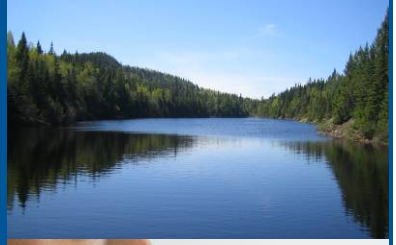







Real-Time Water Quality Report

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

Deployment Period
May 9, 2019 to December 11, 2019

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
Water Resources Management Division

Prepared by:

Leona Hyde
Environmental Scientist
Water Resources Management Division
Department of Municipal Affairs & Environment
4th Floor, Confederation Building, West Block
PO Box 8700, St. John's NL A1B 4J6
Ph. No.: (709) 729 - 3597
Fax No.: (709) 729 - 0320
taraclinton@gov.nl.ca

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.

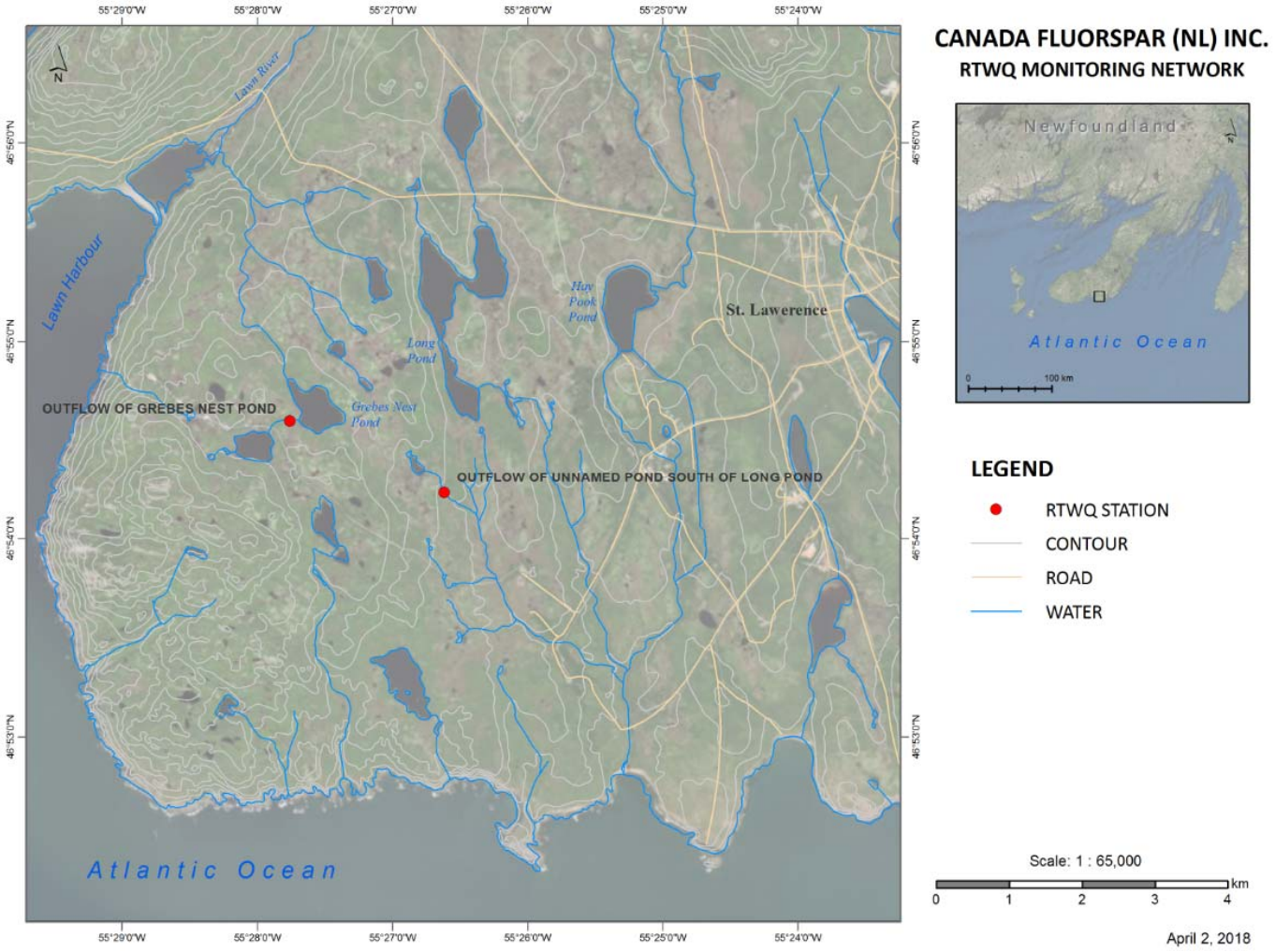

Figure 1: Real-Time Water Quality and Quantity Stations at Canada Fluorspar Inc

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.

