Real Time Water Quality Report

Tata Steel Minerals Canada
Elross Lake Network

Annual Deployment Report 2020

2021-06-06 to 2021-09-08

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

Acknowledgements

The Real-Time Water Quality/Quantity Monitoring Network in the vicinity of the Elross Lake Iron Ore Mine in western Labrador is fully funded by Tata Steel Minerals Canada Limited (TSMC) and its success is dependent on a joint partnership between TSMC, Environment and Climate Change Canada (ECCC), and the Newfoundland & Labrador Department of Environment and Climate Change (ECC). Managers and program leads from each organization are committed to the operation of this network and ensuring that it provides meaningful and accurate water quality/quantity data.

In addition to funding this program, TSMC also assisted ECC staff with fieldwork operations in 2021 due to COVID-19 restrictions.

ECCC plays an essential role in the data logging/communication aspect of the network. In particular, ECCC staff of the Water Survey of Canada visited network stations regularly to ensure that the data logging and data transmission equipment was working properly. ECCC also plays the lead role in dealing with stage and flow issues. ECC is responsible for recording and managing water quality data.

In 2021, the COVID-19 pandemic had a major impact on the province, neighbouring provinces, and all of Canada. The pandemic interrupted shipping routes and supplies, as well as travel and operations. Continued border restrictions and sensitivity around travel interrupted the normal workflow for the real-time monitoring network. Despite all theses challenges, instruments were installed at Elross Creek and Joan Brook by TSMC staff on June 6th-7th and removed by ECC staff on September 8th, 2021.

Introduction

- An agreement was signed on April 18, 2011, between the Newfoundland & Labrador Department of Environment and Climate Change (ECC) and Tata Steel Minerals Canada Limited (TSMC), to establish two real-time water quality/quantity stations in the vicinity of Elross Lake Iron Ore Mine in western Labrador, near Schefferville, QC.
- An amendment to the original agreement was signed on February 10, 2015, to establish an additional station at Joan Brook below the outlet of Joan Lake. The purpose of this station was to monitor the impacts of mining activity on surface water downstream of the five pits (Kivivic 1, 2, 3N, 4 and 5) which are included in the DSO4 Project 2B mining operation. The DSO4 Project 2B mining operation is located approximately 24 km northwest of the main mine complex.
- The official name of each station is ELROSS CREEK BELOW PINETTE LAKE INFLOW, GOODREAM CREEK 2KM NORTHWEST OF TIMMINS 6, and JOAN BROOK BELOW OUTLET OF JOAN LAKE, hereafter referred to as the *Elross Creek Station*, the *Goodream Creek Station*, and the *Joan Brook Station* respectively (Figure 1).

a. Elross Creek Station b. Goodream Creek Station c. Joan Brook Station

Figure 1: RTWQ stations are located alongside (a) Elross Creek, (b) Goodream Creek & (c) Joan Brook

- Please note that the Goodream Creek Station has been temporarily shut down to allow for moving the station to a new location further downstream near Triangle Lake. It is hoped that this move will be completed early in the 2021 field season and that the station will be fully operational at the new location before the end of the 2021 field season.

- Table 1 provides the locations of each station.

Table 1. Geographic coordinates of Elross Creek, Goodream Creek and Joan Brook Stations

	Elross Creek Station		Goodream Creek Station		Joan Brook Station	
	Latitude	Longitude	Latitude	Longitude	Latitude	Longitude
Instrument	54.877757	-67.099728	*54.92794	*67.15597	*55.03334	*-67.17597
Gauge house	54.877698	-67.099848	*54.92794	*67.15597	*55.03334	*-67.17597
Helicopter pad	54.877604	-67.100014	*54.92794	*67.15597	*55.03334	*-67.17597

*General Site Location

- Station sites were selected to monitor all surface water outflows from the Elross Lake mining site and the DSO4 Project 2B mining sites (Figure 2).
- The Elross Creek Station monitors surface water downstream of the Timmins 1 pit, and downstream of Pinette Lake.
- The first Goodream Creek Station monitored potential impacts from groundwater flowing from Timmins 6 pit into the surface water of Goodream Creek. The new Goodream Creek Station will monitor impacts on Goodream Creek near Triangle Lake from the Howse deposit.
- The Joan Brook station monitors surface water downstream of the five pits (Kivivic 1, 2, 3N, 4 and 5) which are included in the DSO4 Project 2B mining operation.
- The Elross Creek and Goodream Creek stations went into operation October 17-18, 2011, recording only stage values for the first 7 months until June 5, 2012, when water quality instruments were first deployed. The Joan Brook station went into operation for stage values and water quality in June of 2016.
- Six parameters are measured at each station during ice-free months, including five water quality parameters (i.e., temperature, pH, specific conductivity, dissolved oxygen and turbidity) and one water quantity parameter (i.e., stage).
- Water quality parameters are recorded on an hourly basis, typically from early-June to early-October, when streams are ice-free. ECC is responsible for collecting and managing this dataset.
- Stage is recorded year-round on an hourly basis. ECCC is responsible for collecting and managing this dataset.
- ECCC is responsible for logging and transmitting all water quality and water quantity data to a central repository via satellite communications.
- The purpose of the real-time network at these stations is to monitor, process, and distribute water quality and water quantity data to TSMC, ECC, and ECCC, for assessment and management of water resources, as well as to provide an early warning of any potential or emerging water issues, so that mitigative measures can be implemented in a timely manner.
- ECC informs TSMC of any significant water quality events by email notification. Monthly and annual deployment reports serve to document water parameters measured at these stations.
- This annual deployment report presents water quality and water quantity data recorded at the Elross Creek and Joan Brook stations from June 6, 2021 to September 8, 2021.

