Real-Time Water Quality Report

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

Deployment Period
October 17, 2019 to December 11, 2019

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
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. These brooks are within the mining site of Canada Fluorspar (NL) Inc, St. Lawrence, Newfoundland & Labrador (Figure 1).

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

Outflow of Grebes Nest Pond

The Outflow of Grebes Nest Pond station is established downstream of the pit dewatering effluent outfall and upstream of John Fitzpatrick Pond. The stream is approximately 1.0 to 2.0 meters wide and sustains a sufficient pool for the instrumentation to be placed in (Figure 2). The pool depth is approximately 0.5 to 1.0 metres. The GPS coordinates for this site are as follows**: N46° 54’ 35.9” W55° 27’ 45.6”**.

The station hut was placed on the north bank looking downstream approximately 5 metres from the stream. This station provides 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, allowing appropriate mitigation measures to be implemented in a timely manner and thus reducing any adverse effect on the downstream systems.

Figure 2: Real-Time Water Quality and Quantity Station at Outflow of Grebes Nest 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 provides near real-time water quality and quantity data to ensure emerging issues associated with the TMF are detected, allowing appropriate mitigation measures to be implemented in a timely manner and 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 (Figure 3). The stream originates from a small unnamed pond and meanders through a marsh environment alongside the TMF. The stream is approximately 1.0 to 2.0 meters wide. At the deployment location, 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” W55° 26’ 37.5”**. The station hut was placed on the right bank looking downstream approximately 8 meters from the stream (Figure 3).

Figure 3: Real-Time Water Quality and Quantity Station at Outflow of Unnamed Pond south of Long Pond.

Quality Assurance and Quality Control

As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.

At deployment and removal, a QA/QC Sonde is temporarily deployed adjacent to the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between the parameters on the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

WRMD staff (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 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 transmission 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 Station's 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: temperature dependent, temperature compensated and temperature independent. Due to the temperature sensor's location on the sonde, the entire sonde must be at a constant temperature before the temperature sensor will stabilize. The values may take some time to climb to the appropriate reading. If a reading is taken too soon it may not accurately portray the water body.

Table 2: Instrument performance rankings

Station	Date	Action	Comparison Ranking				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Grebes Nest Pond	**Oct 17**	**Deployment**	Excellent	Fair	Fair	Good	Good
	Dec 11	**Removal**	Good	Excellent	Excellent	Excellent	Poor
Unnamed Pond	**Oct 17**	**Deployment**	Excellent	Excellent	Good	Excellent	Fair
	Dec 11	**Removal**	Good	Marginal	Excellent	Excellent	Good

At deployment of the field instrument at Outflow of Grebes Nest Pond site, the water temperature, dissolved oxygen, and turbidity data ranked ‘Excellent’ to ‘Good’ while pH and conductivity ranked ‘Fair’ against the QA sonde data.

During removal of the instrument, the ranking for temperature, pH, conductivity, and dissolved oxygen data were ‘Excellent’ or ‘Good’ while turbidity ranked ‘Poor’ against the QA data. Turbidity data ranked as ‘Poor’ at removal due to a result of sediment or silt build up on the sensor over the long deployment.

At deployment of the field instrument at Outflow of Unnamed Pond south of Long Pond, the temperature, pH, specific conductivity, and dissolved oxygen data ranked ‘Excellent’ to ‘Good’ while turbidity ranked ‘Fair’ respectfully against the QA sonde data.

During removal of the instrument, the rankings for temperature, conductivity, dissolved oxygen and turbidity data were ‘Excellent’ or ‘Good’ while pH ranked ‘Marginal’ against the QA data.

Concerns or Issues during the Deployment Period

Outflow to Grebes Nest Pond station is fed via Grebes Nest Pit. The lack of consistent flow results in significant stage level fluctuations across a deployment.

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

Outflow of Grebes Nest Pond

Water Temperature

Water temperature ranged from 2.41°C to 10.28°C during the deployment period (Figure 4). The average water temperature for the deployment is 6.26°C.

Outflow of Grebes Nest Pond station is fed by dewatering from Grebes Nest Pit. It does not have consistent flow, thus the stage data can fluctuate significantly across a deployment. Stage fluctuations can influence water temperature as indicated in Figure 4.

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

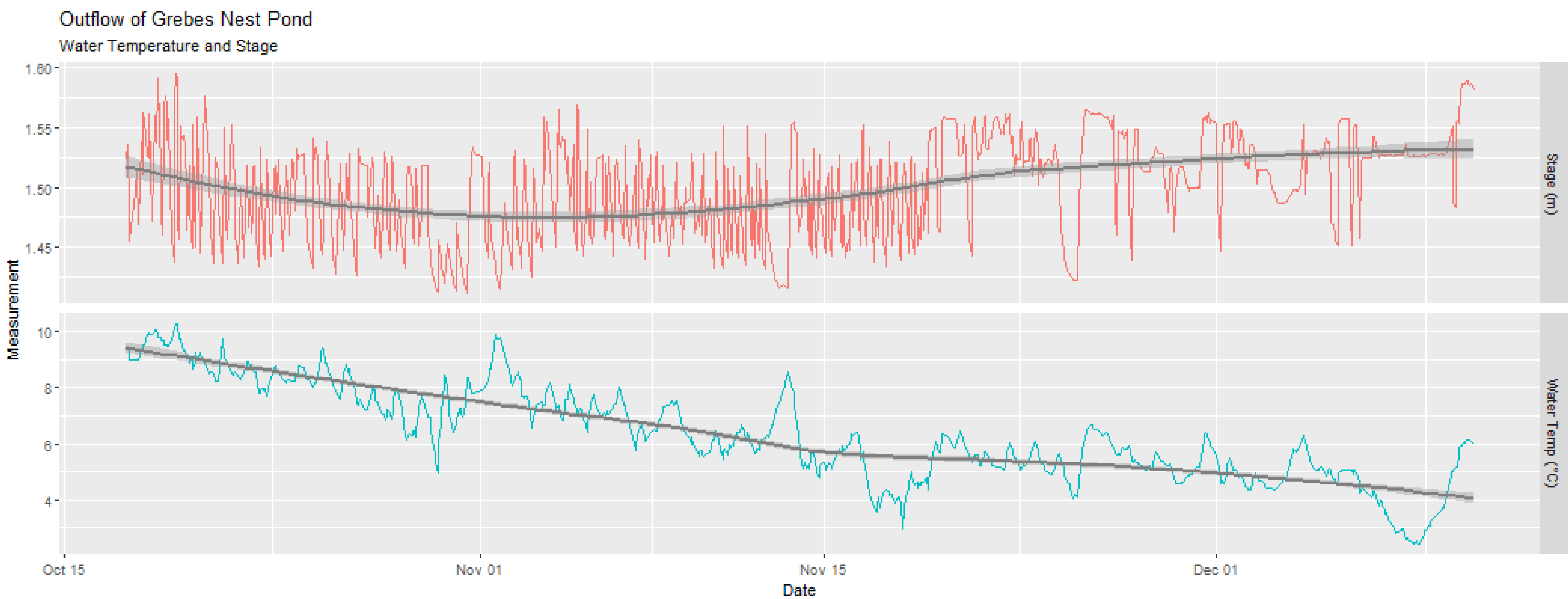

Figure 4: Water temperature (°C) values at Outflow of Grebes Nest Pond

pH

Throughout the deployment period, pH values ranged between 6.21 pH units and 7.21 pH units with a median of 6.78.