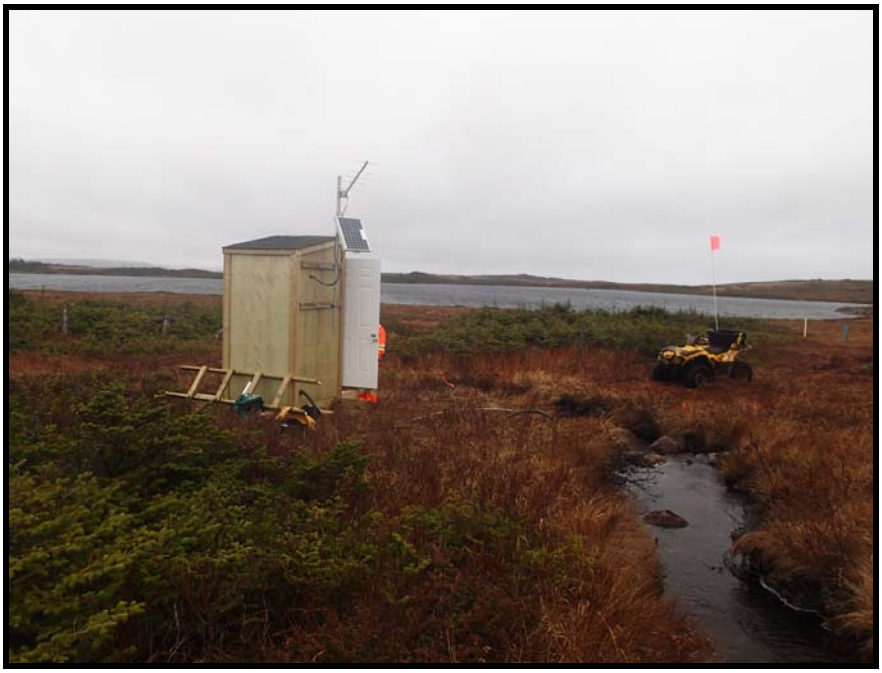

Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest Pond.

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). An additional water quality parameter, total dissolved solids (TDS) is calculated from specific conductivity and water temperature.

Water quality data is recorded 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.mae.gov.nl.ca/waterres/rti/stations.html

Data Interpretation

Performance issues and data records were interpreted for each station during the deployment period for the following parameters:

- Water Temperature (^{o}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 provided in Appendix A.

The following report discusses the water quality parameters over the deployment period from May 9, 2019 to December 11, 2019. These interpretations aim to point out seasonal and overall trends and any major issues influencing the parameters. Any gaps in data are the result of transmission loss or periods where the instrument was removed from the water.

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 Municipal Affairs and Environment (MAE) are responsible for maintenance of the real-time water quality monitoring equipment, as well as recording and managing the water quality data. Leona Hyde is MAE's main contact for the real-time water quality monitoring operation 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. Quality assurance procedures are carried out with each deployment period. Deployment periods for 2019 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 B 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.mae.gov.nl.ca/waterres/rti/rtwq/csdr/index.html

Table 1: Water quality instrument deployment start and end dates for 2019 at Canada Fluorspar (NL) Inc

		Deployment	Removal
Canada Fluorspar Real Time Stations	Outflow of Grebes Nest Pond	May 9, 2019	July 11, 2019
	Outflow of Unnamed Pond south of Long Pond	May 9, 2019	July 11, 2019
	Outflow of Grebes Nest Pond	July 11, 2019	August 20, 2019
	Outflow of Unnamed Pond south of Long Pond	July 11, 2019	August 20, 2019
	Outflow of Grebes Nest Pond	August 20, 2019	October 17, 2019
	Outflow of Unnamed Pond south of Long Pond	August 20, 2019	October 17, 2019
	Outflow of Grebes Nest Pond	October 17, 2019	December 11, 2019
	Outflow of Unnamed Pond south of Long Pond	October 17, 2019	December 11, 2019

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

During the deployment year, the water supply for Outflow of Grebes Nest Pond station was intermittent. The brook is fed upstream of the Real-Time station by dewatering of Grebes Nest Pit. After January 2019, CFI stopped pumping into the sedimentation pond, instead running water lines from the pit into the large brook through a geotextile bag for water supply. The station went offline from May 21st - 22nd and May 25th-29th due to transmission error resulting in loss of data for this period. The water quality sonde was temporarily removed on July 12th and was reinstalled on the 15th due to low water levels. The station experienced spotty transmissions from August 4-15th due to hardware issues.