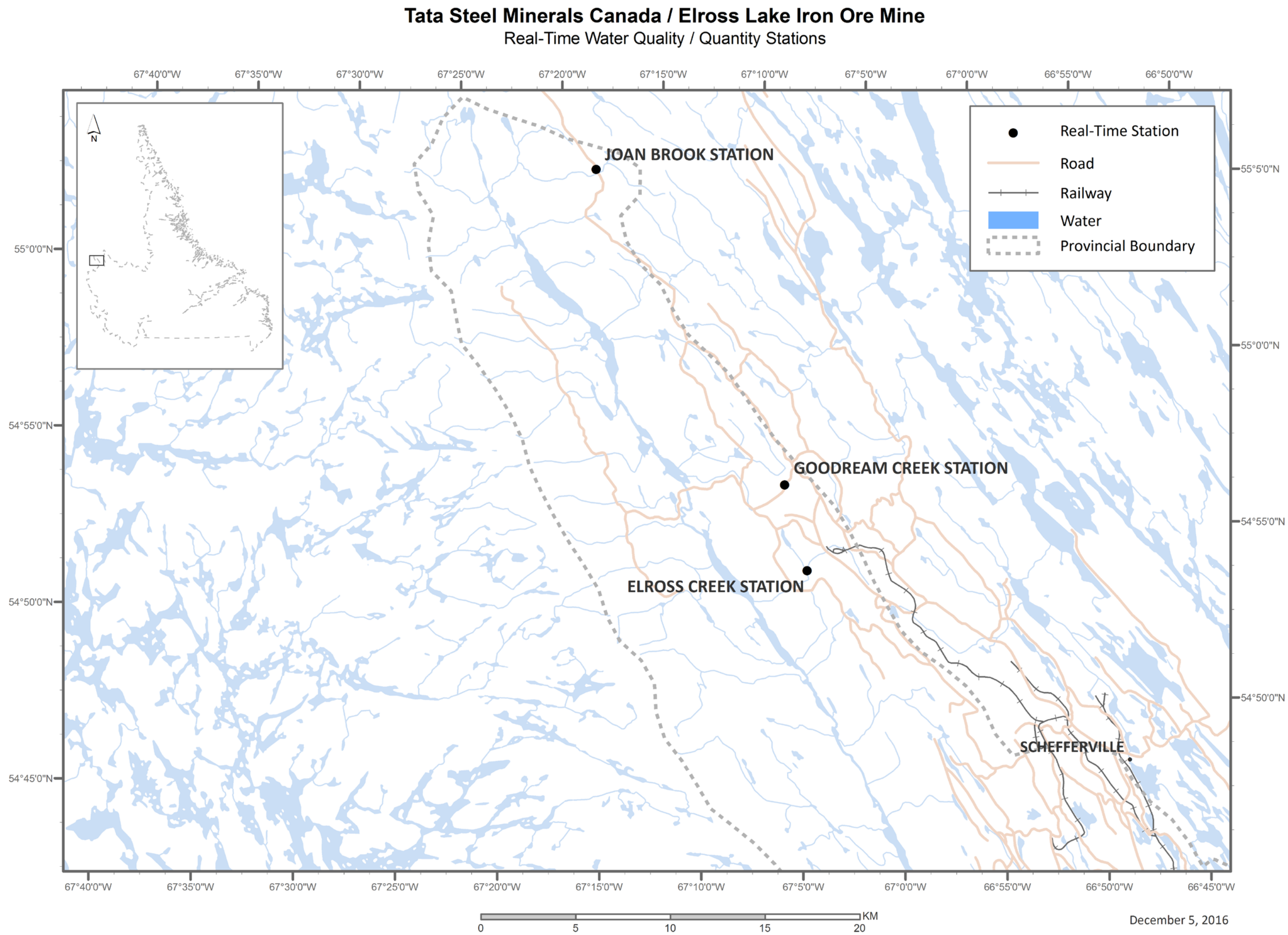

Figure 2. Map of real-time water quality/quantity stations in the vicinity of Elross Lake Iron Ore Mine in Western Labrador.

Quality Assurance & Quality Control

- Water quality parameters are measured at each station using a Hydrolab DataSonde instrument (Figure 3).

Model DS5 © 2005 Hach Company

Figure 3. Hydrolab DataSonde used for monitoring five water quality parameters.

- 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 four instrument sensors (i.e., pH, specific conductivity, dissolved oxygen, and turbidity sensors).
- Quality assurance procedures are generally carried out every 30-45 days, before the start of a new deployment period. Deployment start and end dates are summarized in Table 2.

Table 2. Water quality instrument deployment start and end dates for 2021 at Elross Creek, Goodream Creek and Joan Brook.

Station	Start date	End date	Duration (days)
Elross Creek	2021-06-07	2021-06-30	23
	2021-06-30	2021-07-16	16
	2021-07-16	2021-09-08	52
Joan Brook	2021-06-06	2021-06-30	24
	2021-06-30	2021-07-15	15
	2021-07-15	2021-09-08	53
Goodream Creek	NA	NA	NA

- As part of the quality control procedures, instrument performance is tested at the start and end of its deployment period. The process is outlined in Appendix A.
- Instruments are assigned a performance rating (i.e., poor, marginal, fair, good or excellent) for each water quality parameter measured.
- The rankings of field instrument sensors to QAQC instrument sensors could not be provided as adjacent QAQC readings were limited. Where possible, grab samples were collected upon deployment to provide another way to QAQC three of the sensors. Table 3 below indicates the

comparison rankings of the instrument being deployed to the corresponding QAQC instrument or grab sample, as available.

Table 3. Instrument sensor performance compared to QAQC grab sample or instrument at the start of deployment period for the Elross Creek and Joan Brook RTWQ stations.

Station	Stage of deployment	Date (yyyy-mm-dd)	Temperature (˚C)	pH	Specific conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Turbidity (NTU)
Elross Creek	Start	2021-06-07	Good*	Good#	Excellent#	NA	Poor#
	End	2021-06-30	NA	NA	NA	NA	NA
	Start	2021-06-30	NA	Good#	Excellent#	NA	Fair#
	End	2021-07-16	NA	NA	NA	NA	NA
	Start	2021-07-16	NA	NA	NA	NA	NA
	End	2021-09-08	Excellent	Excellent	Excellent	Excellent	Good
Joan Brook	Start	2021-06-06	Excellent*	Good#	Excellent#	NA	Excellent#
	End	2021-06-30	NA	NA	NA	NA	NA
	Start	2021-06-30	Poor*	Good#	Excellent#	NA	Excellent#
	End	2021-07-15	NA	NA	NA	NA	NA
	Start	2021-07-15	NA	NA	NA	NA	NA
	End	2021-09-08	Excellent	Good	Excellent	Excellent	Poor

*QAQC comparison to instrument owned by TSMC #QAQC comparison to grab sample NA-No comparison available

- Bath tests conducted in the winter of 2021 prior to the commencement of the field season showed that all sensors performed well for all instruments.

