Real-Time Water Quality Annual Report

Outflow of the Steady below Rambler's Nugget Pond Mill Site

July 16 to
November 27, 2019

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

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Introduction

- The Real-Time Water Quality (RTWQ) Monitoring station at Outflow of the Steady is funded by Rambler Metals and Mining Canada Inc. The program is a joint partnership between Rambler and the Newfoundland & Labrador Department of Municipal Affairs and Environment (MAE).
- The real-time water quality monitoring station at Outflow of the Steady was installed in July 2019 by MAE staff.
- The water quality instrument was first deployed July 16 and removed November 27 to prevent damage during the winter months.
- This station measures the following water parameters: temperature, pH, specific conductivity, dissolved oxygen, turbidity and water quantity (stage). Parameters are recorded on an hourly basis during the deployment period and are available in real-time online: https://www.mae.gov.nl.ca/wrmd/ADRS/v6/Template_Station.asp?station=NLENHM0002

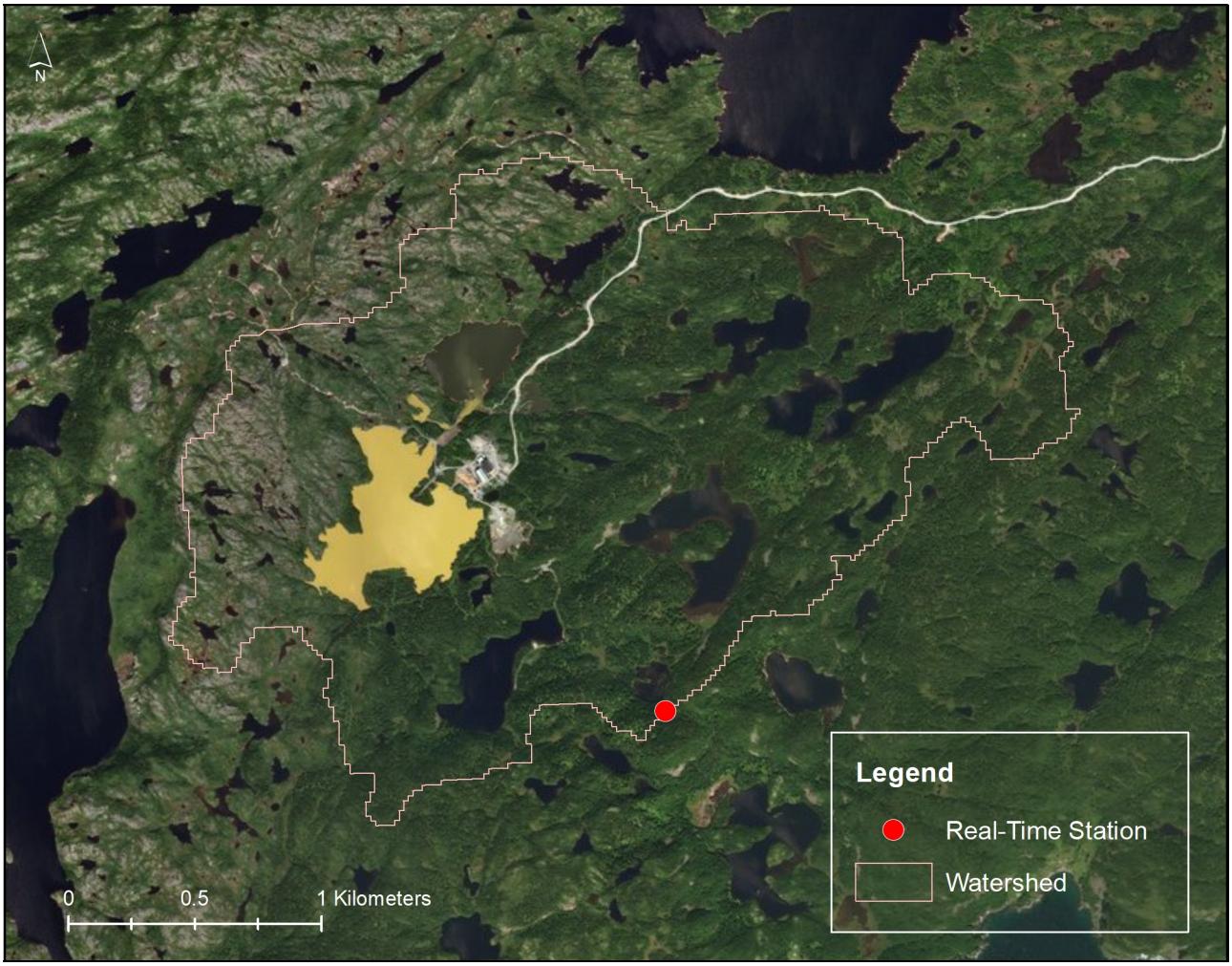

Figure 1: Map of Rambler's Nugget Pond Mill tailings management facility area and the RTWQ station

