Real-Time Water Quality Deployment Report

Outflow of the Steady at Rambler Mine

July 6 to
August 23, 2023

Newfoundland Labrador

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

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General

- The Water Resources Management Division, in partnership with Rambler Metals and Mining Canada Ltd., maintain one real-time water quality and water quantity station at the Outflow of the Steady.
- This station is situated downstream of the Nugget Pond Mill tailings management facility (Figure 1).
- On July 6, 2023, a real-time water quality monitoring instrument was deployed at the station Outflow of the Steady. The instrument was deployed for a period of 47 days. This was the first deployment for this station in 2023.
- Water Resources Management Division staff monitor the real-time web pages regularly.

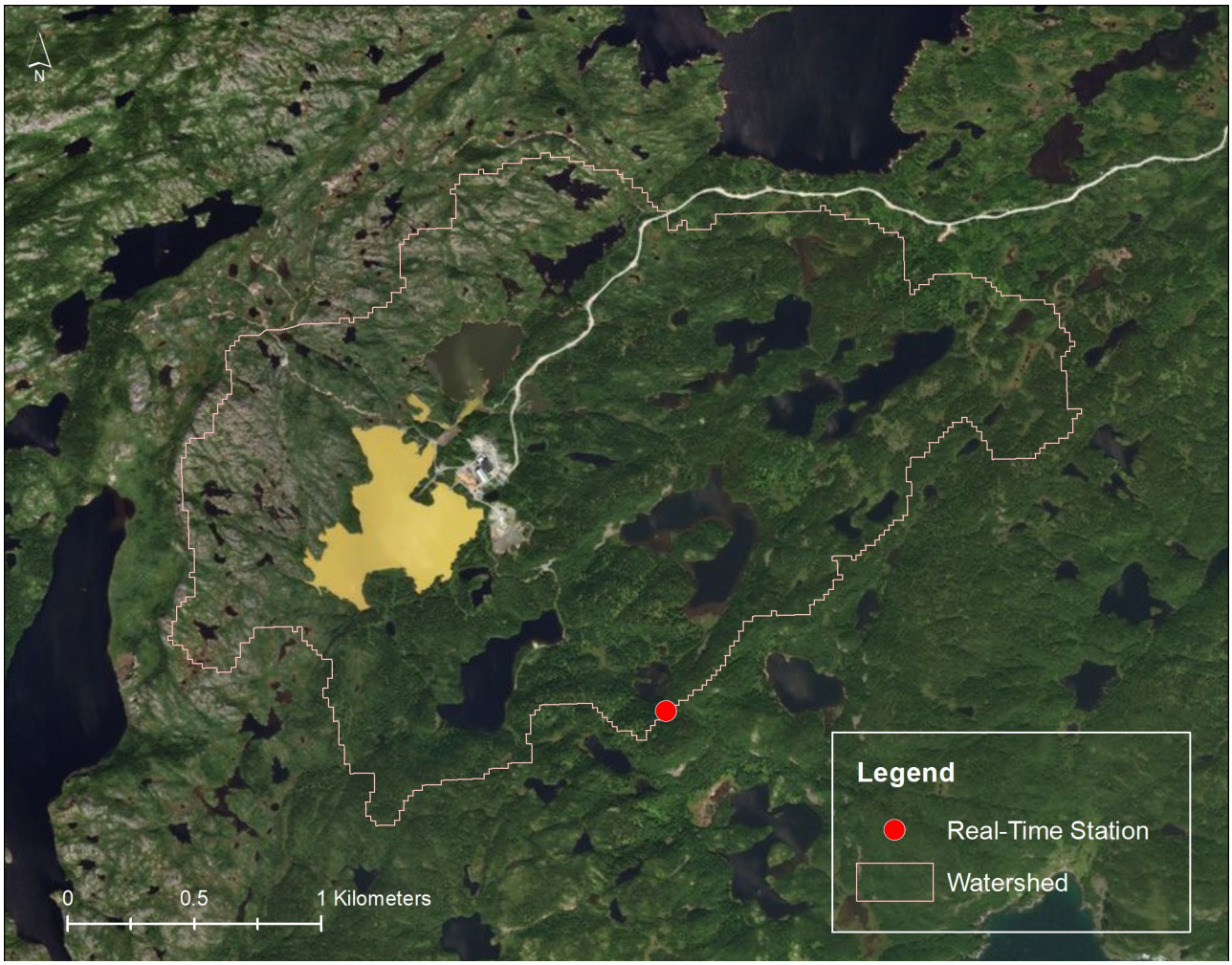

Figure 1: Location of the real-time station downstream of Rambler's Nugget Pond Mill tailings management facility

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 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 1).