Deployment Notes

- Mining operations at TSMC's DSO project in 2021 consisted of mining from 2 deposits: Goodwood pit (Quebec) and Kivivic 2 pit (Nfld), both located in Area 4. Low grade Run of Mine (ROM) material was hauled to the concentrator where the ore is beneficiated before sending to Sept-Iles via rail. Direct Ship Ore (DSO) ROM material was hauled to Plant 2 where it is crushed and screened then sent to Sept-Iles via rail. Rock was also drilled and blasted at KM14 rock quarry and crushed into various sizes for construction purposes. In 2021, repair work began on the Goodwood sedimentation pond and the repairs are expected to continue in 2022.
- Due to the Covid-19 pandemic and associated issues with travel across borders, TSMC staff on site deployed and removed the equipment for the majority of the 2021 field season.
- The Goodream Creek Station was not active for the 2021 season pending its move to a new location further downstream near Triangle Lake. It was hoped that this move would be completed in 2021, however this was not accomplished, and now it is planned for early in the 2022 field season.

Data Interpretation

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

  (i.) Stage (m)
  (ii.) Temperature (^{o}C)
  (iii.) pH
  (iv.) Specific conductivity (µs/cm)
  (v.) Dissolved oxygen (mg/l)
  (vi.) Turbidity (NTU)

- A description of each parameter is provided in Appendix B.

Water Temperature

- Water temperature ranged from 0.60˚C to 16.70˚C at Joan Brook with a median of 8.30˚C, and from 2.70˚C to 16.07˚C at Elross Creek with a median of 10.66˚C (Figure 4).
- Water temperatures at both stations displayed large diurnal variations. This is typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures. Joan Brook had a greater daily range, reaching much lower temperatures than Elross Creek.
- Both stations displayed typical seasonal trends, increasing into summer and decreasing again as fall approached. Abnormal increases and decreases occurred occasionally at both stations concurrently, indicating the changes were associated with weather conditions.

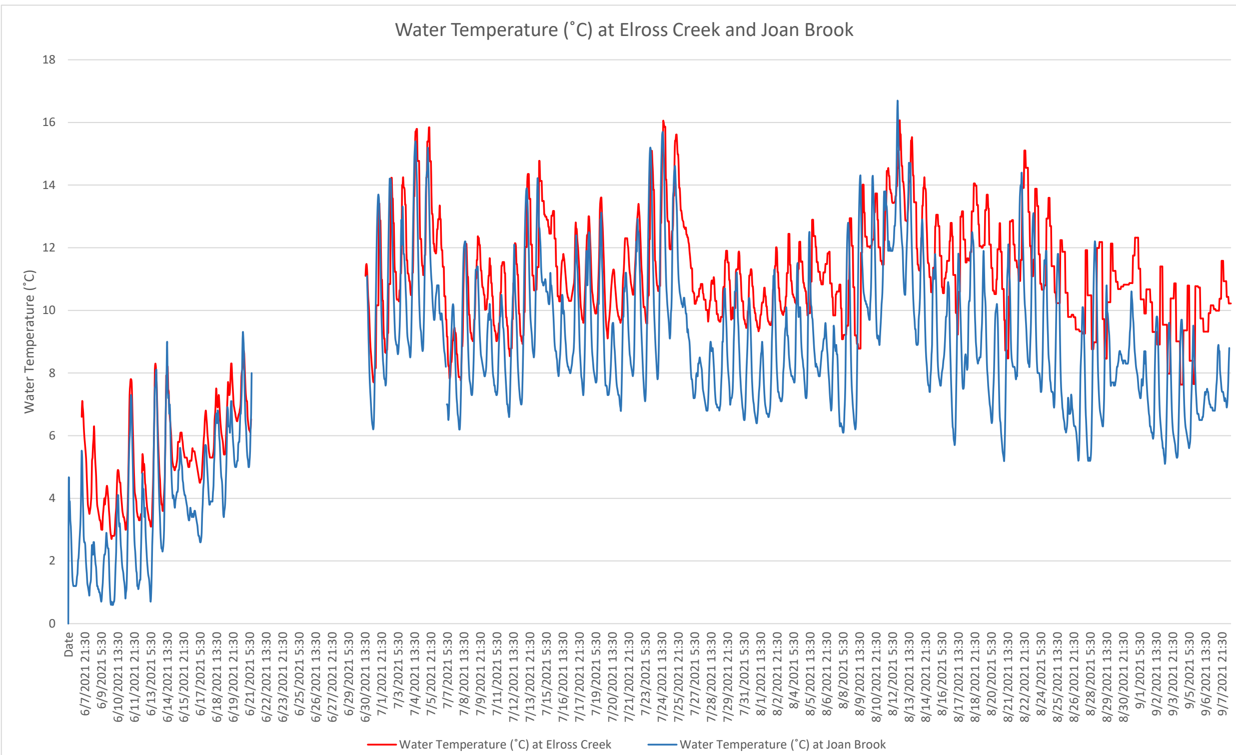

Figure 4: Water Temperature (°C) at Joan Brook and Elross Creek

pH

- pH values ranged from 6.36 units to 6.98 units at Elross Creek with a median of 6.70 units, and from 5.99 units to 6.89 units at Joan Brook with a median of 6.60 units. pH values at both stations are relatively stable throughout the deployment (Figure 5).
- pH values show diurnal variations at both stations. These diurnal variations are related to diurnal fluctuations in temperature, oxygen and photosynthetic cycling of CO_2 by aquatic organisms.
- Values at Elross Creek were generally higher than at Joan Brook, except for the last few weeks of deployment. A noticeable drop in pH occurred at Elross Creek on August 6th, likely due to the large precipitation event at this time (Appendix C: August 6th-14.9mm) which added more acidic water to the system. However, pH at Joan Brook was not similarly affected. After this event, pH at Elross continued a gradual decline.
- At both stations, values occasionally dropped below the CCME minimum pH guideline for the protection of aquatic life (6.5 pH units). It should be noted that acidic waters are quite common in Canada, particularly in boreal and northern ecoregions, and pH is often naturally below the minimum guideline.