- The purpose of this network is to monitor, process, and distribute water quality/quantity data to Rambler Metals and Mining Canada Inc. and MAE for assessment and management of water resources, as well as to provide an early warning for any potential or emerging water issues, allowing mitigative measures to be implemented in a timely manner.
- MAE provides Rambler Metals and Mining Canada Inc. with monthly and annual deployment reports. Data is available in near real-time on the Department of Municipal Affairs and Environment's website.
- Gaps in the water quality data are the result of transmission loss by the station or the removal of inaccurate data due to ongoing station maintenance during that time period.
- The initial deployment for the 2019 season was on July 16th. The instrument was removed for the winter season on November 27th. The following report depicts and discusses water quality events throughout this time period. For more in-depth analysis, please refer to the individual deployment reports.

Maintenance and Calibration

- To ensure accurate data collection, maintenance and calibration of the water quality instrumentation is performed normally approximately every 45 days. However, due to logistical issues in 2019, the instrument was deployed for 81 days during the second deployment. The instrument performed well during this time.
- Maintenance includes a thorough cleaning of the instrument and replacement of any small sensor parts that are damaged or unsuitable for reuse. Once the instrument is cleaned, MAE staff carefully calibrate each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity to ensure accurate data collection.
- Installation and removal dates for the 2019 season are summarized in the table below.

Table 1: Water quality instrument deployment start and end dates for 2019

Installation	Removal	Deployment duration (days)
July 16	September 6	56
September 6	November 27	81

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 each 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 parameters recorded by the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 2).

Table 2: 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 broken down into three groups: temperature dependant, temperature compensated and temperature independent. Since the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the 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.
- Deployment and removal comparison rankings for the Outflow of the Steady water quality station for the two deployment periods from July 16th to November 27th, 2019, are summarized in Table 3.
- For additional information and explanations of rankings, please refer to the 2019 monthly deployment reports.

Table 3: QA/QC comparison rankings for Outflow of the Steady July 16 – November 27, 2019

	Date		Instrument #	Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Outflow of the Steady	16-Jul-19	Deployment	19E100335	NA	NA	NA	NA	NA
	06-Sep-19	Removal	19E100335	Excellent	Excellent	Good	Excellent	Excellent
	06-Sep-19	Deployment	17M102371	Excellent	Good	Excellent	Excellent	Excellent
	27-Nov-19	Removal	17M102371	Excellent	Good	Fair	Good	Excellent

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from July 16th, 2019 to November 27th, 2019 at Outflow of the Steady.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

Outflow of the Steady below Nugget Pond Mill

- Water temperature ranged from 0.70 to 23.85°C during the 2019 deployment season. The median value was 12.18 °C (Figure 2).
- Water temperature increases at the beginning of the deployment and decreases during the later portion of the season. This is expected as ambient air temperature warms the water in the summer and cools water into the fall.