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 corrected for backwater effect. 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

The Outflow of Grebes Nest Pond water temperature ranged from 2.41°C and 22.58°C while Outflow of Unnamed Pond south of Long Pond station the temperature ranged from -0.04 °C to 26.88 °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 11.62°C was higher than that of Outflow to Grebes Nest Pond which was 9.54°C (Table 3).

Water temperatures at all three 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.

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 2019 Water Temperature data at Fluorspar Real-Time Stations

	Water Temperature (oC)	
	Outflow of Grebes	Outflow of Unnamed
Min	2.41	-0.04
Max	22.58	26.88
Median	9.54	11.62

Figure 7: Water temperature (°C) values at the Canada Fluorspar Real-Time Water Quality Stations

pH

The Outflow of Grebes Nest Pond pH ranged from 6.21 to 8.13 while Outflow of Unnamed Pond south of Long Pond station the pH ranged from 7.31 to 8.44 (Table 4).

For the majority of the deployment, the pH data from 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. This pH range is lower than Outflow of Unnamed Pond and variations in measurements are a result of the dewatering effluent on the brook. The Outflow of Grebes Nest pond median of 7.6 pH units was higher than the median recorded for the 2018 deployment of 6.21 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 (Figure 9). The annual median at Unnamed Pond of 8.01 pH units was higher than the median recorded during 2018 of 7.87 pH units (Appendix D). Issues with seepage from the polishing pond may be affecting the values at this location.

Both water bodies decrease in stage during the same timeframes indicating that external climatic influences were likely the cause for some of the fluctuations in pH levels.

Table 4. Summary of 2019 pH data at Fluorspar Real-Time Stations

	pH(pH units)	
	Outflow of Grebes	Outflow of Unnamed
Min	6.21	7.31
Max	8.13	8.44
Median	7.6	8.01

Canada Fluorspar (NL) Inc, Newfoundland and Labrador

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

Specific Conductivity

Conductivity levels over the deployment year ranged from 190.2 µS/cm to 586.91 µS/cm at Outflow of Grebes Nest Pond (Table 5).

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.

Specific conductivity data recorded at Outflow of Grebes Nest Pond was generally higher in 2019 than 2018. The median for 2019 was 344.145 µS/cm compared to the 2018 median of 244.44 µS/cm. This was likely a result of the water supply issues and pumping schedule on site throughout 2019. There were occasions when the brook was not being supplemented and this likely resulted in a greater concentration of particle matter. Conductivity increases steadily over the summer period, peaking at its highest on June 27th before returning to background levels. Rainfall events can flush particles and reduce the conductivity in a brook for a short period of time, however, with the sediment laden intake from the pumping of Grebes Nest Pit upstream, the conductivity at Outflow to Grebes Nest Pond remained above 190 µS/cm throughout 2019 (Figure 10).

Conductivity levels at Outflow of Unnamed Pond south of Long Pond ranged from 182.12 µS/cm to 507.59 µS/cm. The 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 steadily increased. Conductivity levels started to plateau in October, but showed high variability between November and December.

Specific Conductivity levels at Outflow of Unnamed Pond south of Long Pond generally increased in 2019 when compared to 2018 data. The 2018 median was 234.8 µS/cm and the 2019 median was recorded at 357.94µS/cm. The conductivity data collected at Outflow of Unnamed Pond south of Long Pond indicates the seepage from the polishing pond upstream may be the result of higher conductivity levels recorded (Figure 10).

Table 5. Summary of 2019 specific conductivity data at Fluorspar Real-Time Stations

	Specific Conductivity (uS/cm)	
	Outflow of Grebes	Outflow of Unnamed
Min	190.2	182.12
Max	586.91	507.59
Median	344.145	357.94