Table 1: 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. Because 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 station Outflow of the Steady deployed between July 6 and August 23, 2023 are summarized in Table 2.

Table 2: Comparison rankings for Outflow of the Steady station July 6 – August 23, 2023.

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Outflow of the Steady	July 6, 2023	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	August 23, 2023	Removal	Excellent	Good	Good	Excellent	Excellent

- Deployment rankings were all ‘excellent’ or ‘good’.
- At removal, all parameters ranked ‘excellent’ or ‘good’.
- There are a few circumstances which may cause less than ideal QA/QC rankings to be obtained. These include: the placement of the QA/QC sonde in relation to the field sonde; the amount of time each sonde was given to stabilize before readings were recorded; and deteriorating performance of one of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality related events from July 6 to August 23 at the station Outflow of the Steady.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

Outflow of the Steady

- Water temperature ranged from 14.41 to 27.40°C during this deployment period (Figure 2).
- Water temperature steadily increased during the month of July and fluctuated throughout August. These fluctuations in water temperature correspond with ambient air temperatures as summer progresses (Figure 2).

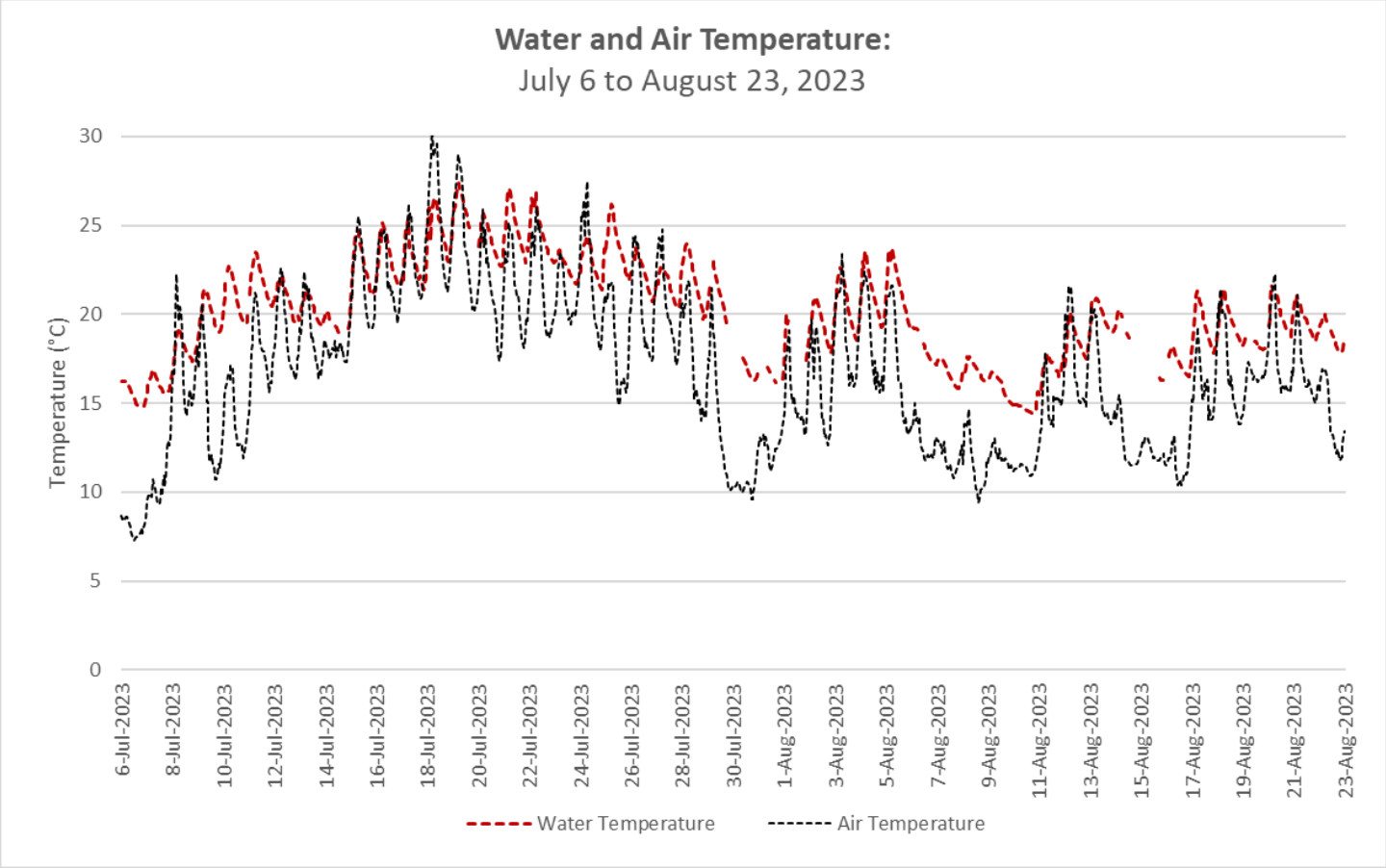

Figure 2: Water and Air Temperature – Outflow of the Steady

(Weather data collected at La Scie)

- pH ranged between 6.78 and 7.40 pH units throughout the deployment period, with a median value of 7.18 units (Figure 3).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.
- Significant rainfall (evident as a rise in stage levels) can cause a slight dip in pH levels. This is a common occurrence in freshwater as the slightly acidic rain influences the overall pH of the river for a short period of time (Figure 3).
- Overall, pH showed a slight increasing trend throughout the deployment.

