dissolved oxygen data at Canada Fluorspar Inc. Real-Time Stations

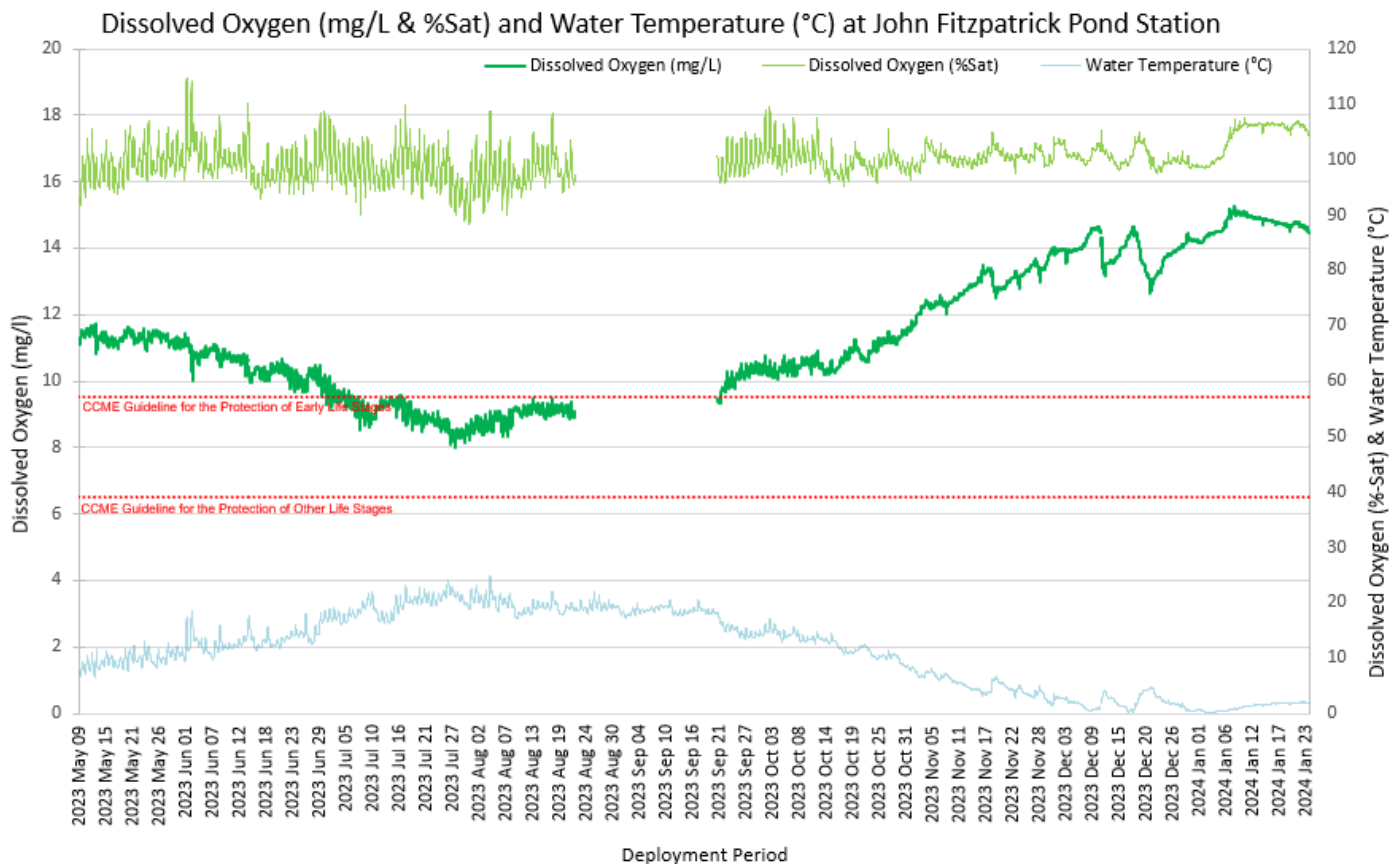|	John Fitzpatrick Dissolved Oxygen		Unnamed Pond Dissolved Oxygen	
	mg/L	%Sat	mg/L	%Sat
Min	8.01	88.30	7.44	89.30
Max	15.28	114.70	14.90	109.80
Median	11.02	99.80	10.58	98.20