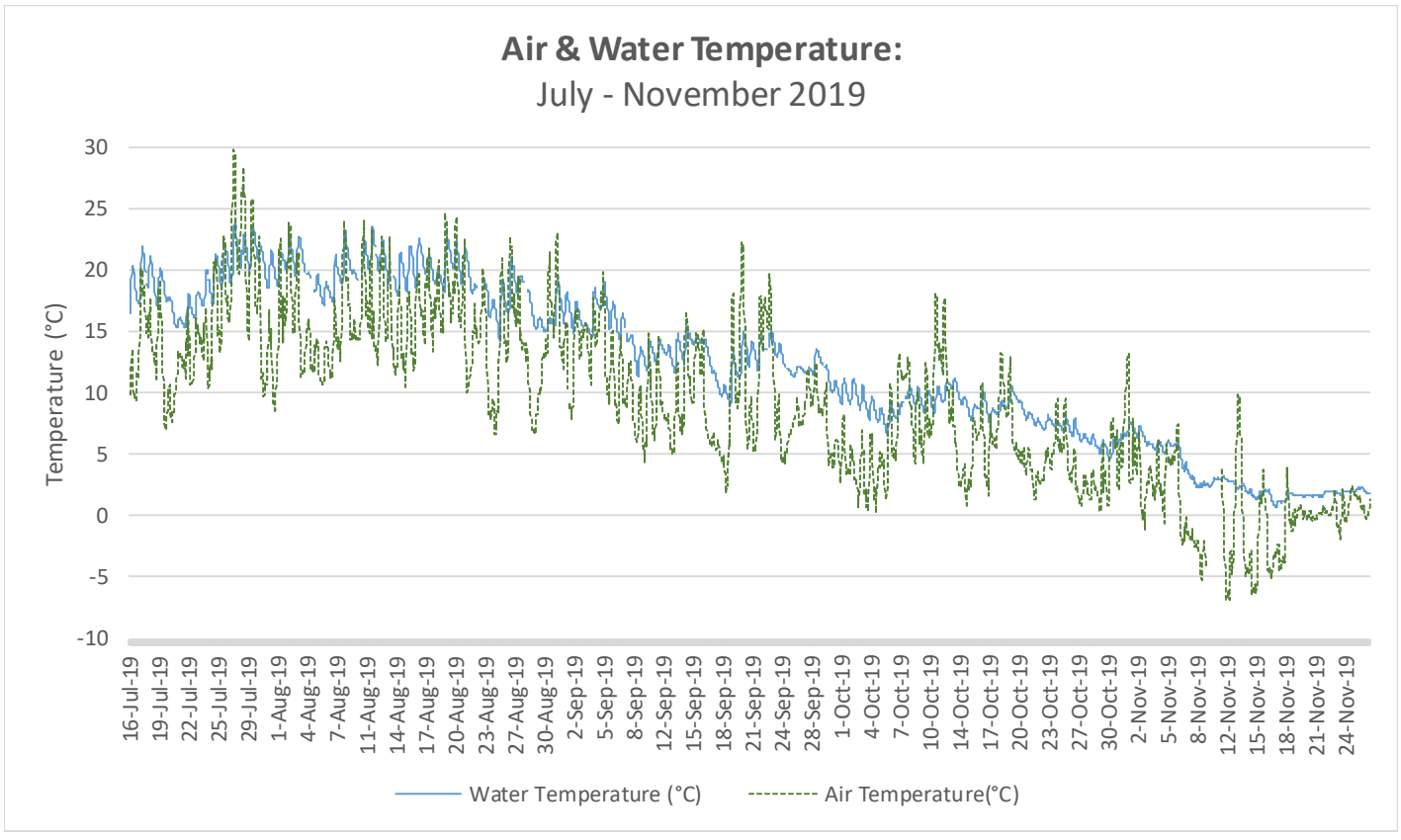

Figure 2: Water and Air Temperature – Outflow of the Steady
(Weather data from ECCC climate at La Scie)

- pH ranges from 6.81 to 7.41 pH units at Outflow of the Steady during the 2019 deployment season (Figure 3). The median pH is 7.04.
- pH fluctuates daily. All values during the deployment are within the CCME Water Quality Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units).
- pH increases slightly during August then remains relatively stable until the end of the season in November.