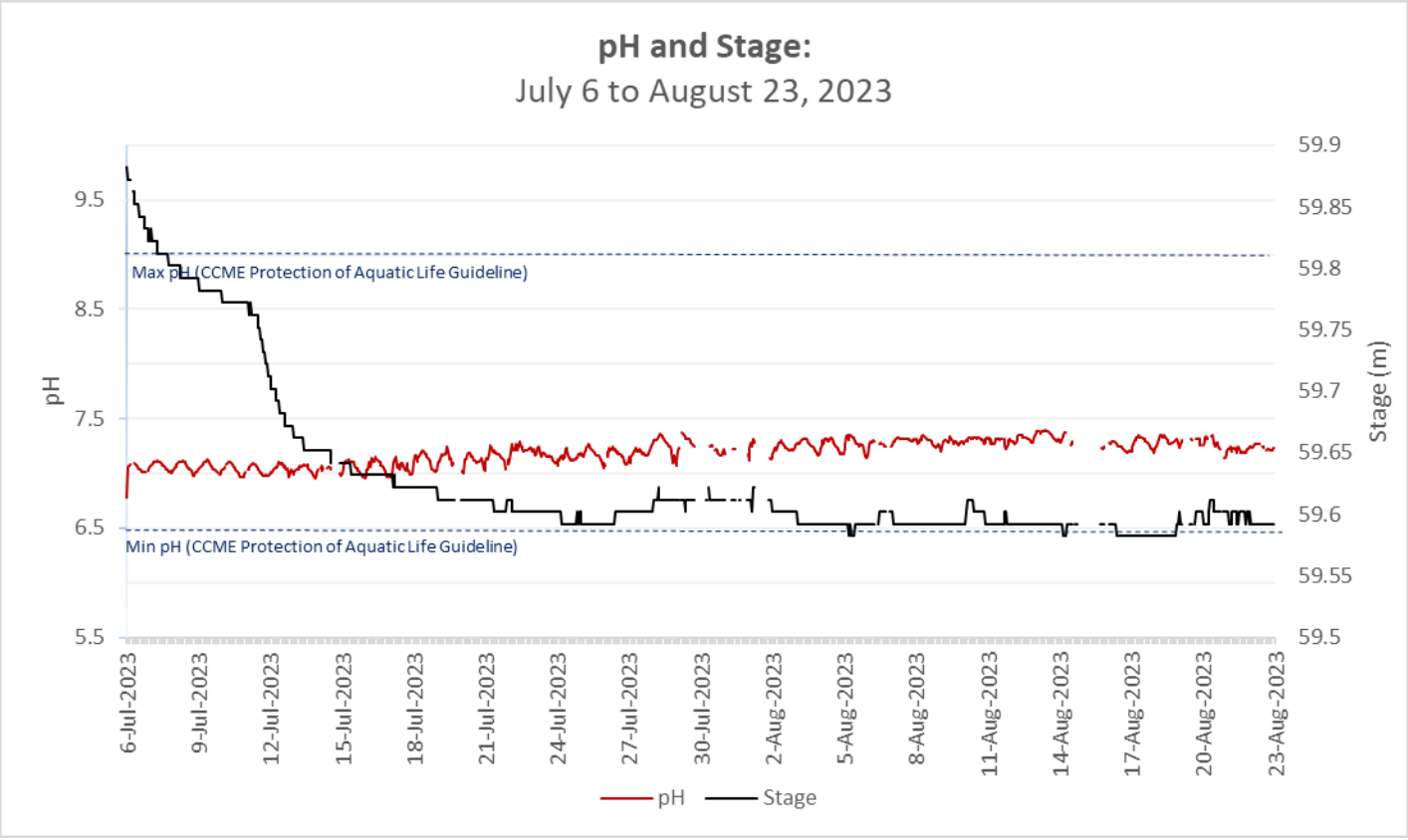

Figure 3: Water pH– Outflow of the Steady

- Specific conductivity ranged from 157.07 to 179.59 µs/cm (Figure 4).
- Specific conductivity steadily increased until late July, at which point it began to fluctuate. The fluctuations correspond to an increase in precipitation observed throughout the remainder of the deployment.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

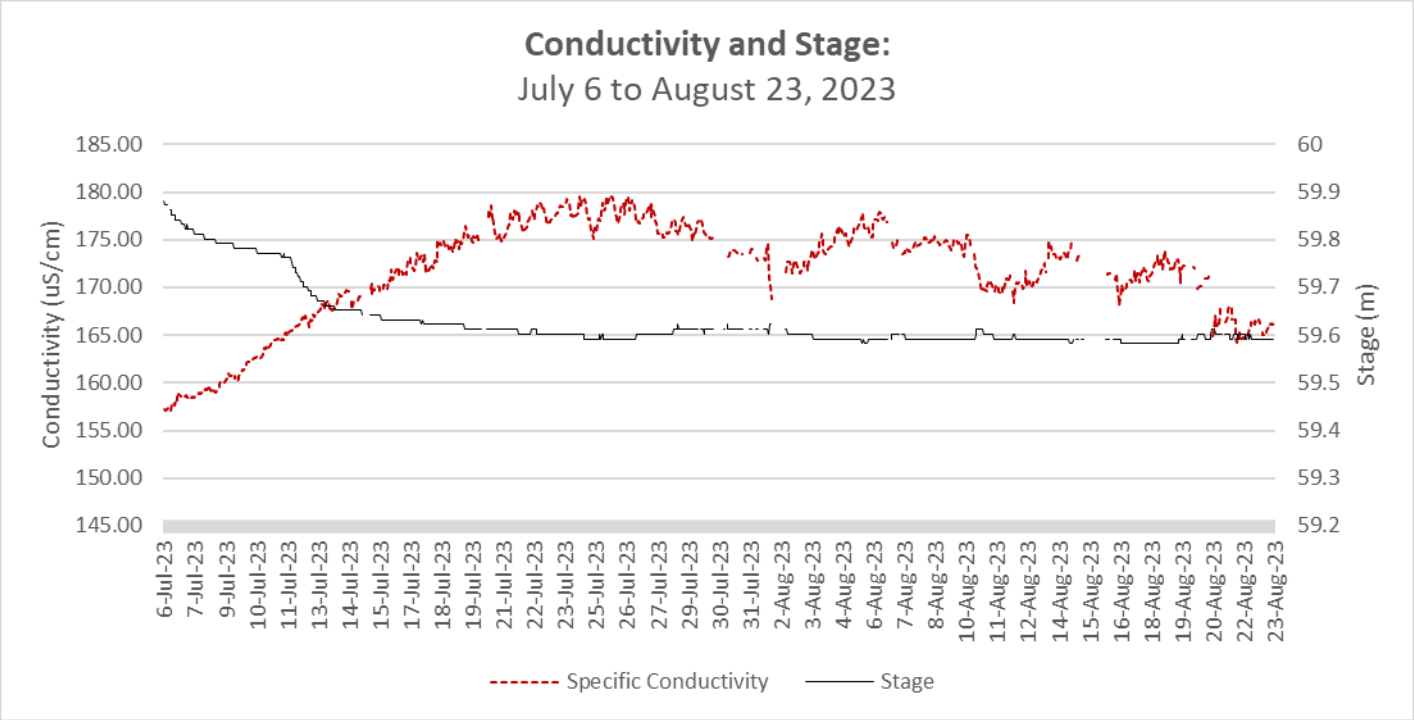

Figure 4: Specific Conductivity of Water - Outflow of the Steady

- The saturation of dissolved oxygen ranged from 87.09% to 111.79% and a range of 7.40 to 9.99 mg/l was recorded for the concentration of dissolved oxygen with a median value of 8.98 mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stages of Cold Water Biota of 6.5 mg/l. The majority of values were below the minimum CCME Guideline for the Protection of Early Life Stages of Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in dark blue on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature. Dissolved oxygen decreased during the first portion of this deployment period as water temperatures warmed, and continued to fluctuate throughout the deployment period, corresponding closely to water temperature.