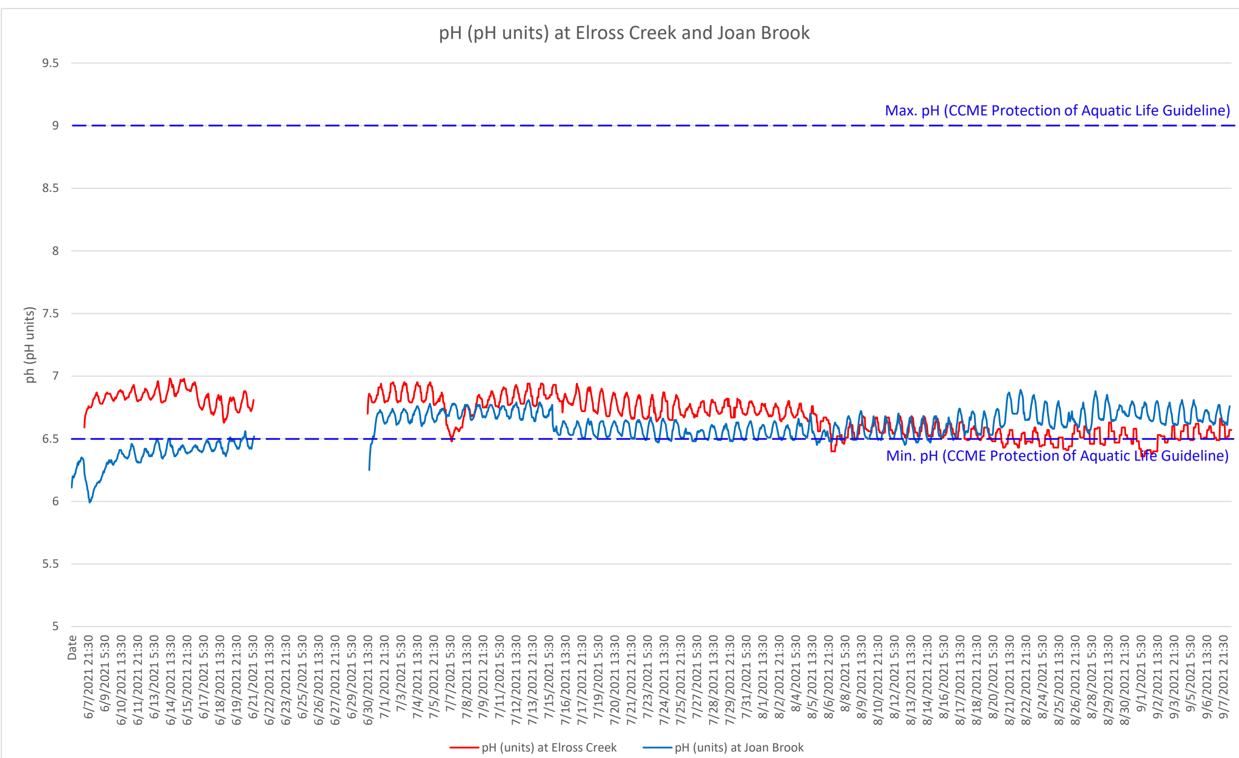

Figure 5: pH (ph units) at Joan Brook and Elross Creek

Specific Conductivity and TDS

- Specific Conductivity ranged from 15.0 µs/cm to 24.6 µs/cm at Elross Creek with a median of 20.0 µs/cm, while Joan Brook ranged from 2.4 µs/cm to 16.2 µs/cm with a median of 8.6 µs/cm (Figure 6).
- Total dissolved solids (TDS) ranged from 0.0016 to 0.0104 g/L at Joan Brook and 0.0096 to 0.0157 g/L at Elross Creek (Figure 6).
- Specific conductivity is relatively stable at Elross Creek while it follows a gradual increasing trend at Joan Brook. The limited range of data over the deployment is consistent with data from previous years.
- As water is added to the system by precipitation, the water column is diluted, decreasing the conductivity. At Elross Creek, there are several significant drops in conductance levels which occur concurrently to dips at Joan Brook (June 6th, August 6th), indicating they are the result of precipitation. However, other drops do not (June 16th). A significant increase over a two-day period occurred August 20-22 at Joan Brook. The conductivity data from Elross Creek does not indicate a similar increase during this timeframe. The cause of this increase is unknown.