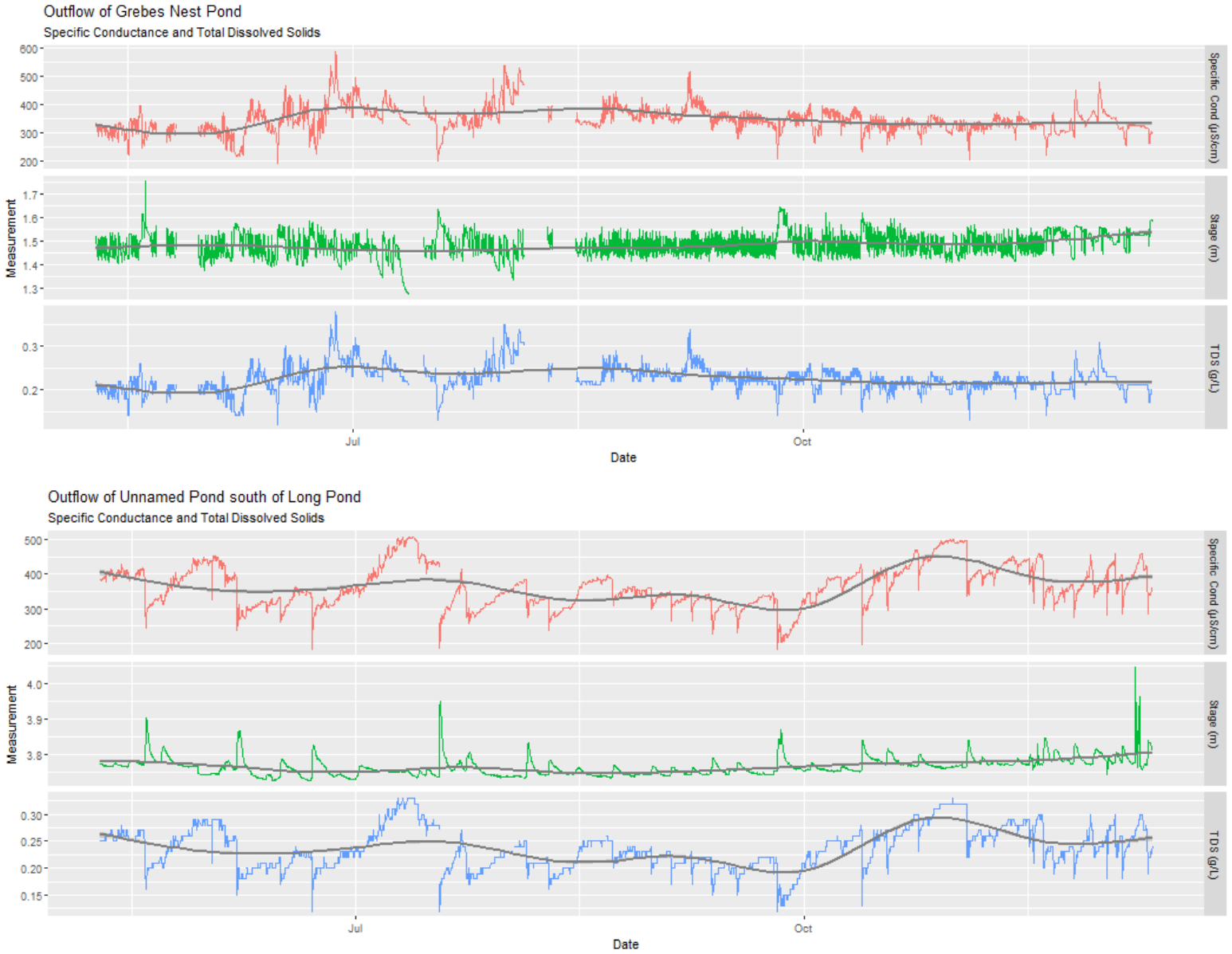

Figure 10: Specific conductivity (µS/cm) at the Canada Fluorspar (NL) Inc Real-Time Stations

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 7.36 mg/L to 13.27 at Outflow of Grebes Nest Pond (Table 6), the percent saturation levels for dissolved oxygen ranged 70.7% Saturation to 131% Saturation. The 2019 median of 10.41mg/L dissolved oxygen for Outflow of Grebes Nest Pond was higher than the 2018 median of 10.025 mg/L.

Outflow of Unnamed Pond south of Long Pond dissolved oxygen concentration ranged from 7.95 mg/L to 14.59 mg/L and Saturation ranged from 90.8 % to 103.6 %. The recorded median dissolved oxygen value for 2019 was 10.81 mg/L, while the median for 2018 was 11.00 mg/L (Appendix D).