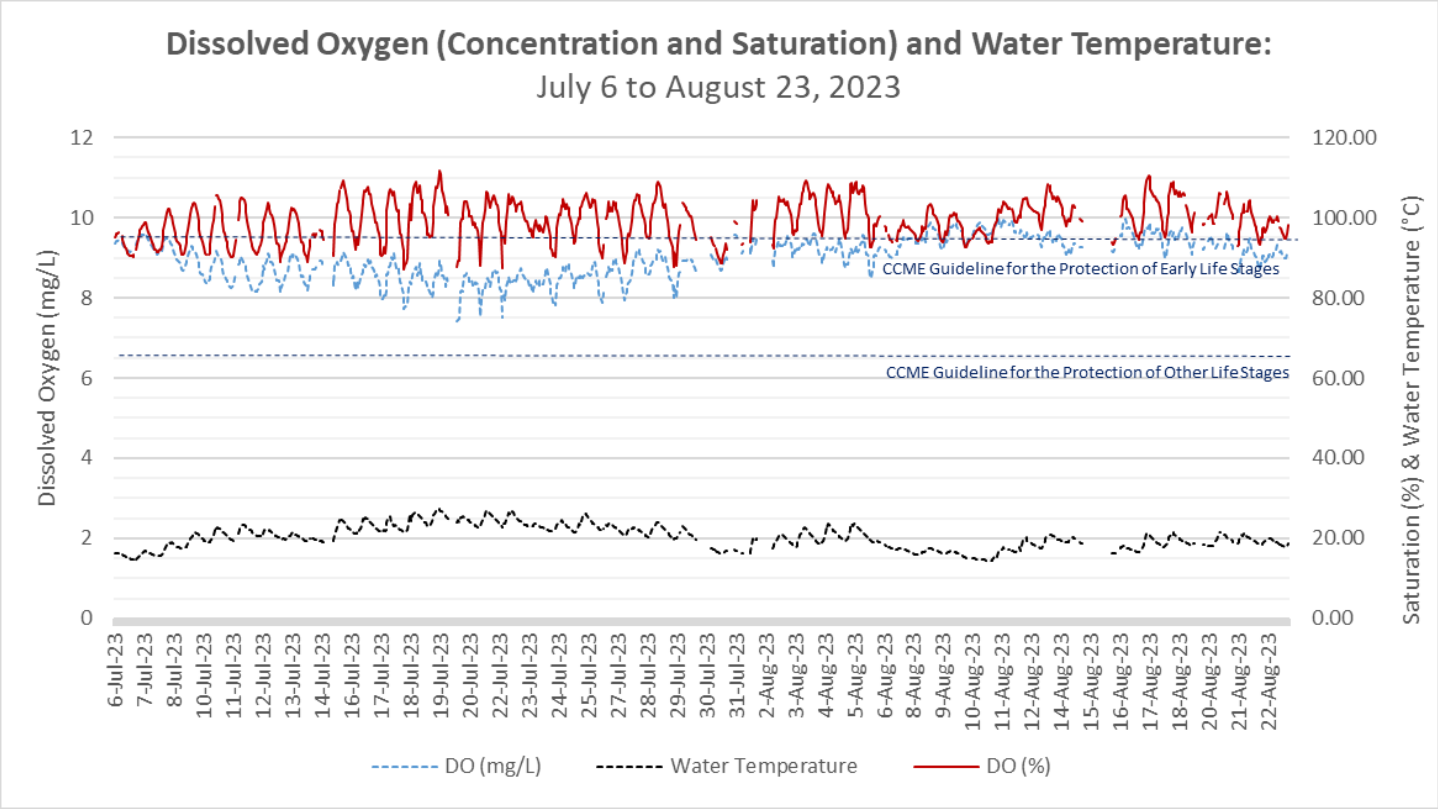

Figure 5: Dissolved Oxygen and Water Temperature – Outflow of the Steady

- Turbidity values range from -0.07 NTU to 2.31 NTU with a median of 0.14, indicating very clear background turbidity.
- Turbidity increased during periods of precipitation, indicating either sediment was washed into the river with the precipitation, or the increased stage level and turbulence caused sediment in the river to suspend within the water column, increasing turbidity values until the sediment settled out again (Figure 6).