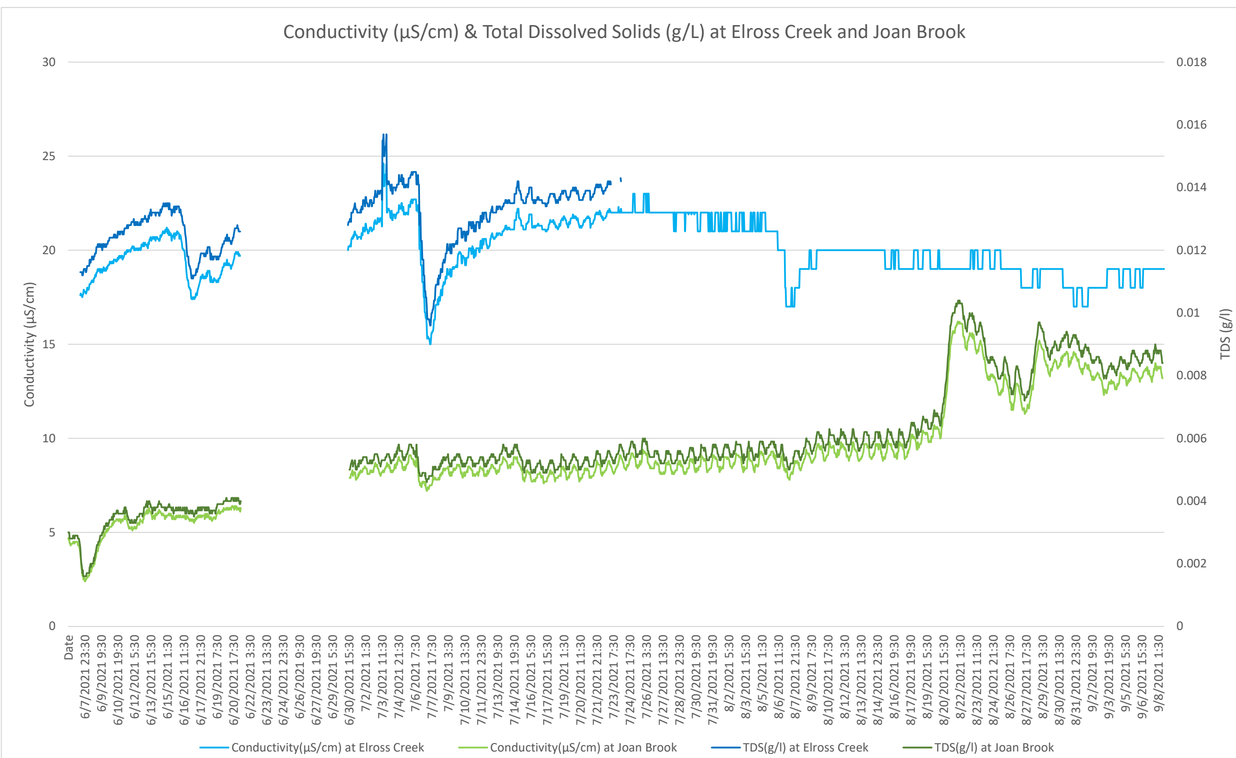

Figure 6: Specific Conductivity (µS/cm) and Total Dissolved Soilds – TDS (g/L) at Joan Brook and Elross Creek

Dissolved Oxygen

- Dissolved Oxygen (DO) values ranged from 8.05 mg/l (80.6%) to 11.28 mg/l (89.5%) at Elross Creek and from 8.53 mg/l (80.9%) to 12.32 mg/l (90.2%) at Joan Brook (Figure 7). Elross Creek values were consistently below those of Joan Brook.
- DO levels show diurnal variations at both stations. These diurnal variations are related to diurnal fluctuations in temperature and photosynthetic cycling of CO_2 by aquatic organisms.
- Trends in DO corresponded well with the inverse of water temperature (Figure 4), since colder water has a greater potential to dissolve oxygen compared to warmer water. As a result, oxygen levels dropped around July 3rd, July 12th, July 21st, and August 12th when water temperatures increased briefly, influence by air temperatures (Appendix C).
- DO values at both Elross Creek and Joan Brook remained above the cold water minimum guidelines set for aquatic life during other life stages (6.5 mg/L) throughout the deployment, but values hovered around the guideline for early life stages (9.5 mg/l).