The pH data remained within the Canadian Council of Ministers of the Environment (CCME) guidelines for the protection of aquatic life for the majority of the deployment, dipping below during precipitation events. This pH range is lower than that recorded in the previous deployments and variations in measurements are a result of the dewatering effluent on the brook. Every brook is different with its own natural background range. It is not uncommon for Newfoundland and Labrador waters to be below or within the CCME pH guidelines.

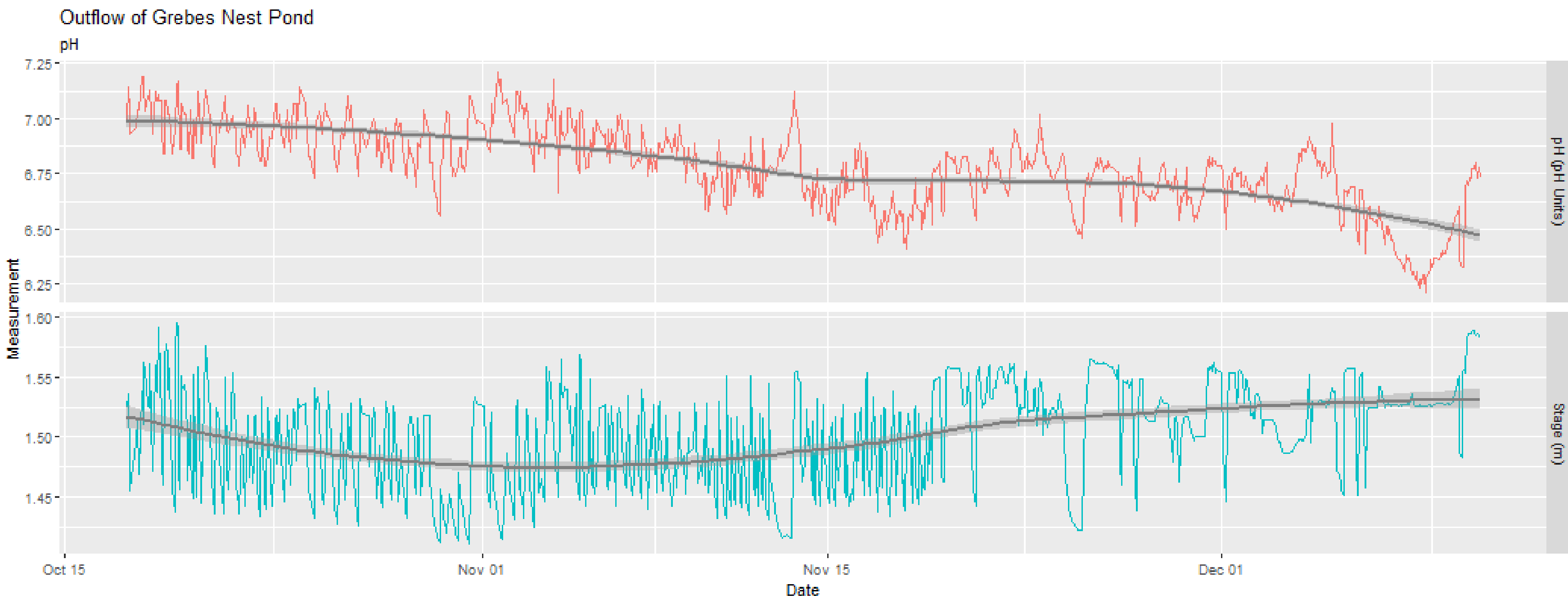

Figure 5: pH (pH units) values

Specific Conductivity

The conductivity levels were within 203.4 µS/cm and 477.7 µS/cm during this deployment period (Figure 6). The specific conductivity probe measured the diluted salts and inorganic materials present in the brook. The conductivity in a brook can be diluted and decreased by rainfall or increased by rainfall if there is surface runoff into the brook.

Across the deployment period, the conductivity in the brook fluctuated with the changes to stage level. During stage increases, the conductivity levels responded by decreasing as the water was diluted. This trend was evident on November 19th.