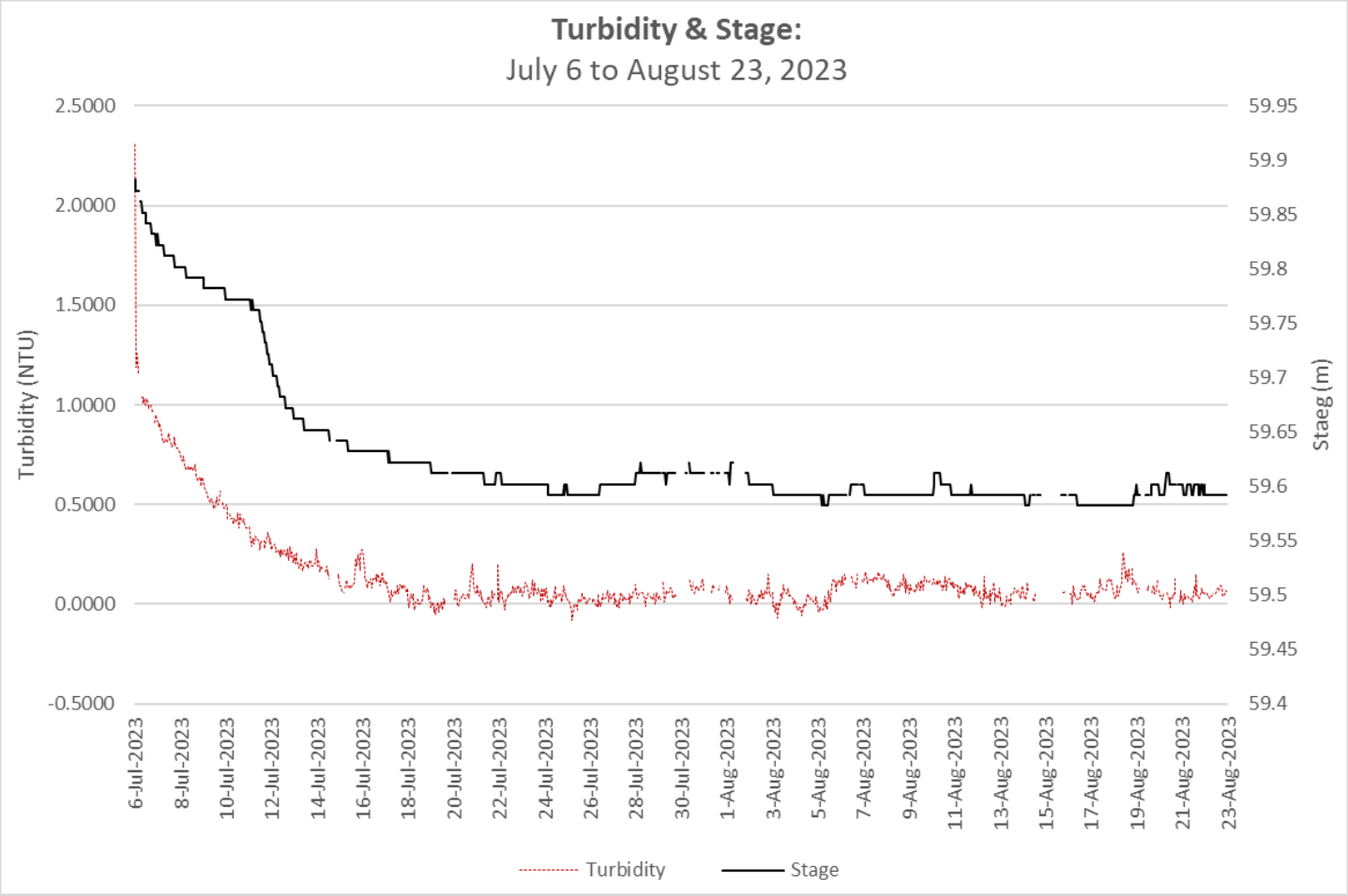

Figure 6: Turbidity – Outflow of the Steady

- Precipitation during the deployment period is graphed below (Figure 7).
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