Figure 12: Dissolved Oxygen (%Sat and mg/l) and Water Temperature (°C) at John Fitzpatrick Pond Real-Time Station throughout 2023
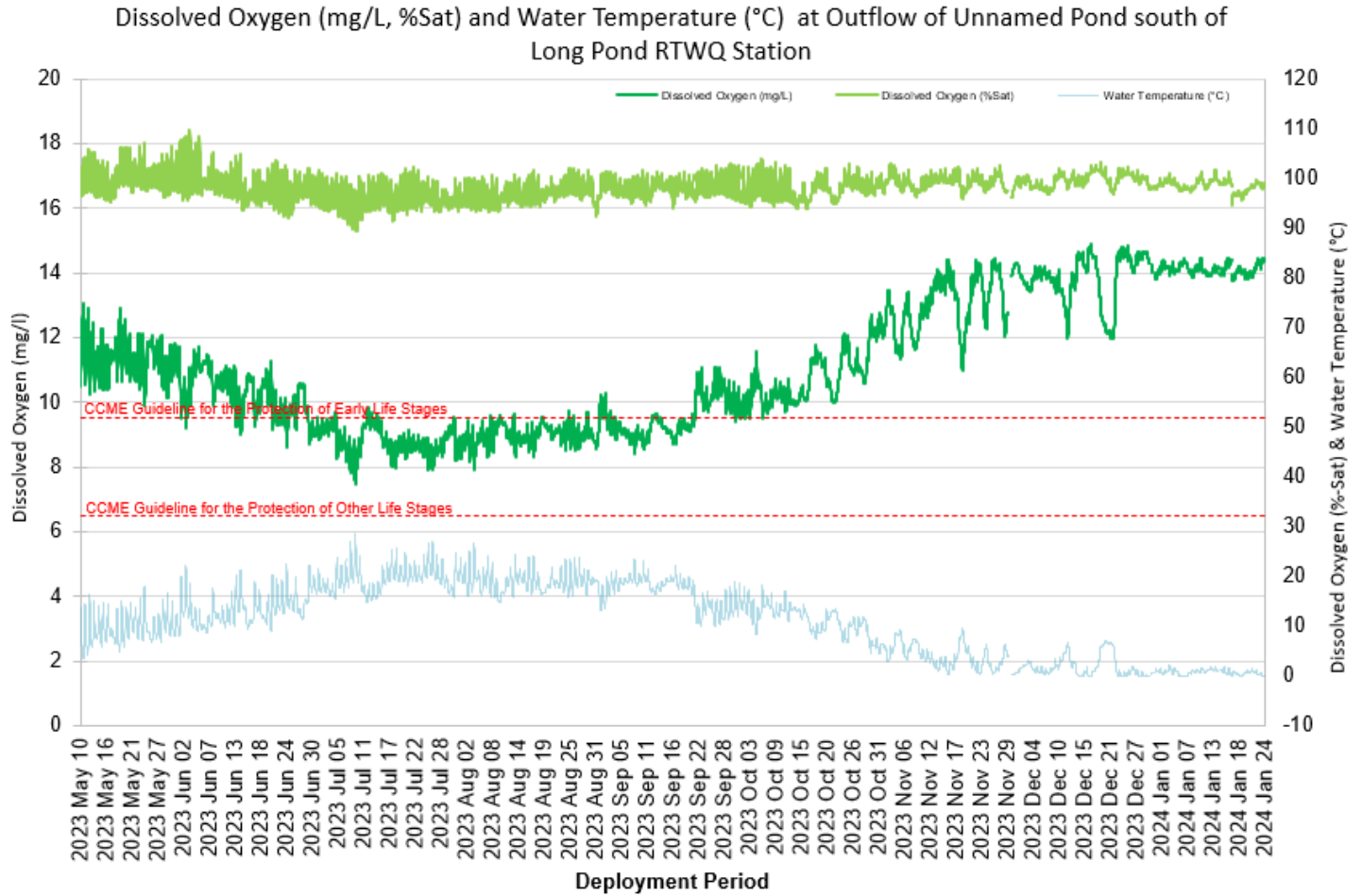
Figure 13: Dissolved Oxygen (%Sat and mg/l) and Water Temperature (°C) at Outflow of Unnamed Real-Time Station throughout 2023

Turbidity

Turbidity levels during the deployment ranged from 0.3 NTU to 18.5 NTU at John Fitzpatrick Pond and 0.6 NTU to 14.1 NTU at Outflow of Unnamed Pond south of Long Pond.