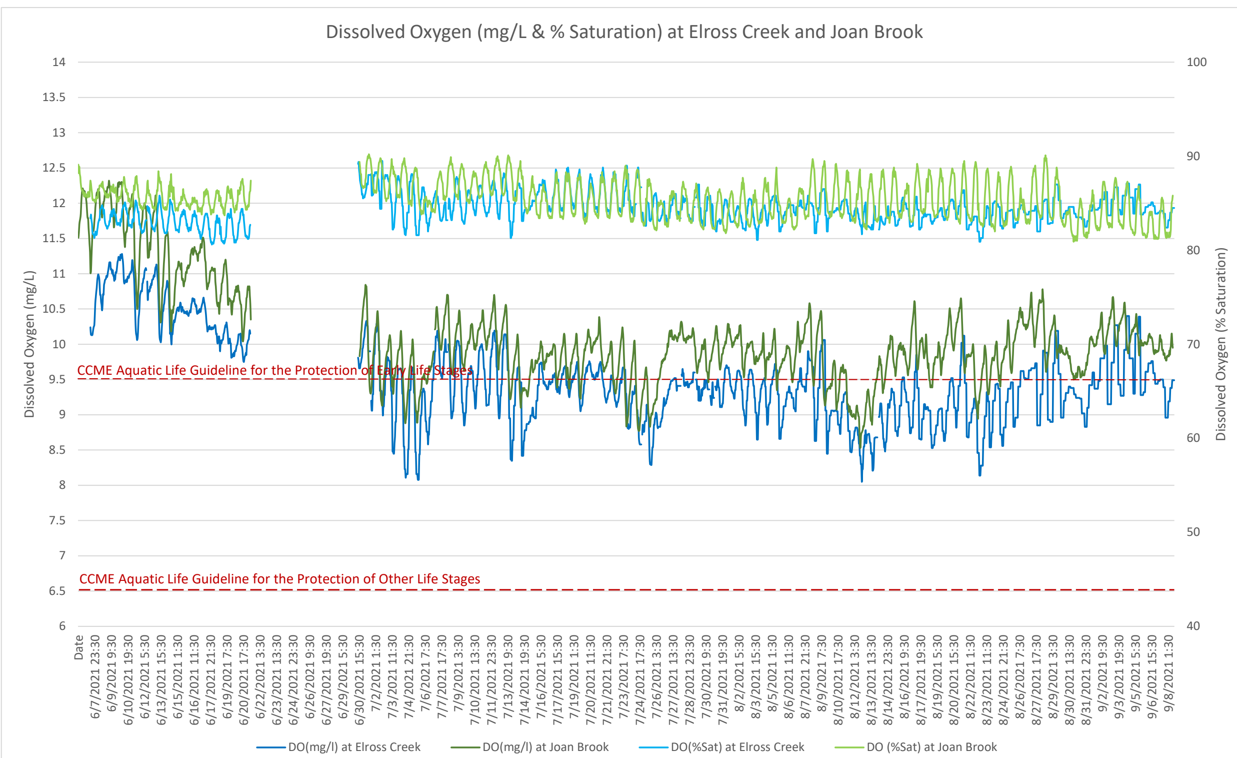

Figure 7: Dissolved Oxygen (mg/L & % saturation) at Joan Brook and Elross Creek

Turbidity

- Turbidity values ranged from 8.0 NTU to 178.9 NTU at Elross Creek with a median of 9.42 NTU, and from 0.0 NTU to 2834 NTU at Joan Brook with a median of 19.2 NTU (Figure 8a & 8b). It should be noted that turbidity data from Elross Creek was very limited due to transmission and power issues.
- At Elross Creek and Joan Brook, there were significant spikes in turbidity which corresponded closely with significant increases in flow as indicated by stage height (Figure 9).
- In previous years, Joan Brook normally experiences little turbidity. However, in 2021, the data recorded a higher than normal median for this station of 19.2 NTU. It is likely that the Joan Brook turbidity sensor was impacted by sedimentation buildup from July 16th until its removal on September 8th.