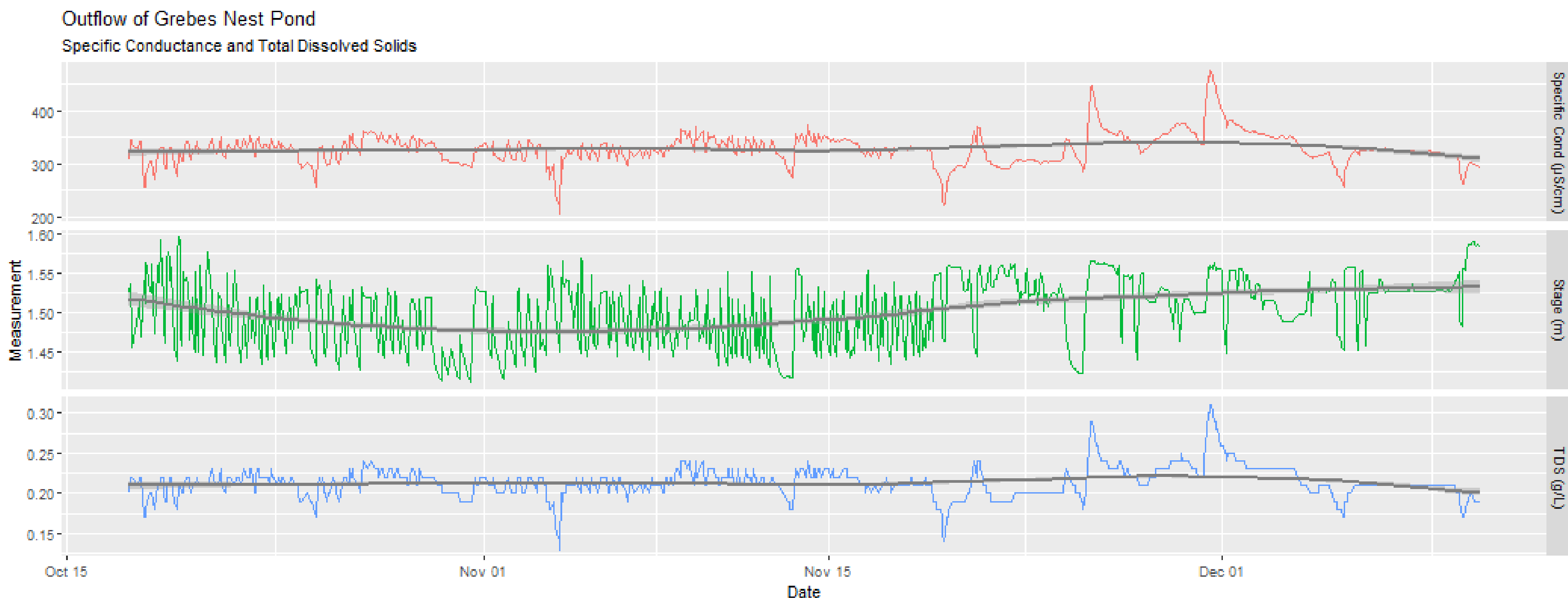

Figure 6: Specific conductivity (µS/cm) values

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 8.85 mg/L to a maximum of 13.05 mg/L. The percent saturation levels for dissolved oxygen ranged within 75.8% Saturation to 108.7% Saturation (Figure 7). With seasonal temperature decreasing, the rise in dissolved oxygen is evident (Figure 7).

Values remained above CCME's minimum Guideline for the Protection of Other Life Stages throughout the deployment but were below the Guideline for Early Life Stages for a portion of the deployment when water temperature was higher than normal.

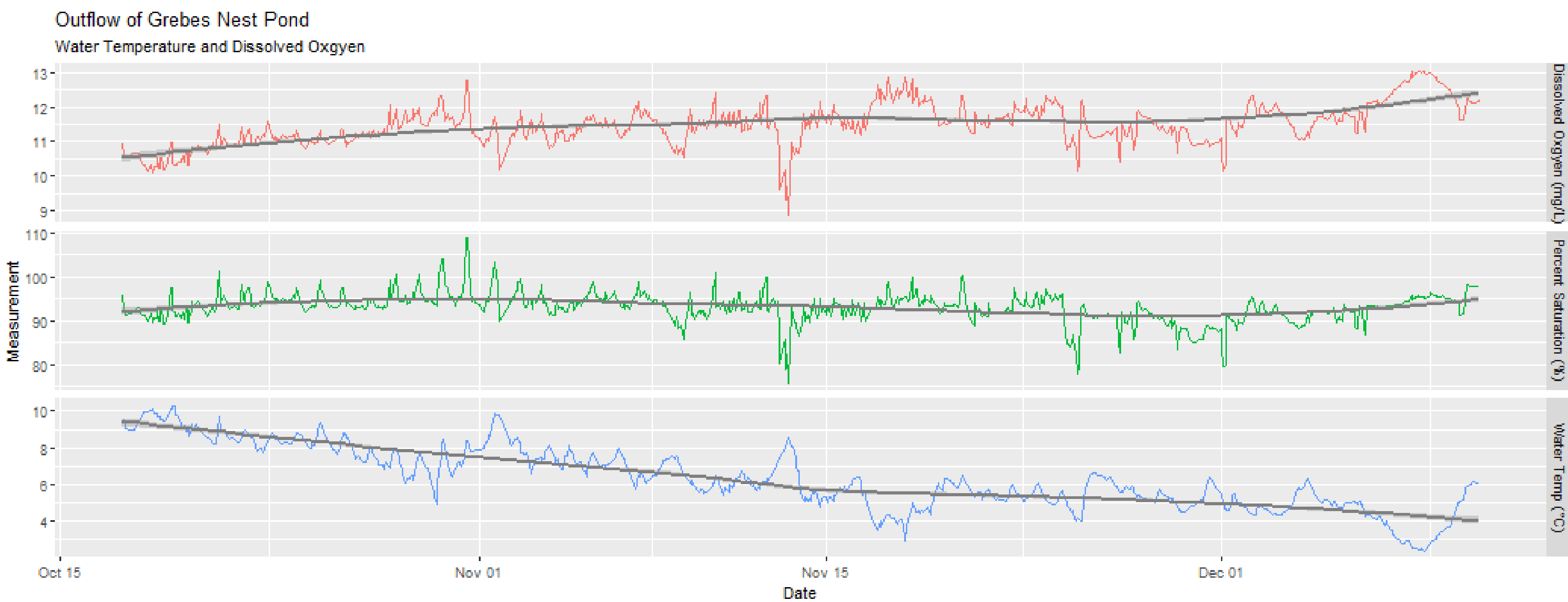

Figure 7: Dissolved Oxygen (mg/L & Percent Saturation) values and Water Temperature (°C)

Turbidity

Turbidity levels during the deployment ranged within -0.2 NTU and 3548.1 NTU (Figure 8). The deployment data had a median of 66.8 NTU. The high turbidity the week of November 17th was caused by heavy and significant rainfall.

Outflow to Grebes Nest Brook is fed upstream by dewatering of Grebes Nest Pit and is heavily impacted by the material from the pit. The real-time station has significant fluctuations as the sediment as is repeatedly resuspended into the water column.