DO levels show diurnal variations for both stations. These diurnal variations are related to diurnal fluctuations in temperature and photosynthetic cycling of CO2 by aquatic organisms. Trends in DO corresponded well with the inverse of water temperature, since colder water has a greater potential to dissolve oxygen compared to warmer water. As a result, DO is generally higher in the spring and fall 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 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 2019 Dissolved oxygen data at Fluorspar Real-Time Stations

	Grebes Dissolved Oxygen		Unnamed Pond Dissolved Oxygen	
	mg/L	%Sat	mg/L	%Sat
Min	7.36	70.7	7.98	90.8
Max	13.27	131	14.59	103.6
Median	10.41	90.6	10.81	98.4

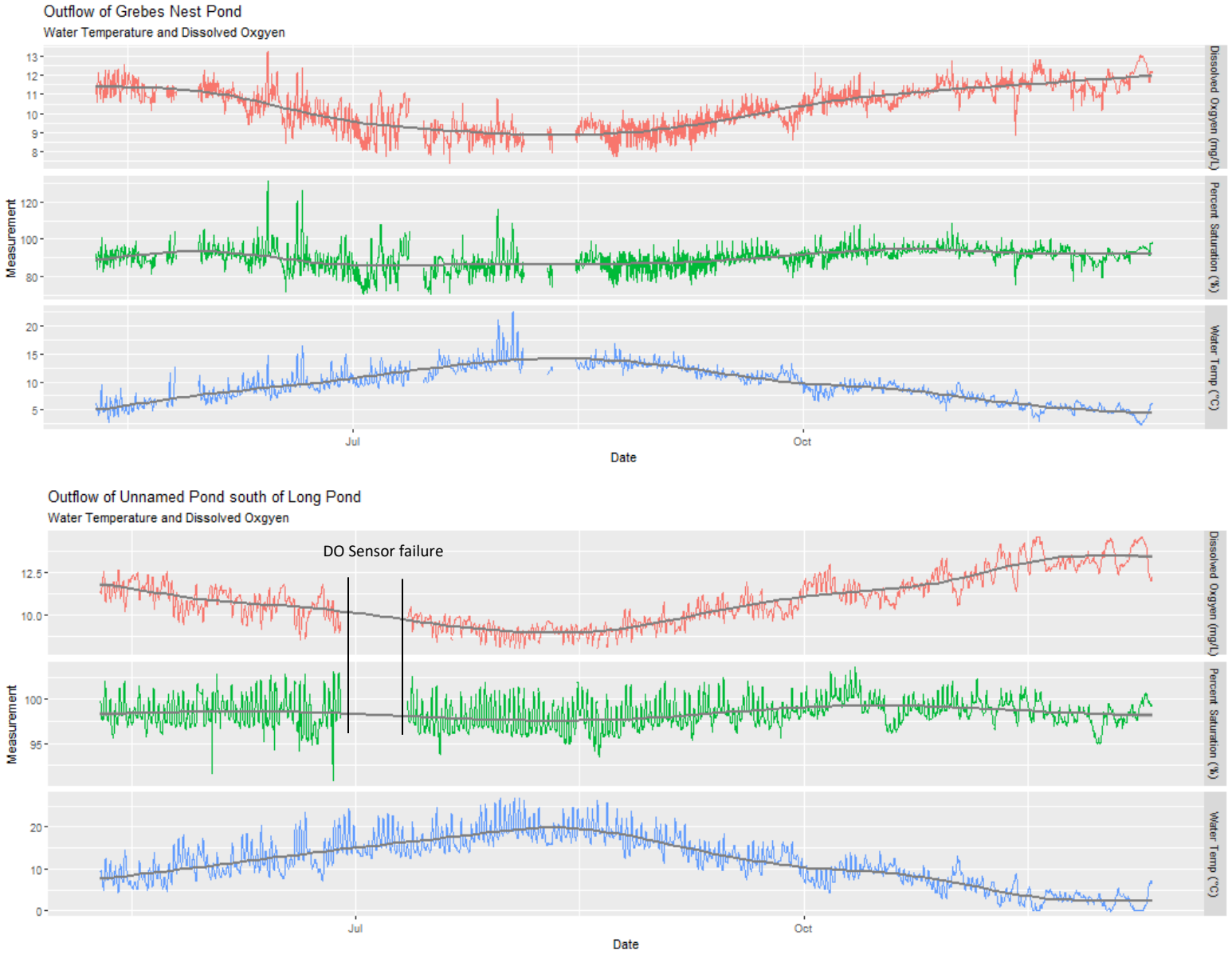

Figure 11: Dissolved Oxygen (mg/L & Percent Saturation) values

Turbidity

Turbidity levels during the deployment ranged from -0.4 NTU to 3548.1 NTU at Outflow of Grebes Nest Pond and Outflow of Unnamed Pond south of Long Pond ranged 6.5 NTU to 166 NTU (Table 7). The highest median was recorded at Outflow of Unnamed Pond south of Long Pond, 48.6 NTU, indicating that the brook had consistently higher turbidity across the deployment year than Outflow of Grebes Nest Pond with a median of 24.3 NTU (Table 7). A higher median for this site is to be expected as there was seepage from the polishing pond upstream. Corrective steps to address the seepage were implemented and a report was submitted from Canada Fluorspar to WRMD on July 19, 2019.