Turbidity levels at both stations remained relatively low and consistent, staying below 20 NTU for the entire year. Spikes in the data are typically a result of precipitation events that could result in increased sediment entering the water column from run-off, or disturbed sediment in the water column. Turbidity returned to background values shortly after spikes.

Table 8. Summary for 2023 Turbidity data at CFI Real-Time stations

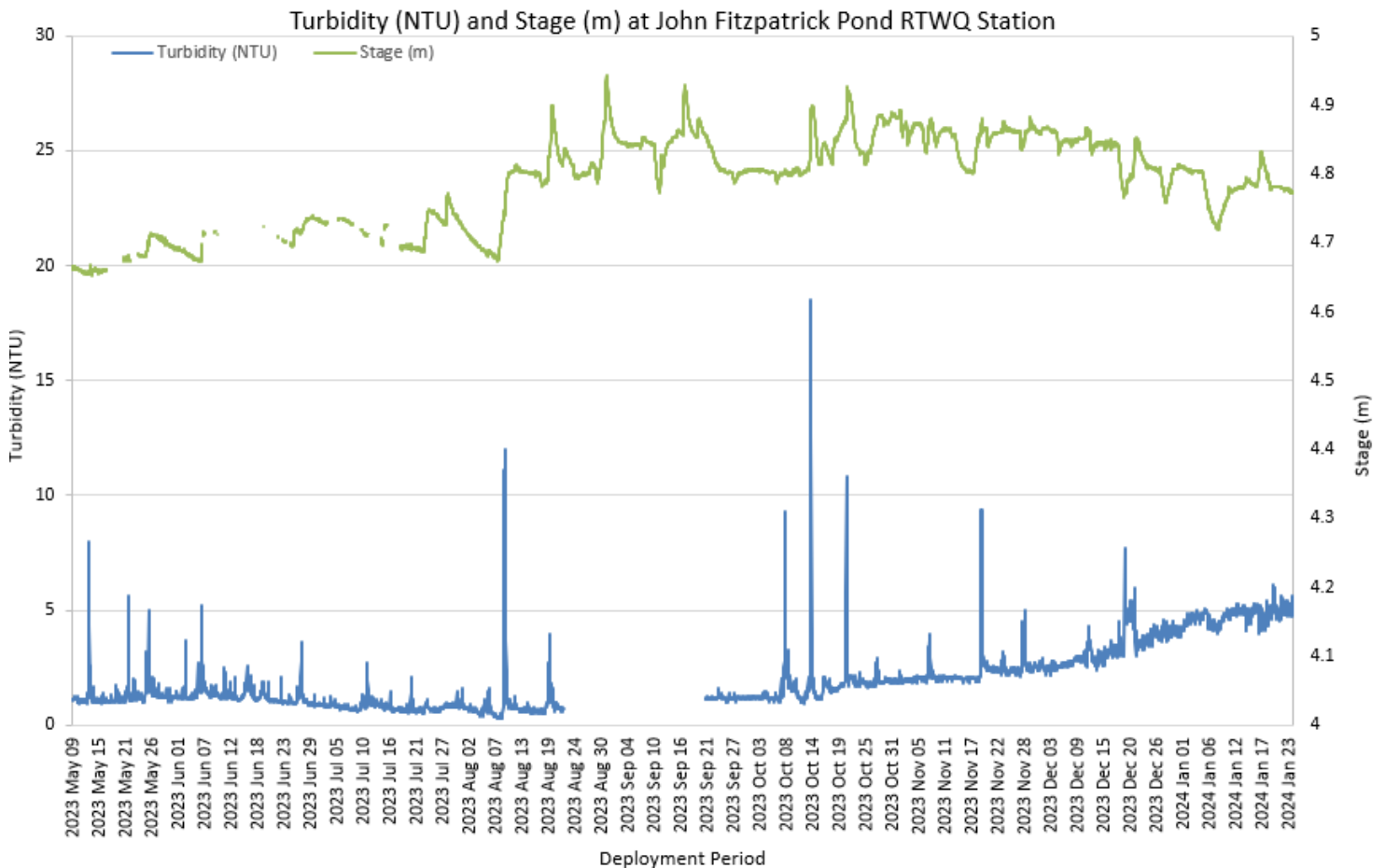|	Turbidity (NTU)	
	John Fitzpatrick	Outflow of Unnamed
Min	0.30	0.59
Max	18.50	14.10
Median	1.45	2.20