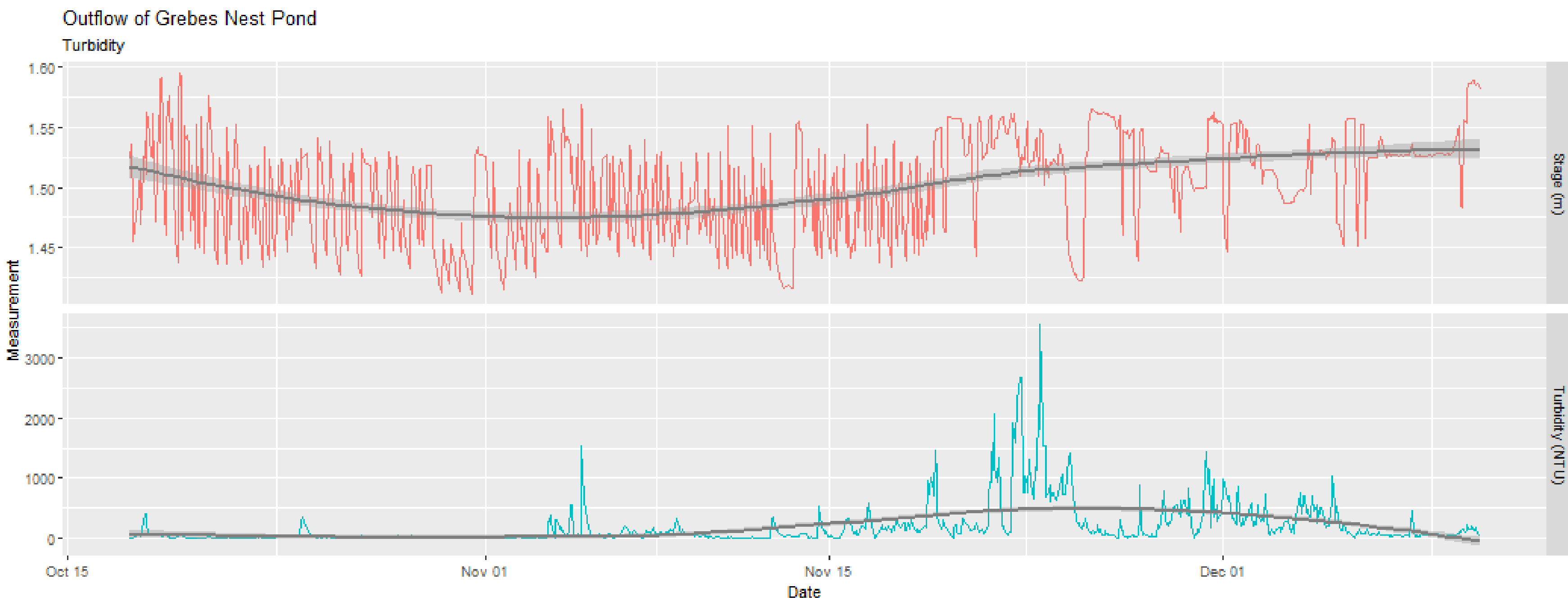

Figure 8: Turbidity (NTU) values.

Total Precipitation & Stage Level

Stage is the level of the water surface above a given datum at the station. Stage provides an estimation of the water level at the station and can explain some of the water quality fluctuations that occur. Stage will increase during rainfall events (Figure 9) and during snow or ice melt as runoff will collect in the brook, influencing the water level.

Although this brook is fed intermittently via dewatering from Grebes Nest Pit, rainfall is very influential as it assists in supplementing the water supply. Large peaks in stage correspond with the precipitation events as noted on Figure 15. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and maximum of 26.5 mm on November 3rd.

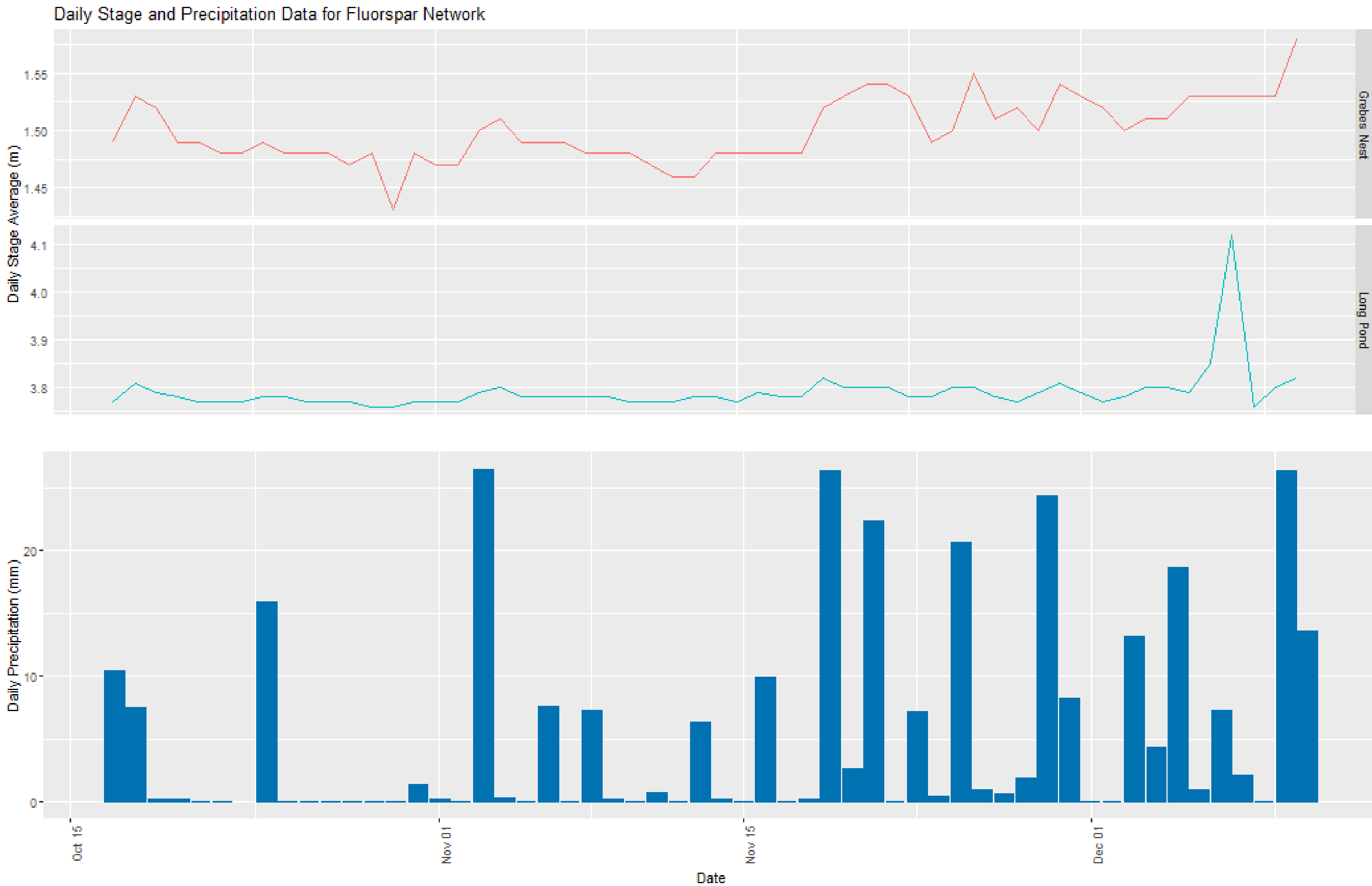

Figure 9: Daily average stage values and daily total precipitation.