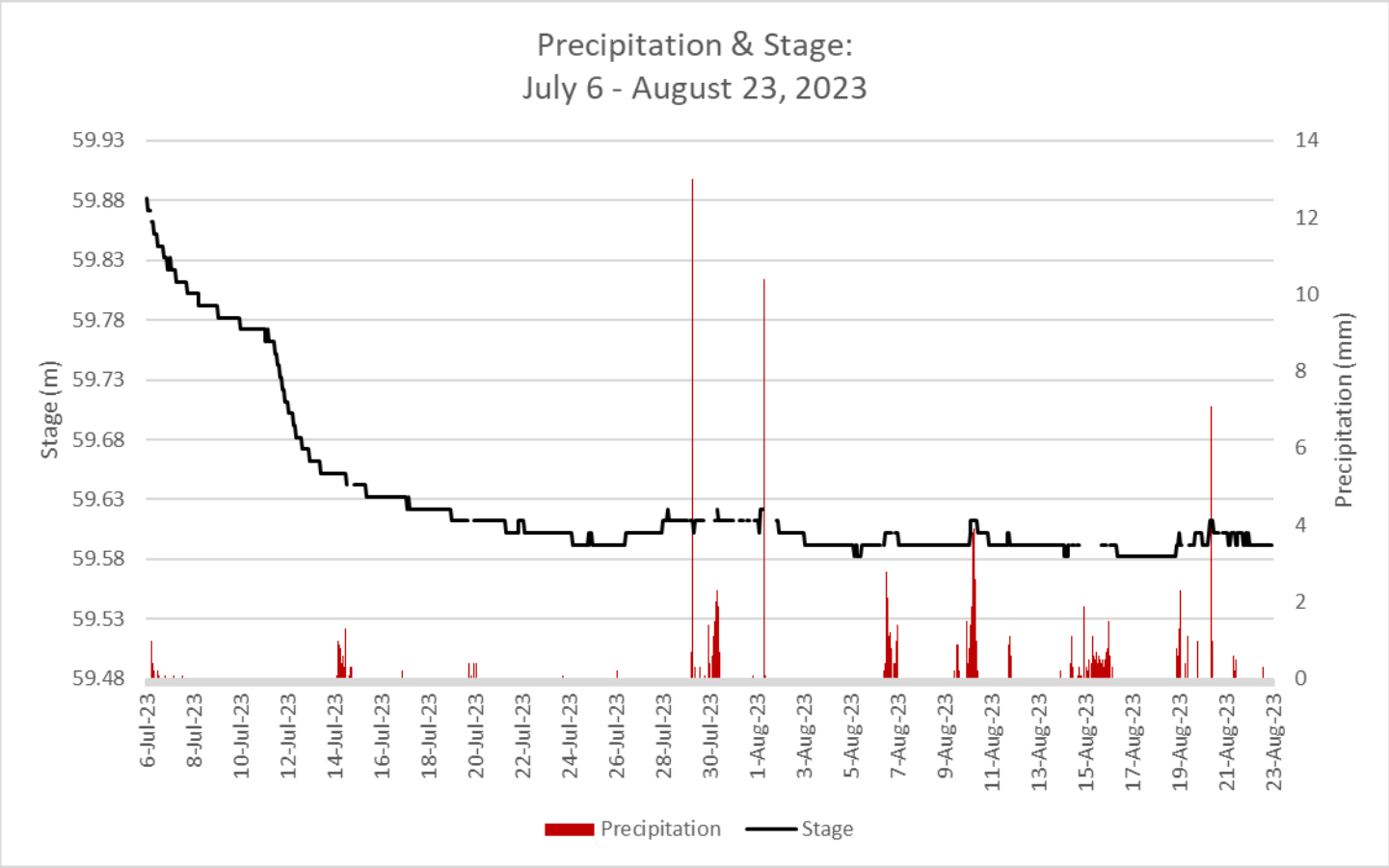

Figure 7: Precipitation – Outflow of the Steady

Conclusions

- An instrument was deployed at the Outflow of the Steady water quality monitoring station on July 6 and removed on August 23, 2023. This was the first deployment of the 2023 season.
- In most cases, weather related events (precipitation and spring ice thaw) explain parameter fluctuations.
- Water temperature generally increased during the deployment period, ranging from 14.41 to 27.40°C. This is expected due to the influence of the ambient air temperature as the summer season progresses.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.78 and 7.40. The brook is influenced by high precipitation events which decrease pH values for a short time.
- Specific conductivity ranged from 157.07 to 179.59 µs/cm, showing a slight increasing trend during the deployment.
- Dissolved oxygen values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. The majority of values were below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The values below this guideline correspond to warming water temperatures.
- Turbidity values of -0.07 NTU to 2.31 NTU with a median of 0.14 NTU indicated low background turbidity.
- Stage was relatively stable after a decrease in early July.
- All data used in the preparation of the graphs and subsequent discussion adhere to stringent QA/QC protocol. Corrected data can be obtained upon request.