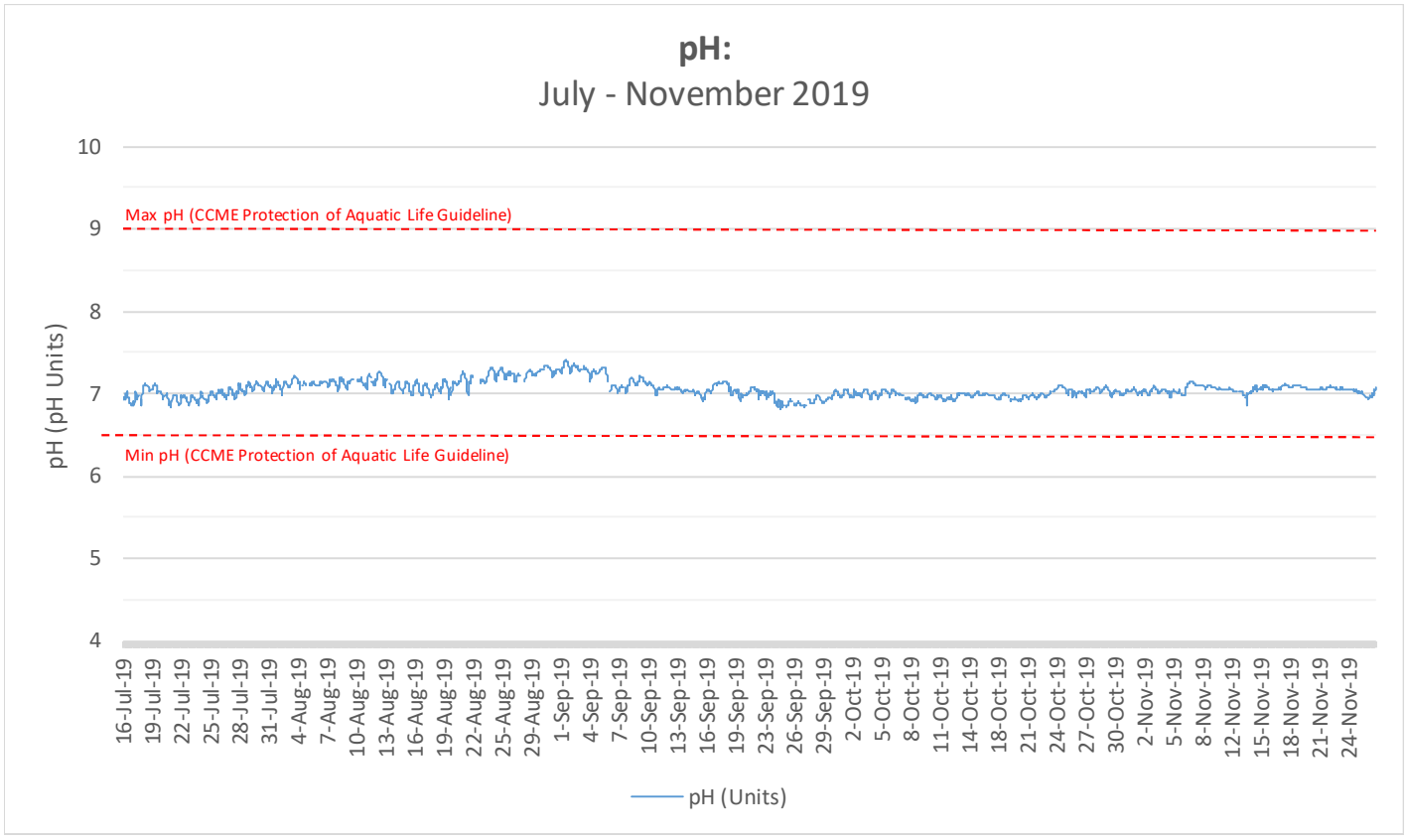

Figure 3: pH – Outflow of the Steady

- Throughout the 2019 deployment season, specific conductivity ranged from 124.1 to 228.8 µs/cm at Outflow of the Steady (Figure 4).
- Conductivity demonstrated an overall increasing trend throughout the year. Decreases were evident and coincided with high stage events. Precipitation events added water to the system, increasing stage, while diluting the water and decreasing the specific conductivity.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