Conclusion

Outflow of Grebes Nest Pond currently flows through an evolving mine site. Grebes Nest Pond has been dewatered for mining purposes and no longer exists. The water supply for Outflow of Grebes Nest Pond station has changed. The water supply is Grebes Nest Pit that is upstream of the Real-Time station. In 2019 water was pumped into the river intermittently, depending on water levels in the pit.

When reviewing the parameter graphs, it was evident that the larger precipitation events affected the water quality. The increased flow from the pit was responsible for the variations in the turbidity levels. Water temperature fluctuated with stage changes, but gradually decreased into the deployment. pH levels at Grebes Nest station were consistent during the deployment, but lower than previous deployments.

Conductivity at the brook ranged from 203.4µS/cm to 477.7µS/cm. The lowest conductivity values were during the stage increases, a result of the brook being diluted then flushed of suspended material for a short period of time.

Outflow to Grebes Nest Pond station is fed via dewatering processes and thus does not always have consistent flow. The dissolved oxygen concentration can change quickly over a few hours or days as water in the pool becomes stagnant. During this deployment, dissolved oxygen increased as water temperatures cooled.

This brook has significant fluctuations in turbidity and the turbidity levels will increase in either high or low stage events due to the influence of the upstream dewatering processes. This deployment experienced high turbidity events; unsettled, gusty weather combined with high precipitation, likely resulted in rough water conditions and stirred up sediments.

Overall, the water quality parameters recorded at Outflow of Grebes Nest Pond displayed events expected of a brook in an environment influenced by anthropogenic activities.

On December 17th the water quality instrument was removed for the winter season. It will be redeployed in the spring when ice conditions permit.

Outflow of Unnamed Pond south of Long Pond

Water Temperature

Water temperature ranges from -0.04°C to 13.03°C with an average of 4.72°C during this deployment period (Figure 10). The water temperature decreases steadily across the deployment, consistent with cooling fall temperatures.

During the large increases in stage at the station, the water temperatures dropped.

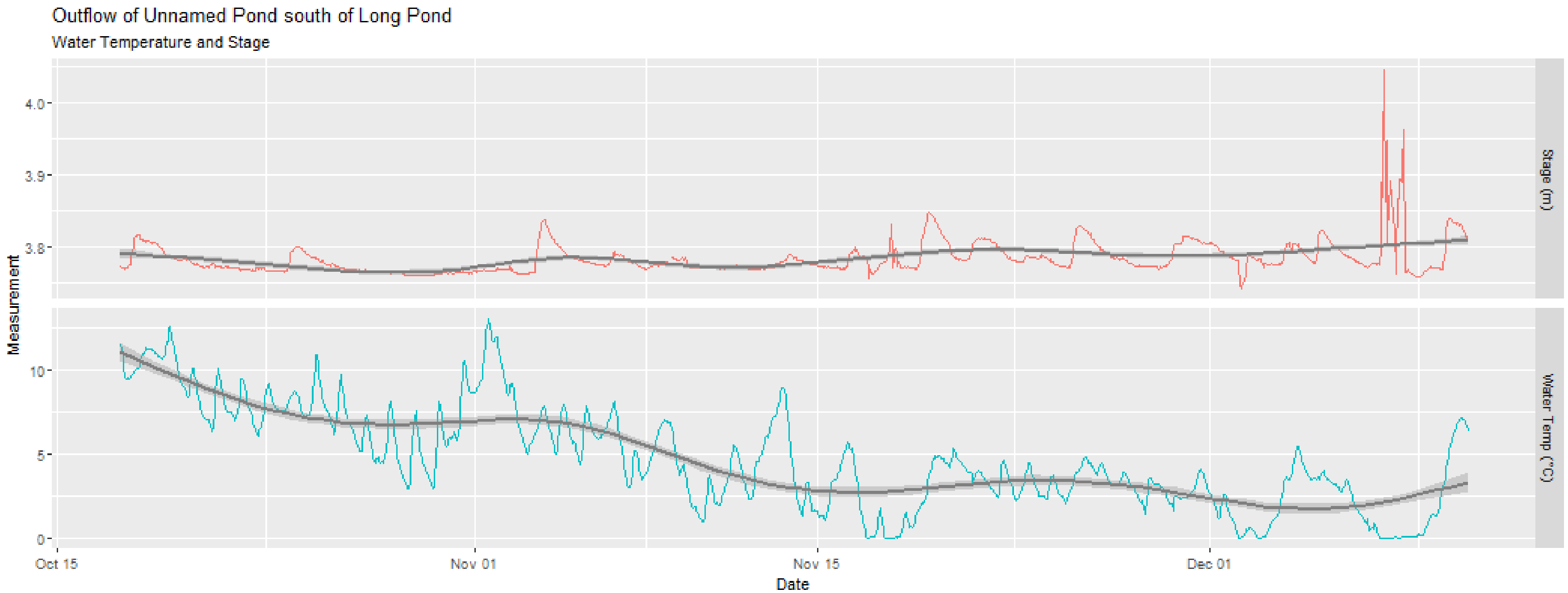

Figure 10: Water temperature (°C) values at Outflow of Unnamed Pond south of Long Pond

pH

Throughout this deployment period, pH values ranged between 7.84 pH units and 8.32 pH units (Figure 11), consistently remaining within the Canadian Council of Ministers of the Environment (CCME) guidelines for aquatic life. Every brook is different with its own natural background range.

The pH data was consistent over the deployment with decreases during the stage increases before returning to background levels shortly after. Natural processes such as rainfall will alter the pH of a brook for a period of time. An example of this trend was evident on November 3rd. Values were notably higher than in the previous deployment.