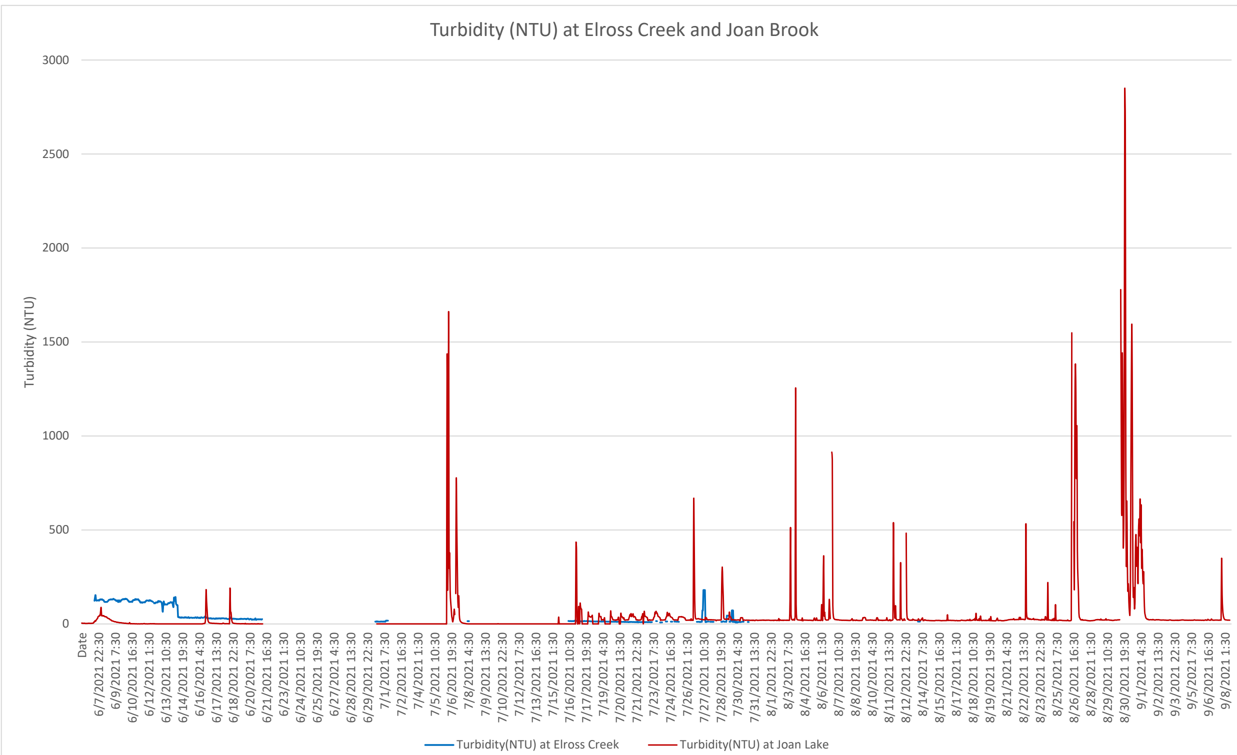

Figure 8a: Turbidity (NTU) at Joan Brook and Elross Creek

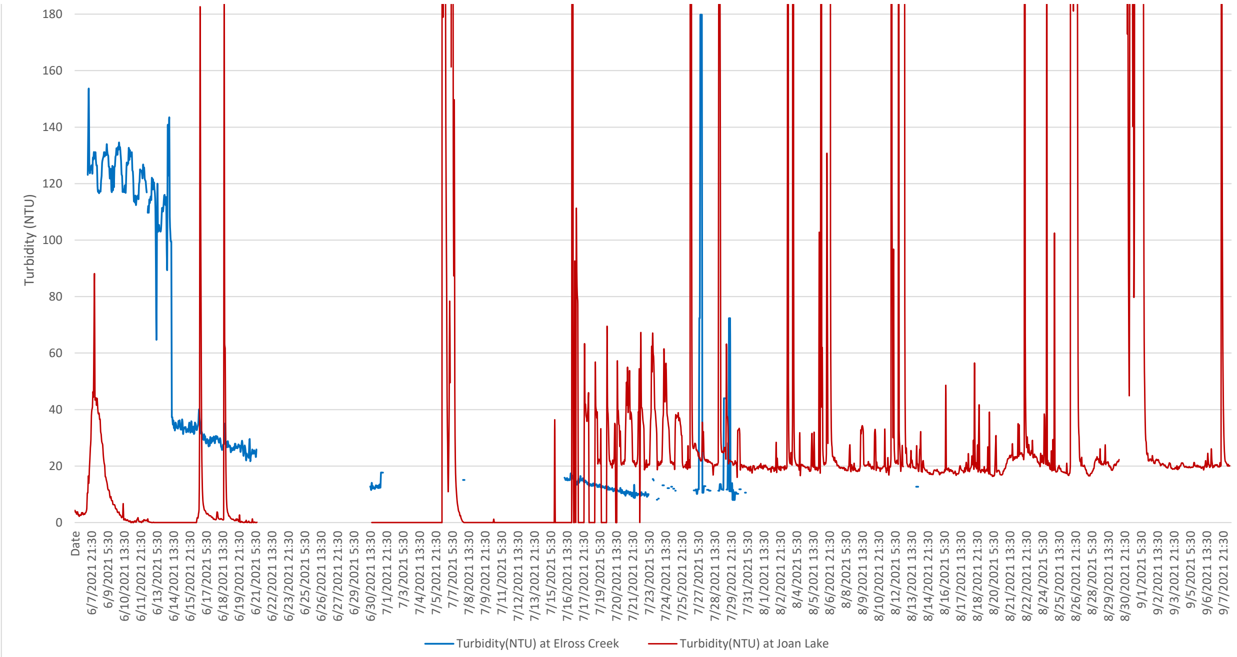

Figure 8b: Turbidity below 180 NTU at Joan Brook and Elross Creek

Stage

- Stage values are based on a vertical reference that is unique to each station. As a result, absolute values of stage are not comparable between stations, but relative changes in stage are.
- Stage fluctuated between 1.115m and 1.270m for a range of 0.155m at Elross Creek, and between 1.576m and 1.879m for a range of 0.303m at Joan Brook (Figure 9). It should be noted that there was limited stage data available for Elross Creek.
- These values are provisional. A complete dataset of quality assured and quality controlled stage values should be available upon request through ECCC after March 2022 (http://www.ec.gc.ca/rhc-wsc/default.asp).
- Fluctuations in stage corresponded well with rainfall events (Climate data located in Appendix C) such as on June 7th and throughout August at Joan Brook. Even though stage data is limited for Elross, it is evident from the available data that large precipitation events such as on July 7th had an affect on all water quality parameters at both stations, although the fluctuations were more pronounced at Elross Creek.