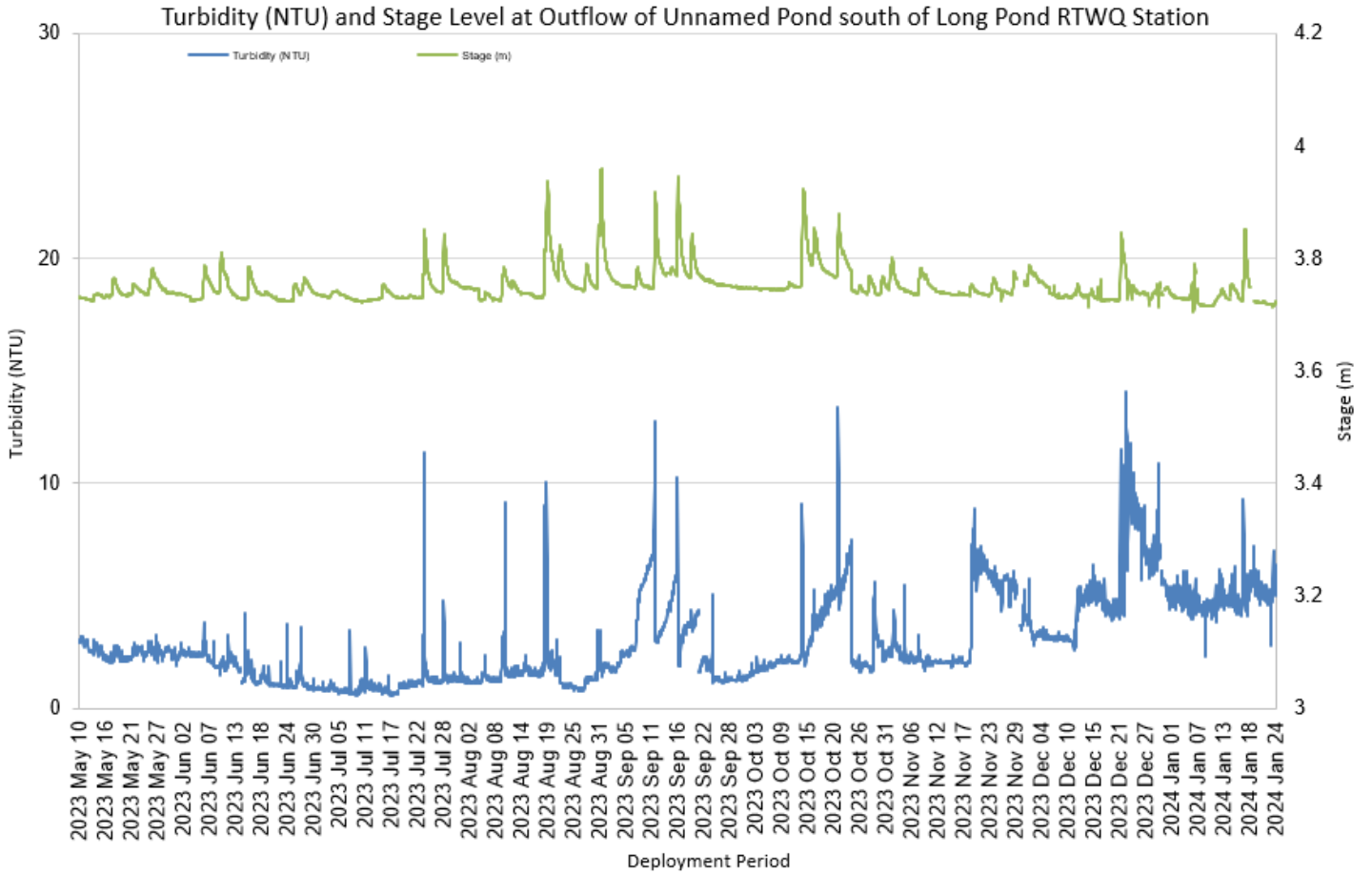**Figure 14: 2023 Turbidity (NTU) measurements record at John Fitzpatrick Pond Real-Time Station**

Figure 15: 2023 Turbidity (NTU) values at Outflow of Unnamed Pond South of Long Pond Real Time Station

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 16) and during any surrounding snow or ice melt as runoff collects in the brooks. Total hourly precipitation data was obtained from Environment Canada's St. Lawrence weather station. Although the stations are not on the same river, both sites had similar peaks in stage during the rainfall events.