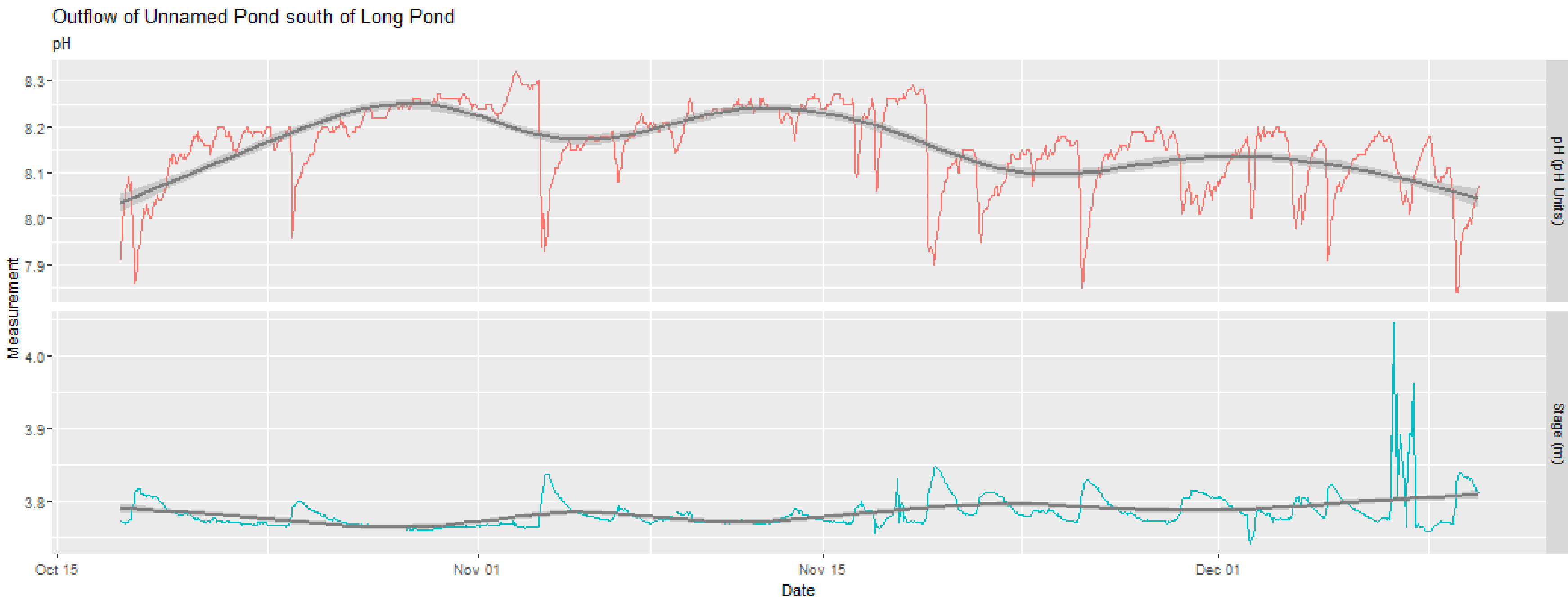

Figure 11: pH (pH units) at Outflow of Unnamed Pond south of Long Pond

Specific Conductivity

The conductivity levels ranged between 274.0 µS/cm and 501.5 µS/cm during deployment with a median value of 406.8 µS/cm.

The conductivity in the brook was influenced by the fluctuation in stage. The addition of water during stage increases dilutes the particle matter and suspended solids present in a water body. When stage level decreases, the conductivity levels will increase as the suspended solids become concentrated in the water column. These relationships can be seen in Figure 12.

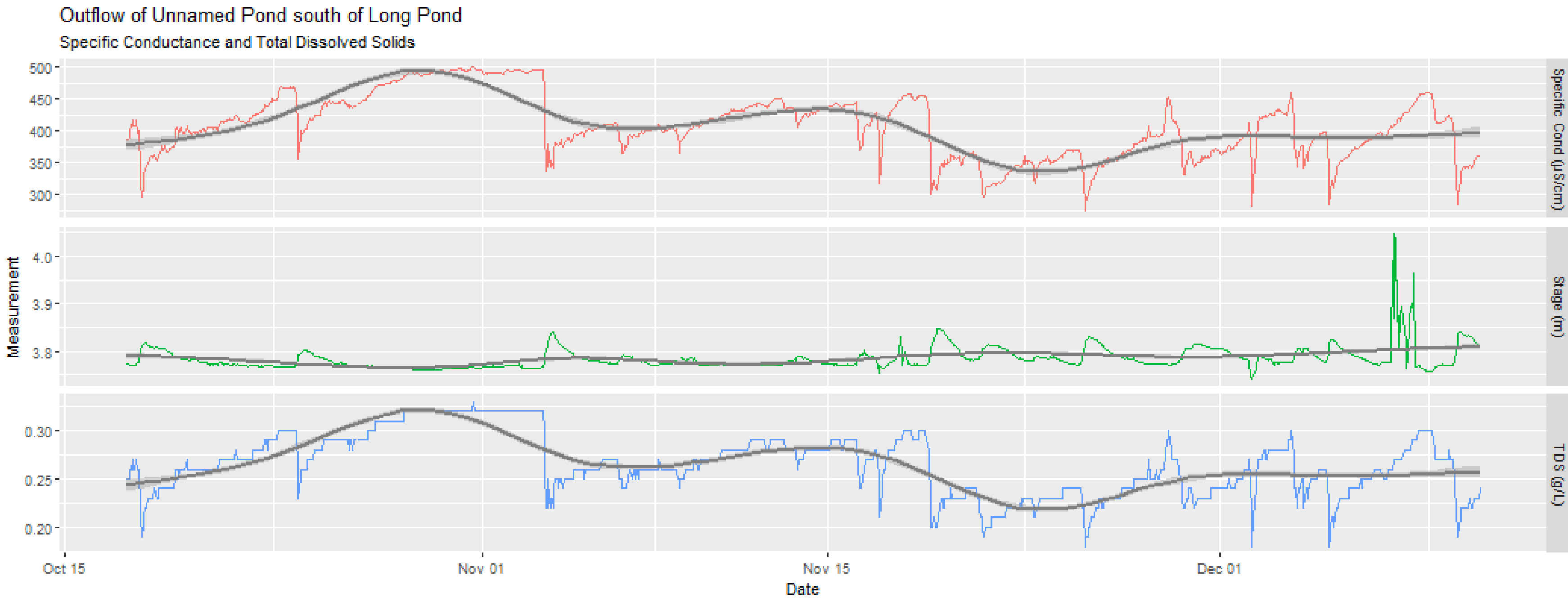

Figure 12: Specific conductivity (µS/cm) at Outflow of Unnamed Pond south of Long Pond

Dissolved Oxygen

The water quality instrument directly measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account the water temperature. During this deployment, the dissolved oxygen levels where within 10.38 mg/L and 14.59 mg/L for concentration and 94.9 % Sat and 102.3 % Sat for percent saturation. Values remained above the minimum CCME Guideline for the Protection of Early and Other Life Stages throughout the deployment.