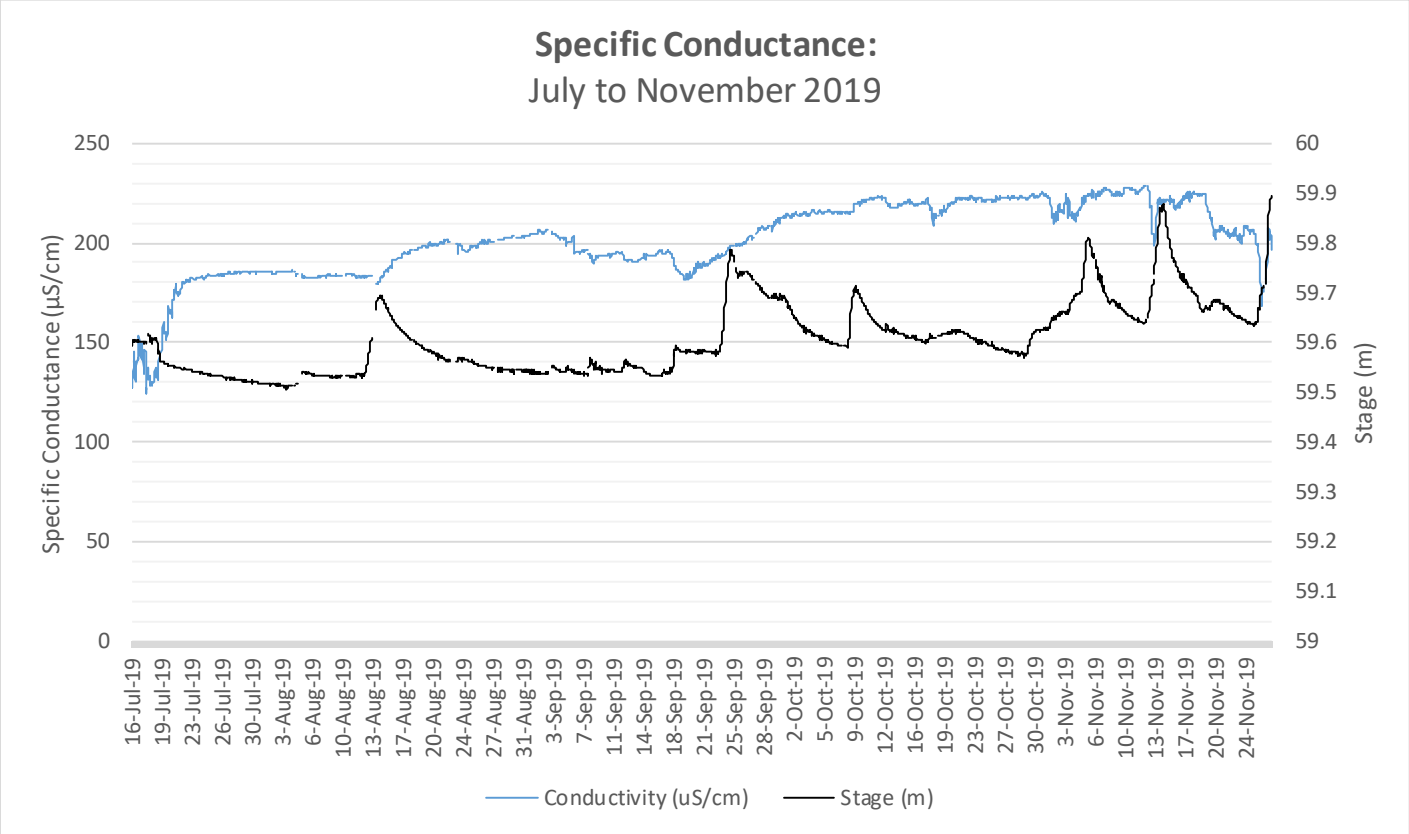

Figure 4: Specific Conductivity and Stage – Outflow of the Steady

- The saturation of dissolved oxygen ranged from 87.8 to 110.8%, while the dissolved oxygen content ranged from 8.10 to 13.56 mg/l, with a median value of 10.11 mg/l (Figure 5).
- Dissolved oxygen fluctuated daily with decreases observed at night.
- Dissolved oxygen is lowest during the summer months when water temperature is warmest. It then increases steadily into the fall as water temperatures cool (Figure 5). Cooler water holds more oxygen than warmer water.
- All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages of 6.5 mg/l. The majority of values recorded were above the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in red on Figure 5.

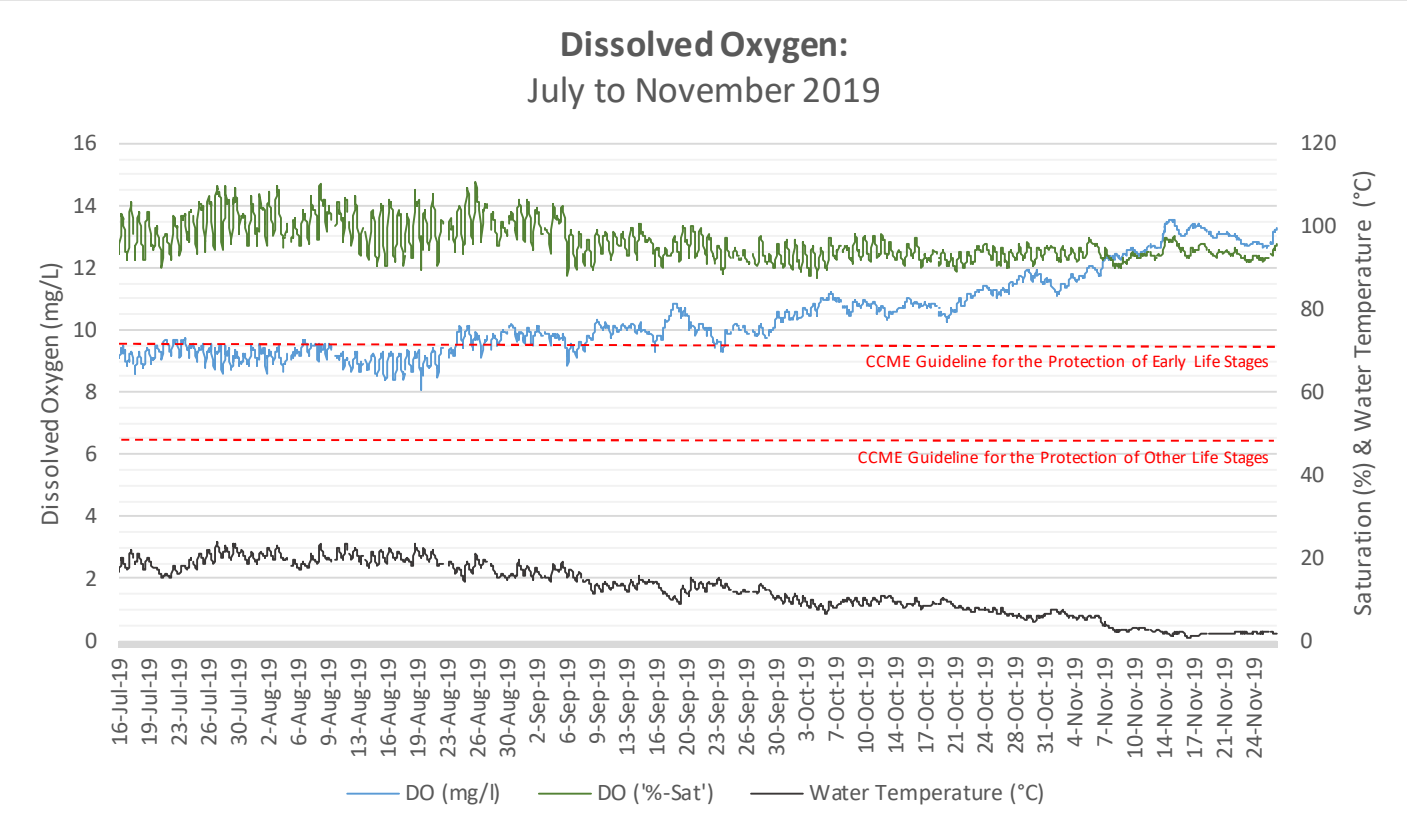

Figure 5: Dissolved Oxygen Concentration and Saturation and Water Temperature – Outflow of the Steady