Water Resources Management Division hydrometric data is quality controlled on a less frequent basis than water quality data due to differences in protocols. The hydrometric data shown in this report is provisional and has not undergone quality control checks.

Table 9. Summary of 2023 Stage data at CFI Real-Time stations

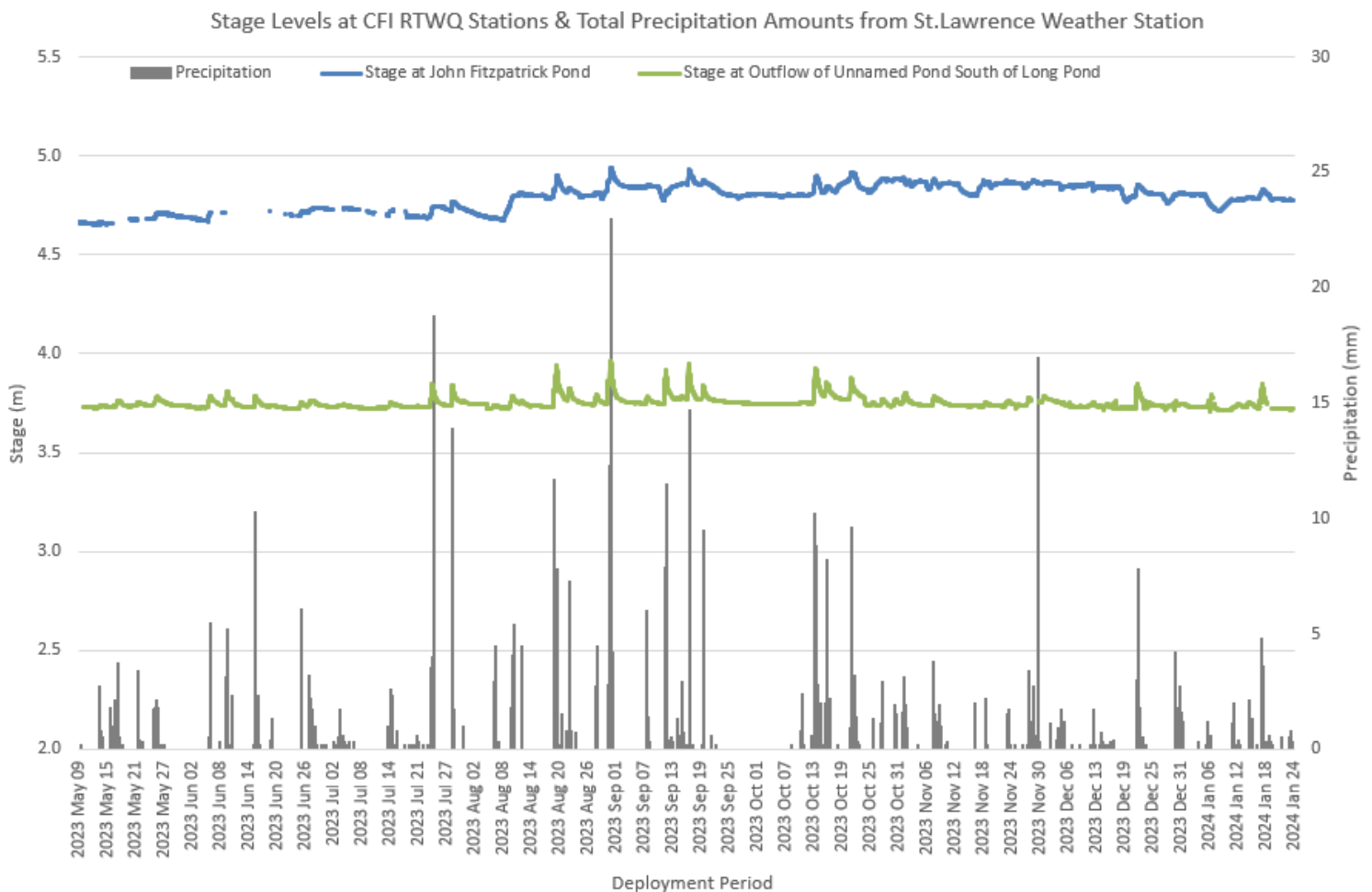|	Stage (m)	
	John Fitzpatrick	Outflow of Unnamed
Min	4.65	3.71
Max	4.94	3.96
Median	4.81	3.74