There is a natural diurnal pattern with dissolved oxygen. Oxygen concentration levels will fluctuate throughout night and day. The significant dips/peaks outside of the diurnal pattern are a result of fluxes in water temperature or influences from rainfall/runoff. This can be seen on Figure 13: as the water temperature peaks, the dissolved oxygen concentration decreases.

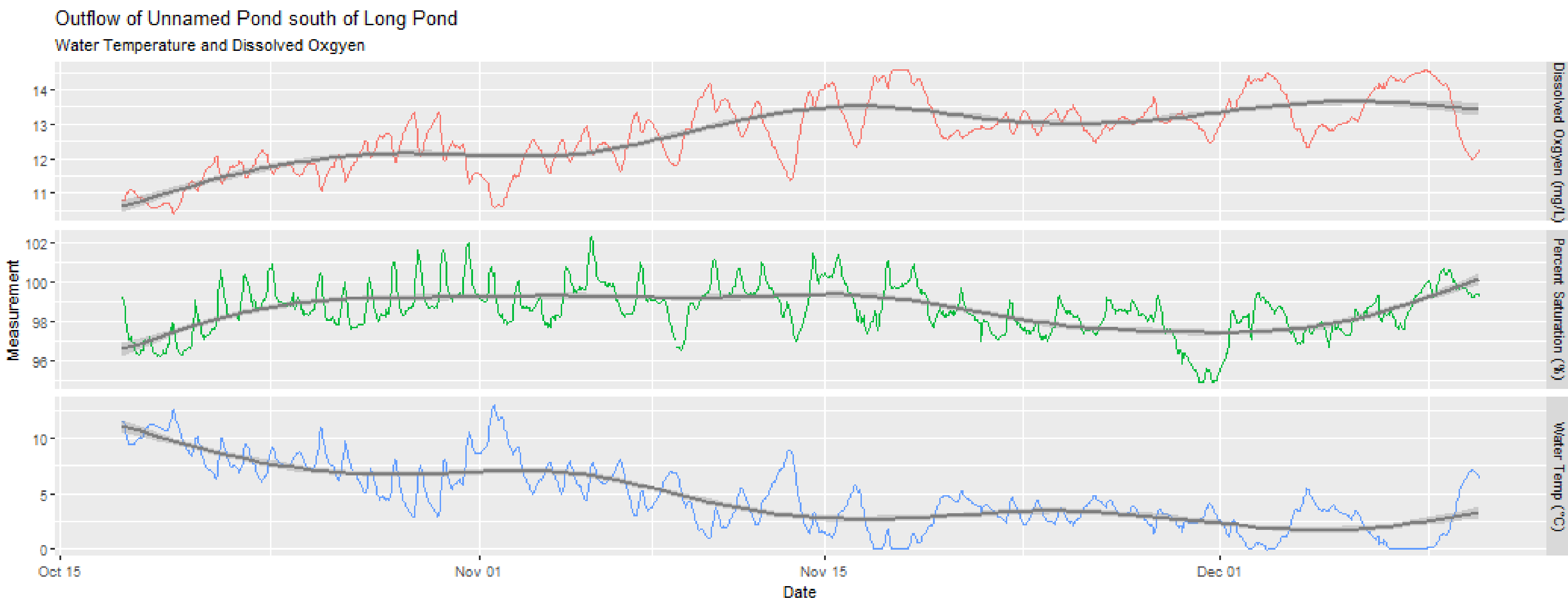

Figure 13: Dissolved Oxygen (%Sat & mg/L) at Outflow of Unnamed Pond south of Long Pond

Turbidity

Turbidity levels during the deployment ranged within 56.8 NTU and 157.8 NTU (Figure 14) with a median value of 118.1 NTU.

The turbidity increased compared to the previous deployment. Turbidity during this deployment was in part due to continued influence of polishing pond seepage on the brook.

Recorded stage events generally increased turbidity for a time before flushing the brook, reducing turbidity to background levels.

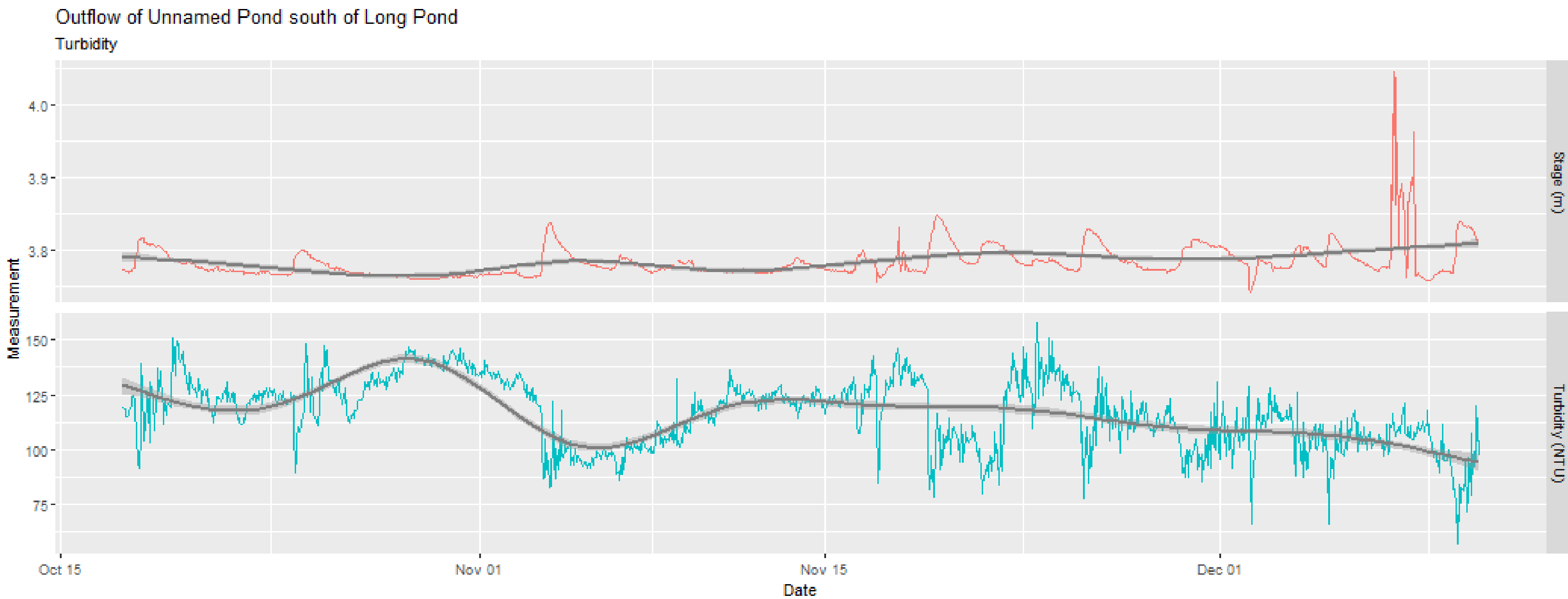

Figure 14: Turbidity (NTU) at Outflow of Unnamed Pond south of Long Pond

Daily Averaged Stage Level and Total Precipitation

Stage is an estimation of water level at the station and can explain fluctuations occurring with other parameters (i.e. Specific Conductivity, DO, turbidity). Stage will increase during rainfall events (Figure 15).