The significant spikes in turbidity at Outflow of Grebes Nest Pond were an accumulation of heavy and significant rainfall with a sporadic pumping schedule which led to the instrument was sitting in stagnant water. It is likely the higher turbidity values are representative of this situation.

The spikes in turbidity at Outflow of Unnamed Pond south of Long Pond corresponded closely with significant increases in flow as indicated by stage height. These events tend to exhibit an initial high peak before quickly returning to lower levels.

The median turbidity for Outflow of Grebes Nest Pond decreased from the previous year (down to 24.3 NTU) while Outflow of Unnamed Pond south of Long Pond increased when compared to the previous year (up to 48.6 NTU). The data indicates that the turbidity levels in the brooks in 2019 varied from the previous year.

Table 7. Summary for 2019 Turbidity data at Fluorspar Real-Time stations

	Turbidity (NTU)	
	Outflow of Grebes	Outflow of Unnamed
Min	-0.4	6.5
Max	3548.1	166
Median	24.3	48.6

Canada Fluorspar (NL) Inc, Newfoundland and Labrador

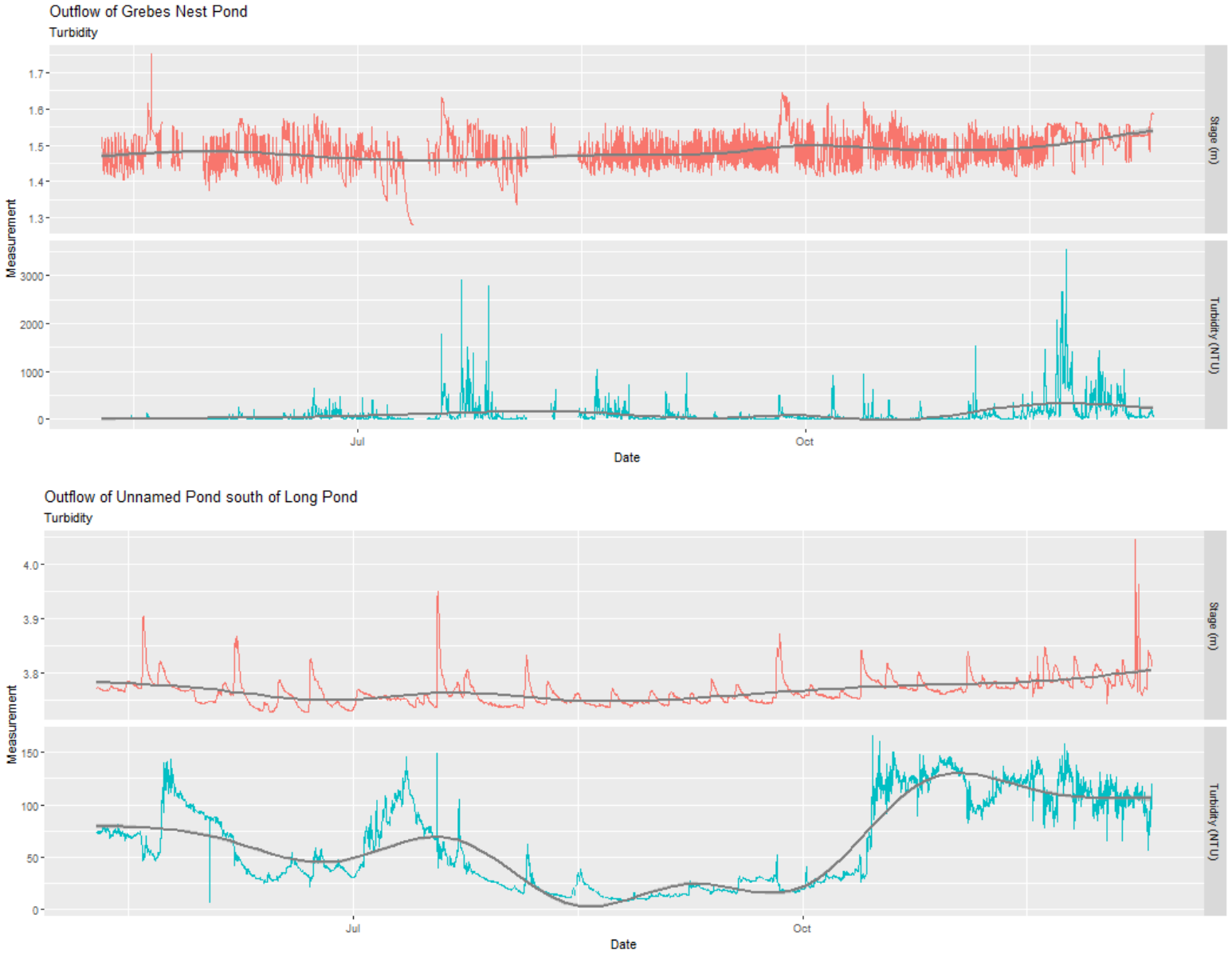

Figure 12: Turbidity (NTU) values at the Canada Fluorspar (NL) Inc Real-Time Stations

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 1.28m to 2.29m (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 3.58m to a maximum of 4.12m. 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 42.9 mm, which occurred on May 18th, 2019.

Table 9. Summary of for 2019 Daily Averaged Stage data at Fluorspar Real-Time stations

	Daily Averaged Stage (m)	
	Outflow of Grebes	Outflow of Unnamed
Min	1.28	3.58
Max	2.29	4.12
Median	1.48	3.76
Range	1.01	0.54

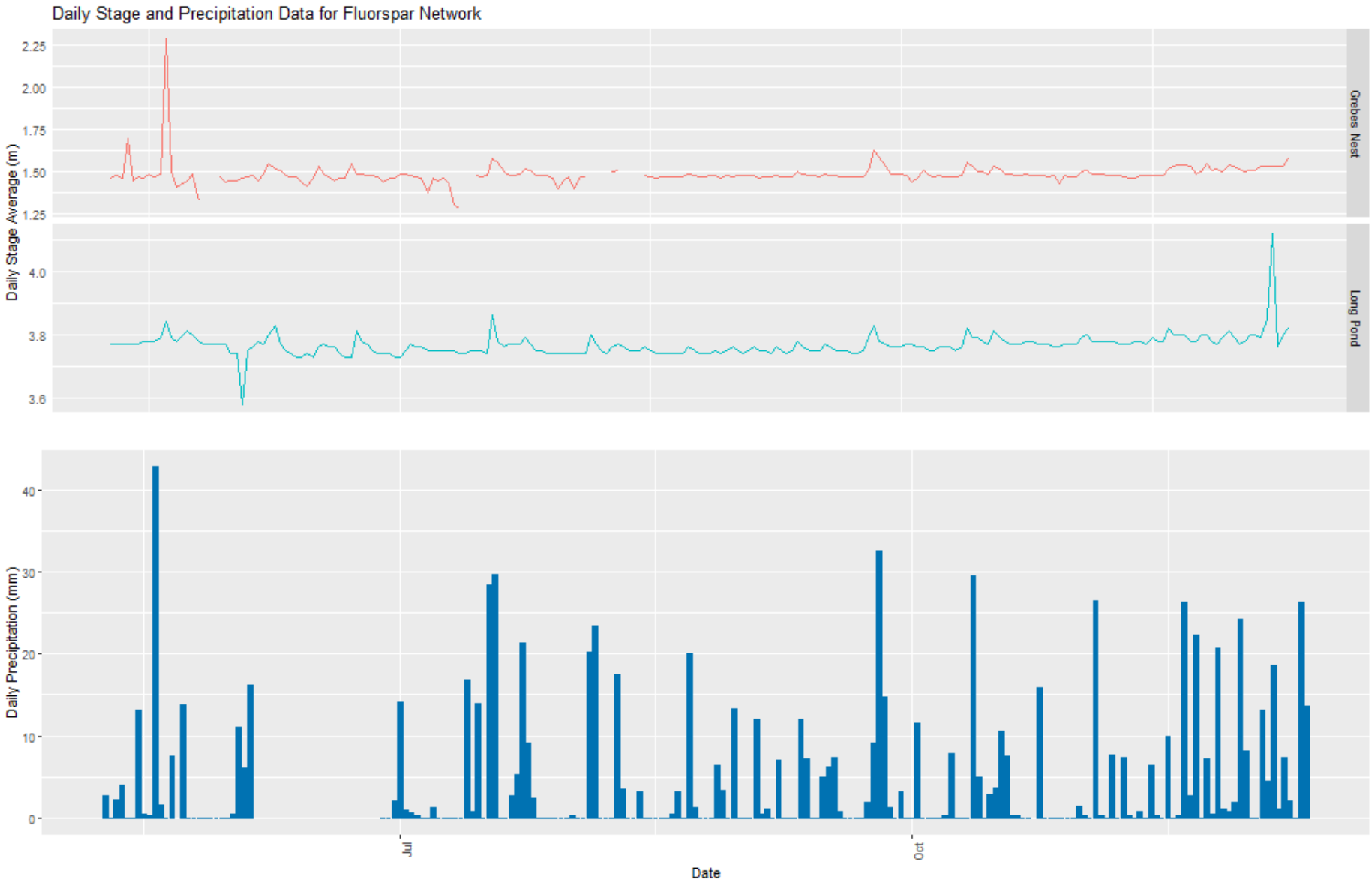

Figure 13: Daily Averaged stage values and total precipitation.