- At the Outflow of the Steady station, turbidity values range from -0.04 to 4.55 NTU with a median value of 0.26 NTU (Figure 6). This indicates very low background turbidity at this location.
- Turbidity remained relatively stable throughout the deployment season with some spikes corresponding to stage increases which suspends sediment and particles into the water column for a short period of time.
- Stage varied from 59.50m to 59.90m, for a range of 0.4m during the year.

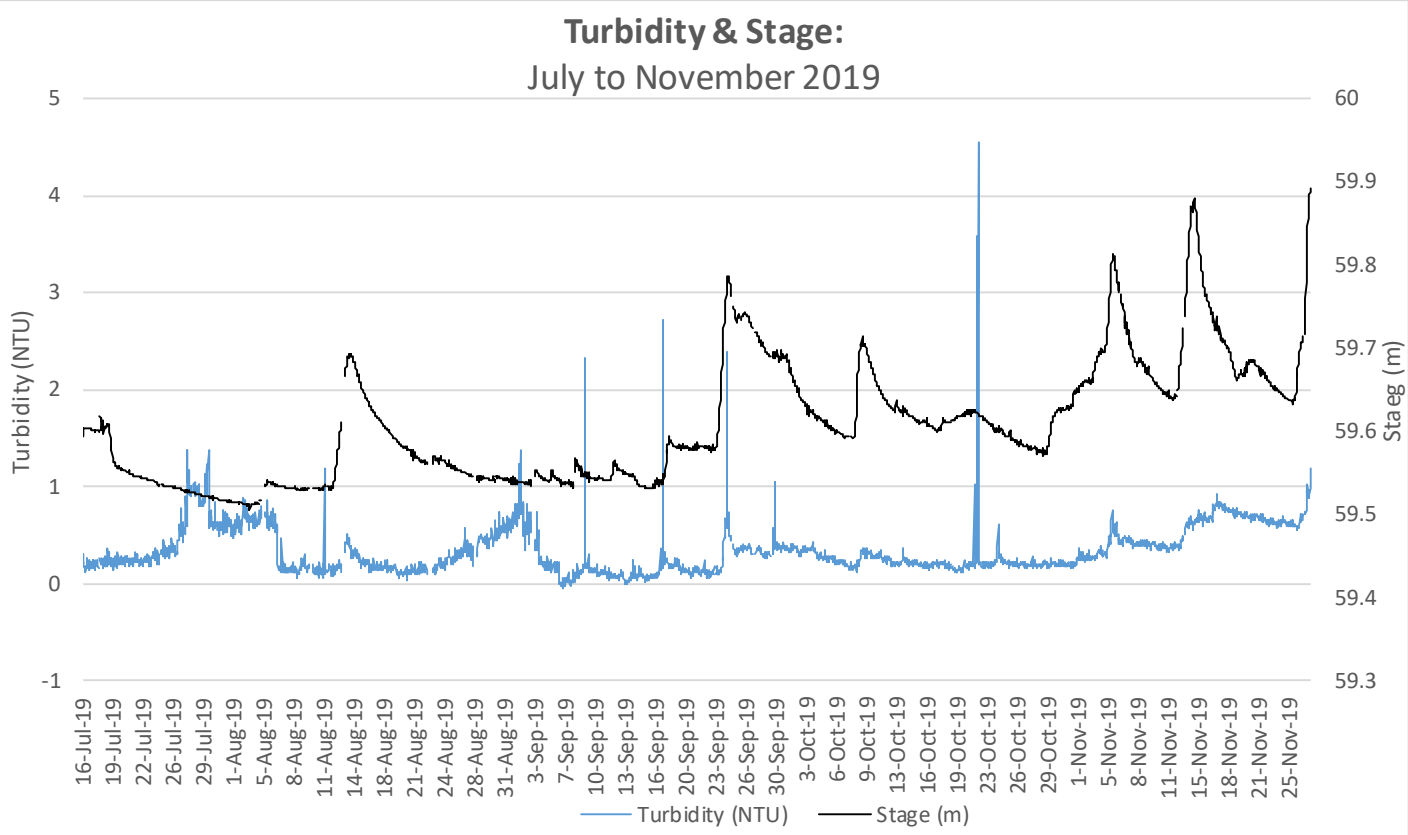

Figure 6: Turbidity and Precipitation – Outflow of the Steady

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Outflow of the Steady (Figure 7).
- Stage levels are generally consistent in the summer months, with an increasing trend into fall. Stage frequently increases in response to precipitation events, but not always. The largest precipitation event occurred November 19th with 32.3mm recorded at La Scie.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