Large peaks in stage correspond with the total precipitation events as noted on Figure 15. Total Precipitation data was obtained from Environment Canada's St. Lawrence weather station. Total precipitation ranges for the deployment period were a minimum of 0.0 mm and maximum of 26.5 mm on November 3rd.

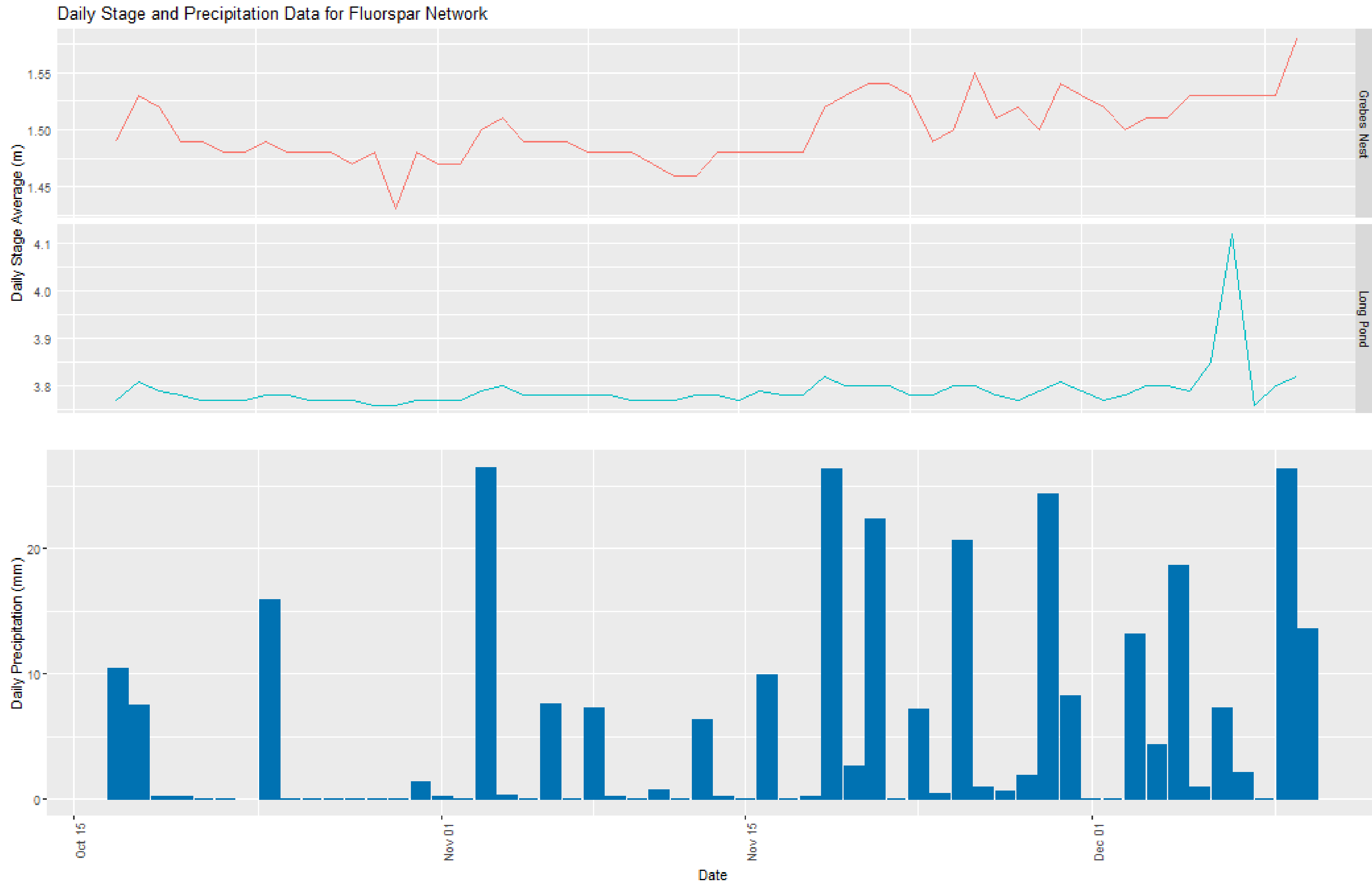

Figure 15: Daily averaged stage values at total precipitation.

Conclusion

The Outflow of Unnamed Pond south of Long Pond is established downstream of the Tailings Management Facility (TMF), to assist in capturing any emerging water quality issues. The Outflow of Unnamed Pond South of Long Pond also flows through an undeveloped area that includes natural wetlands and marshlands. This station is the furthest away from the anthropogenic activities that are occurring on the Canada Fluorspar mine site.

As with many shallow brooks and streams, precipitation events and runoff play a significant role in influencing water quality. Increasing water temperatures during the deployment were representative of the climate for the time of year. The pH values were consistent for this brook with any significant changes in pH data corresponding to a rise in the stage.

Conductivity levels responded to stage fluctuations by decreasing during high stage events and increasing during periods of low stage. Dissolved oxygen levels were influenced by the cooler water temperatures, resulting in increased oxygen levels.

This deployment had a turbidity median of 118.1 NTU which is increased from the last deployment whose median was 39.6 NTU. This deployment experienced prolonged high turbidity, from seepage at the polishing pond and upstream. Corrective steps to address polishing pond seepage were implemented and a report was submitted by Canada Fluorspar to WRMD on July 19, 2019.

Precipitation brings changes to water quality conditions. Most of these changes are natural, quick adjustments in levels before the data returns to background levels. Precipitation can influence 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 range after a water quality event.

On December 17th the water quality instrument was removed for the winter season, it will be redeployed in the spring when ice conditions permit.