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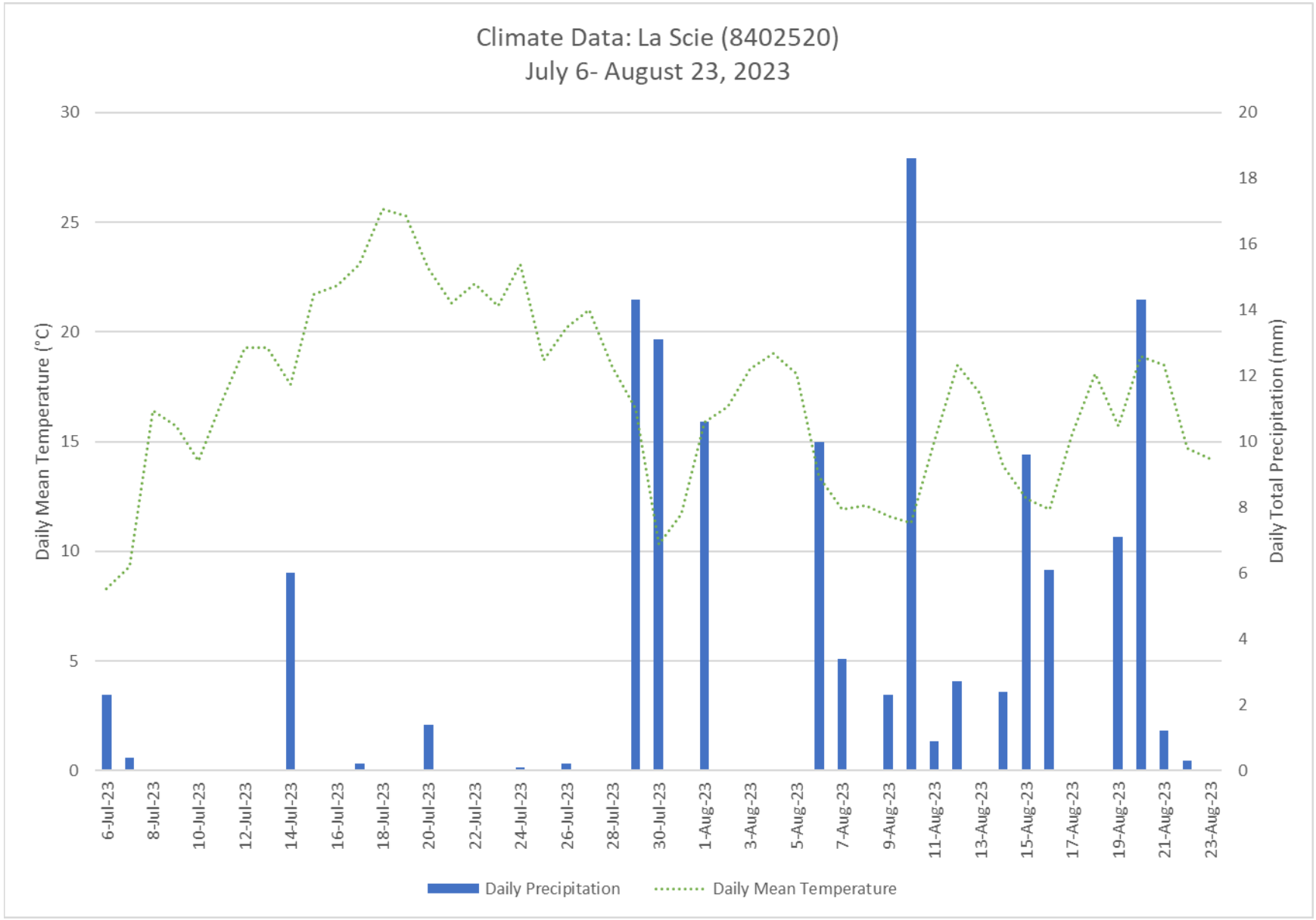
Appendix 1


Climate Data: La Scie (8402520)
July 6- August 23, 2023
Daily Mean Temperature (°C)
Daily Total Precipitation (mm)
30
25
20
15
10
5
0
20
18
16
14
12
10
8
6
4
2
0
6-Jul-23
8-Jul-23
10-Jul-23
12-Jul-23
14-Jul-23
16-Jul-23
18-Jul-23
20-Jul-23
22-Jul-23
24-Jul-23
26-Jul-23
28-Jul-23
30-Jul-23
1-Aug-23
3-Aug-23
5-Aug-23
7-Aug-23
9-Aug-23
11-Aug-23
13-Aug-23
15-Aug-23
17-Aug-23
19-Aug-23
21-Aug-23
23-Aug-23
Daily Precipitation
Daily Mean Temperature