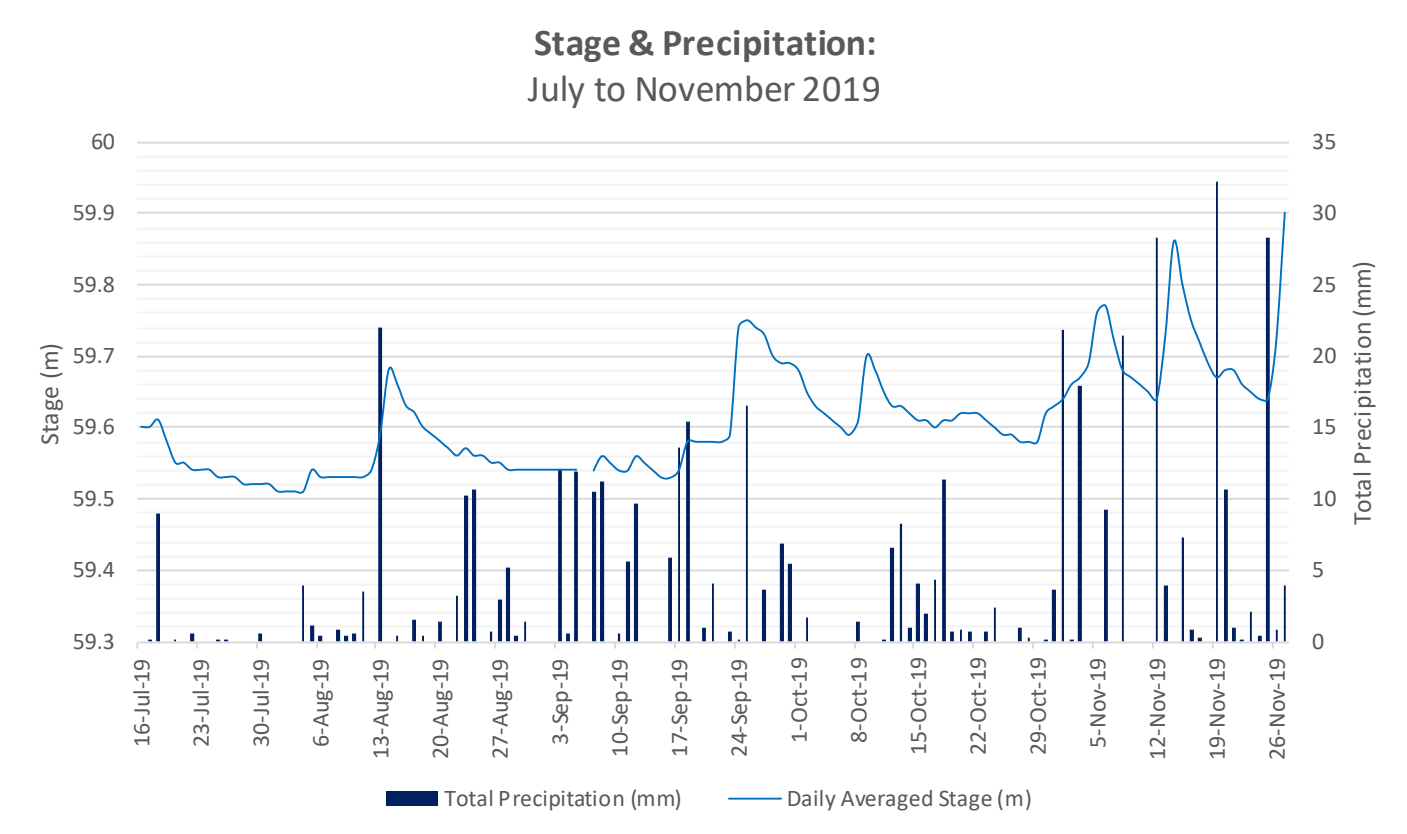

Figure 7: Stage and Precipitation – Outflow of the Steady
(Weather data collected from ECCC climate station at La Scie)

Conclusions

- The instrument at the water quality monitoring station Outflow of the Steady was deployed on July 16th, 2019 and removed on November 27th, 2019 for the winter season.
- Deployment periods were 56 and 81 days. A typical deployment period would normally be approximately 45 days. Due to logistical issues, the deployment periods in 2019 were extended. Staff monitored the data daily for issues. QA/QC sensor rankings show that the extended deployment had no negative effect on the data collected.
- The instrument performed well for the 2019 season with no issues.
- In most cases, weather related events or increases/decreases in water level explain the data fluctuations.
- Most values recorded were within ranges as suggested by the CCME Water Quality Guidelines for the Protection of Aquatic Life.
- Water temperature followed the seasonal trend of increasing during the summer and decreasing into the fall. Water temperature corresponded with air temperature.
- All pH values were within the acceptable range of the CCME Water Quality Guidelines for Protection of Aquatic Life.
- Specific conductivity showed an increasing trend throughout the deployment period, but was influenced by stage increases due to precipitation events.
- When the water was warmest, dissolved oxygen values were below the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold water Biota at Other Life Stages of 6.5 mg/l.
- This station has low background turbidity, but is influenced by stage increases which often increase turbidity for a short period of time.