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 9th, 2019 and removed for the winter season on December 11th 2019.

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.

For the 2019 deployment, the pH data remained within the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life for the deployment at Outflow to Unnamed Pond south of Long Pond and for the majority (98.4%) of the deployment at Outflow of Grebes Nest Pond, dipping below during precipitation events.

Specific Conductivity data recorded at Outflow of Grebes Nest Pond was generally higher in 2019 than 2018. This was likely a result of the water supply issues and pumping schedule on site throughout 2019 deployment year. There were occasions when the brook was not being supplemented and this likely resulted in a greater concentration of particle matter. Outflow of Unnamed Pond south of Long Pond site displayed conductivity increases at the onset of precipitation, before decreasing quickly and then increasing again. During the summer months, the conductivity at Outflow of Unnamed Pond south of Long Pond steadily increased. Conductivity levels started to plateau in October, but showed high variability November and December.

Outflow to Grebes Nest Pond had ongoing turbidity spikes throughout 2019. Between late August and early September, the turbidity levels dropped. Turbidity spikes then returned for the remainder of the year. Outflow of Grebes Nest Pond had intermediate flow issues, resulting in the instrument periodically sitting in stagnant water. It is likely the higher turbidity values are representative of this situation. The spikes in turbidity at Outflow of Unnamed Pond south of Long Pond corresponded closely with significant increases in flow as indicated by stage height. These events tend to exhibit an initial high peak before quickly returning to lower levels.

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

- The field instruments will undergo proficiency testing and evaluation during the winter of 2019-2020. MAE will inform Canada Fluorspar of any instrument performance issues.

- MAE staff will deploy real time water quality instruments in spring 2020, when ice conditions allow and perform regular site visits throughout the 2020 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.

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

- Open communication lines will continue to be maintained between MAE, ECCC and Canada Fluorspar in order to 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.

APPENDIX A

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 (^{o}C) 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 B

INSTRUMENT PERFORMANCE RANKINGS

Instrument Performance Rankings

Station	Date	Action	2019 Deployment Season Comparision Ranking				
			Temperature	pH	Specific Conductivity	Dissolved Oxgyen	Turbidity
Outflow of Grebes Nest Pond	May 9, 2019	Deployment	Excellent	Excellent	Excellent	Excellent	Good
	July 11, 2019	Removal	Good	Excellent	Good	Good	Excellent
Outflow to Unnamed Pond south of Long Pond	May 9, 2019	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	July 11, 2019	Removal	Excellent	Good	Good	Excellent	Marginal
Outflow of Grebes Nest Pond	July 11, 2019	Deployment	Good	Fair	Good	Good	Poor
	August 20, 2019	Removal	Marginal	Excellent	Good	Excellent	Marginal
Outflow to Unnamed Pond south of Long Pond	July 11, 2019	Deployment	Marginal	Excellent	Good	Excellent	Poor
	August 20, 2019	Removal	Good	Excellent	Good	Excellent	Excellent
Outflow of Grebes Nest Pond	August 20, 2019	Deployment	Good	Good	Excellent	Fair	Fair
	October 17, 2019	Removal	Excellent	Good	Fair	Good	Good
Outflow to Unnamed Pond south of Long Pond	August 20, 2019	Deployment	Marginal	Excellent	Excellent	Excellent	Excellent
	October 17, 2019	Removal	Excellent	Good	Fair	Good	Good
Outflow of Grebes Nest Pond	October 17, 2019	Deployment	Excellent	Fair	Fair	Good	Good
	December 11, 2019	Removal	Good	Excellent	Excellent	Excellent	Poor
Outflow to Unnamed Pond south of Long Pond	October 17, 2019	Deployment	Excellent	Excellent	Good	Excellent	Fair
	December 11, 2019	Removal	Good	M	Excellent	Excellent	Good

APPENDIX C

COMPARISON STATISTICS FROM 2017 DEPLOYMENT AT CANADA FLUORSPAR INC

Canada Fluorspar (NL) Inc, Newfoundland and Labrador

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