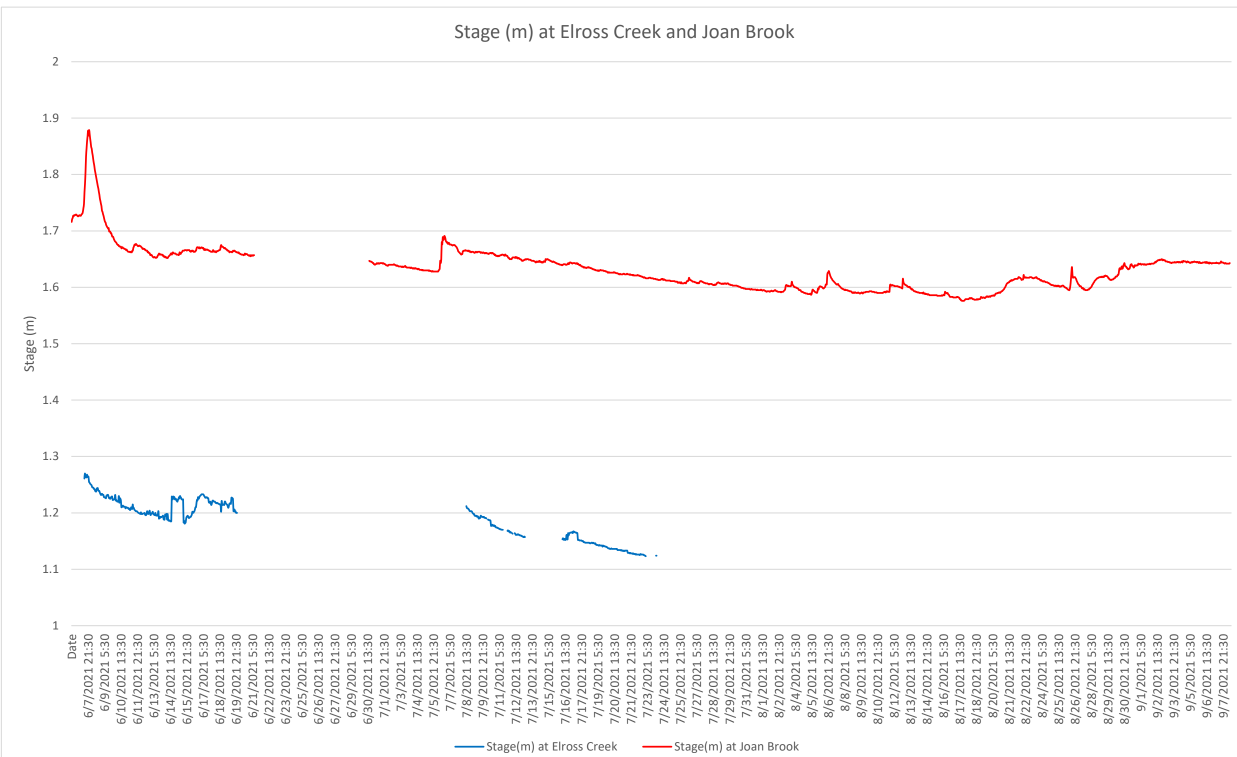

Figure 9: Stage Level (m) at Joan Brook and Elross Creek

Conclusions

- Water quality monitoring instruments were deployed at two established stations near the Elross Lake and DSO4 Project 2B, Iron Ore Mine, between June 6th and September 8th, 2021. The stations are located on Elross Creek and Joan Brook.
- The water quality monitoring instruments were deployed three times during 2021, with the final deployment being lengthy, as there were significant logistical issues related to the Covid-19 pandemic and associated travel bans and challenges which prevented ECC staff from visiting the site.
- Both stations suffered data loss due to transmission and power issues. Elross Creek suffered substantial losses due to continued vandalism by wildlife. Where possible, internally logged data from the sondes were used to limit the data loss for water quality parameters.
- The instruments at Joan Brook and Elross Creek were deployed for a total of 94 days.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - STAGE: Stage values ranged from 1.115 m to 1.270m at Elross Creek, and from 1.576 m to 1.879 at Joan Brook. Fluctuations in stage corresponded well with rainfall events.
    - WATER TEMPERATURE: Water temperature ranged from 2.70˚C to 16.07˚C at Elross Creek and from 0.60˚C to 16.70˚C at Joan Brook. Water temperatures at both stations display diurnal variations. Trends in water temperature corresponded very well with seasonal air temperature trends.
    - pH: pH values ranged from 6.36 units to 6.98 units at Elross Creek and from 5.99 units to 6.89 units at Joan Brook. pH values show diurnal variations at both stations. pH values were gradually increasing at Joan Brook and decreasing at Elross Creek across the deployment season.
    - SPECIFIC CONDUCTIVITY: Specific Conductivity ranged from 15.0 µs/cm to 24.6 µs/cm at Elross Creek, and from 2.4 µs/cm to 16.2 µs/cm at Joan Brook. Specific conductance was stable at Elross Creek but showed an increasing trend at Joan Brook.
    - DISSOLVED OXYGEN: Dissolved Oxygen (DO) values ranged from 8.05 mg/l (80.6%) to 11.28 mg/l (89.5%) at Elross Creek and from 8.53 mg/l (80.9%) to 12.32 mg/l (90.2%) at Joan Brook. 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 was highest when water temperatures were coolest.
    - TURBIDITY: Turbidity values ranged from 8 NTU to 179.8 NTU at Elross Creek, and from 0.0 NTU to 2834 NTU at Joan Brook. At both stations there were spikes in turbidity which correspond closely with increases in stage. These spikes are generally short lived before returning to background levels. Joan Brook may have experienced sedimentation buildup during the last deployment as background values at this time hovered around 20 NTU instead of the usual 0 NTU for this location.

Path Forward

- ECC staff will redeploy RTWQ instruments at Elross Creek and Joan Brook in the spring of 2022, when ice conditions allow. The field season will be broken down into four, month long deployment periods, and ECC staff will perform regular site visits for calibration and maintenance of the instruments.
- ECC staff will continue to work co-operatively with TSMC staff to co-ordinate the relocation of the Goodream Creek Station to a new monitoring location further downstream on Goodream Creek above Triangle Lake. An instrument will be redeployed at the new Goodream Creek location as soon as possible in the 2022 field season once the new station hut is installed.
- ECC staff will continue to rely on input and assistance from TSMC staff in the operation and maintenance of all three TSMC Real Time Water Quality stations at Elross Creek, Goodream Creek and Joan Brook. Every effort will be made to coordinate in advance with TSMC staff for site visits during the 2022 field season. ECC staff are very appreciative of the field assistance provided by TSMC staff during the 2021 field season and are hoping to carry on with this arrangement again next year.
- If necessary, deployment techniques will be evaluated and adapted to each site, ensuring secure and suitable conditions for RTWQ monitoring.
- ECC staff will update TSMC staff on any changes to processes and procedures with handling, maintaining and calibrating the real-time instruments.
- ECCC staff will perform regular site visits to ensure water quantity instrumentation is correctly calibrated and providing accurate measurements.
- Parameter alerts will be set prior to the 2021 deployment season to notify ECC staff by email of any emerging water quality issues.
- TSMC will continue to be informed of data trends and any significant water quality events in the form of email and/or monthly deployment reports, when the deployment season begins. TSMC will also receive an annual report, summarizing the events of the deployment season.
- ECC has begun development of models using water quality monitoring data and grab sample data to estimate a variety of additional water quality parameters (e.g., TSS and major ions). This work will continue with a goal in implementing these models for RTWQ data collected.
- ECC will continue to work on its Automatic Data Retrieval System, to incorporate new capabilities in data management and data display.
- ECC will be active in creating new value added products using the RTWQ data and water quality indices.
- Open communication will continue to be maintained between ECC, ECCC and TSMC employees involved with the agreement, in order to respond to emerging issues on a proactive basis.

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APPENDIX A
Quality Assurance / Quality Control Procedures

- As part of the Quality Assurance / Quality Control (QA/QC) protocol, the performance of a station's water quality instrument (i.e., Field Sonde) is rated at the start and end of its deployment period. The procedure is based on the approach used by the United States Geological Survey (Wagner *et al.* 2006)[1].
- At the start of the deployment period, a fully cleaned and calibrated QA/QC water quality instrument (i.e., QA/QC Sonde) is placed *in-situ* with the fully cleaned and calibrated Field Sonde. After Sonde readings have stabilized, which may take up to five minutes in some cases, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde. If the readings from both Sondes are in close agreement, the QA/QC Sonde can be removed from the water. If the readings are not in close agreement, there will be attempts to reconcile the problem on site (e.g., removing air bubbles from sensors, etc.). If no fix is made, the Field Sonde may be removed for recalibration.
- At the end of the deployment period, a fully cleaned and calibrated QA/QC Sonde is once again deployed *in-situ* with the Field Sonde, which has already been deployment for 30-40 days. After Sonde readings have stabilized, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde.
- Performance ratings are based on differences listed in the table below.

	Rating				
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 ≤ 35 (µS/cm)	≤ ±3	> ±3 to 10	> ±10 to 15	> ±15 to 20	> ±20
Sp. Conductance > 35 (□S/cm)	≤ ±3	> ±3 to 10	> ±10 to 15	> ±15 to 20	> ±20
Dissolved Oxygen (mg/l)	≤ ±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 (NTU)	≤ ±5	> ±5 to 10	> ±10 to 15	> ±15 to 20	> ±20

[1] Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1–D3, 51 p. + 8 attachments; accessed April 10, 2006, at *http://pubs.water.usgs.gov/tm1d3*

APPENDIX B
Water Parameter Description

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 effluence, saline inflows or aquatic organisms involved in the photosynthetic cycling of CO_2 (Allan 2010).

Specific conductivity - Specific conductivity (�S/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25ºC. 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 C

Climate Data from Nav Canada Station: Schefferville - 7117823