Path Forward

- The field instrument will undergo proficiency testing and evaluation during the winter of 2019-2020. MAE will inform Rambler Metals and Mining Canada Inc. 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 (ADRS), to incorporate new capabilities in data management and data display.
- Open communication lines will continue to be maintained between MAE and Rambler in order to respond to emerging issues on a proactive basis. Rambler Metals and Mining Canada Inc. will receive monthly deployment reports and an annual report, summarizing the events of the deployment season.

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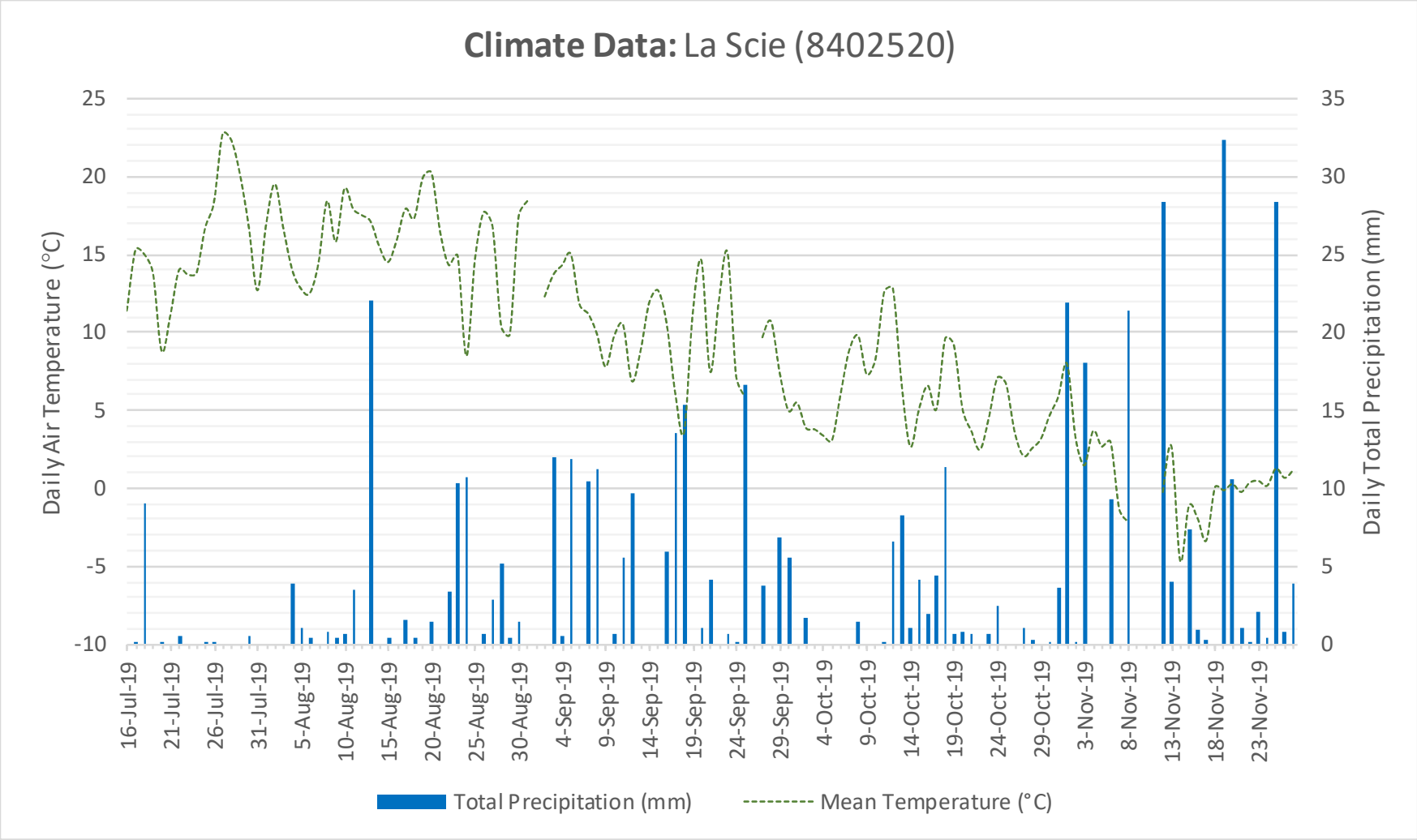
Appendix 1: Air Temperature and Precipitation



Appendix 2: RTWQ Monitoring Station Outflow of the Steady