Figure 16: 2023 Stage values and total hourly precipitation from St. Lawrence Weather Station

Conclusion

The water quality monitoring for the Canada Fluorspar Inc. network commenced at John Fitzpatrick Pond and Outflow to Unnamed Pond south of Long Pond on May 9th, 2023 and May 10th, 2023, respectively. Instruments were removed at both stations for the winter season on January 24th, 2024. 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 John Fitzpatrick Pond are impacted by anthropogenic changes from adjacent mining activity. The health of a brook can be determined by how quickly it returns to its background data level after a water quality event.

Throughout deployment, water temperatures followed the expected seasonal trend of increasing during the summer and decreasing into the fall. pH at both stations remained relatively consistent across deployments. Specific conductivity fluctuated with stage increases at Outflow of Unnamed, while conductivity at John Fitzpatrick Pond observed a noticeable increase near the midway point of deployment season due to pumping activities, although both stations remained within healthy ranges. Turbidity remained relatively low and consistent throughout the deployment season at both stations, other than a few spikes which coincide with precipitation events.

The water quality parameters displayed expected data for surface water bodies that can be periodically impacted by anthropogenic events.

Path Forward 2024

- The water quality instruments will undergo proficiency testing and evaluation during the winter of 2023-2024. ECC will inform Canada Fluorspar of any instrument performance issues.

- ECC staff will deploy real time water quality instruments in spring 2024, when ice conditions allow and perform regular site visits throughout the 2024 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.

- ECC staff will continue monitoring water level, recording water quantity measurements, and maintaining equipment upkeep.

- Ongoing liaison between ECC and Canada Fluorspar 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 (℃) 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

COMPARISON STATISTICS ACROSS DEPLOYMENTS AT CANADA FLUORSPAR INC

Comparison Statistics from 2019

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

Comparison Statistics from 2020

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

Comparsion Statistics from 2021

	Water Temperature (oC)		pH (pH units)		Specific Conductivity (µS/cm)		Dissolved Oxygen (mg/L)		Dissolved Oxygen (%Sat)		Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed	Outflow of Grebes	Outflow of Unnamed	Outflow of Grebes	Outflow of Unnamed	Outflow of Grebes	Outflow of Unnamed	Outflow of Grebes	Outflow of Unnamed	Outflow of Grebes	Outflow of Unnamed
Min	0	-0.01	6.88	6.37	144.9	76.08	8.91	7.98	85.8	88.1	0.8	3.1
Max	19.2	27.28	8.35	8.02	497.95	510.94	14.16	14.25	108.6	118.4	6616	792.5
Median	9.78	10.87	7.76	7.46	341.1	169.41	10.85	10.93	97.6	98.4	12.4	20

Comparsion Statistics from 2022

	Water Temperature (oC)		pH (pH units)		Specific Conductivity (µS/cm)		Dissolved Oxygen (mg/L)		Dissolved Oxygen (%Sat)		Turbidity (NTU)	
	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed
Min	-0.21	-0.17	6.59	6.43	92.2	70.24	8.2	8.04	89.1	90.9	0.04	0.3
Max	25.36	28.49	7.85	8.15	165.6	358.74	15.4	15.12	114.7	108.3	95.54	202.3
Median	13.05	13.16	7.61	7.71	155.75	248.88	10.92	10.45	101.3	98.8	1.18	3.8

Comparsion Statistics from 2023

	Water Temperature (oC)		pH (pH units)		Specific Conductivity (µS/cm)		Dissolved Oxygen (mg/L)		Dissolved Oxygen (%Sat)		Turbidity (NTU)	
	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed	John Fitzpatrick	Outflow of Unnamed
Min	0.01	-0.06	7.03	6.78	98.4	88.88	8.01	7.44	88.3	89.3	0.3	0.59
Max	24.8	28.58	8	8.1	272.52	365.26	15.28	14.9	114.7	109.8	18.5	14.1
Median	12.25	11.99	7.75	7.78	197.06	242.84	11.02	10.58	99.8	98.2	1.45	2.2