Real-Time Water Quality Deployment Report

Outflow of the Steady at Rambler Mine

July 28 to
September 15, 2021

Newfoundland Labrador

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

Contents

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 28, 2021, a real-time water quality monitoring instrument was deployed at the station Outflow of the Steady. The instrument was deployed for a period of 49 days. This was the second deployment for this station in 2021.
- The station experienced issues with the hydrometric (stage/water quantity) equipment during this deployment, resulting in no stage data for this period. WRMD will troubleshoot and make repairs as soon as possible.
- Water Resources Management Division staff monitor the real-time web pages regularly.

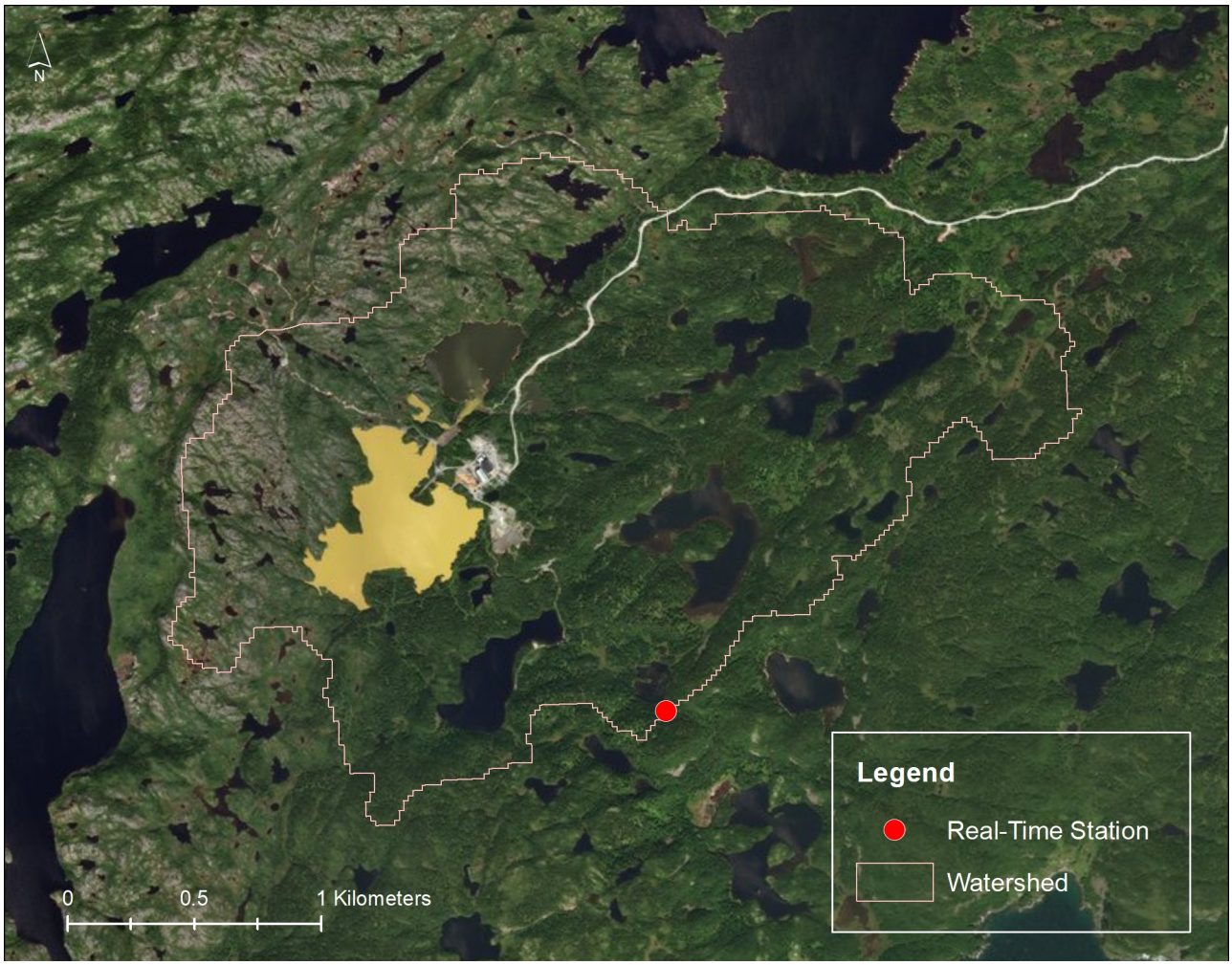

Figure 1: Location of the real-time station downstream of Rambler's Nugget Pond Mill tailings management facility

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 28 and September 15, 2021 are summarized in Table 2.

Table 2: Comparison rankings for Outflow of the Steady station July 28 – September 15, 2021.

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Outflow of the Steady	July 28, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	September 15, 2021	Removal	Good	Fair	Excellent	Good	Excellent

- Deployment rankings were all 'excellent'.
- At removal, rankings were all either 'excellent' or 'good' with the exception of pH which again ranked 'fair'.
- 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 28 to September 15 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 12.52 to 26.28ºC during this deployment period (Figure 2).
- Water temperature gradually increased during the first half of the deployment and then began a gradual decrease for that last portion of the deployment. The changes correspond with ambient air temperature as summer progresses and changes into fall (Figure 2).

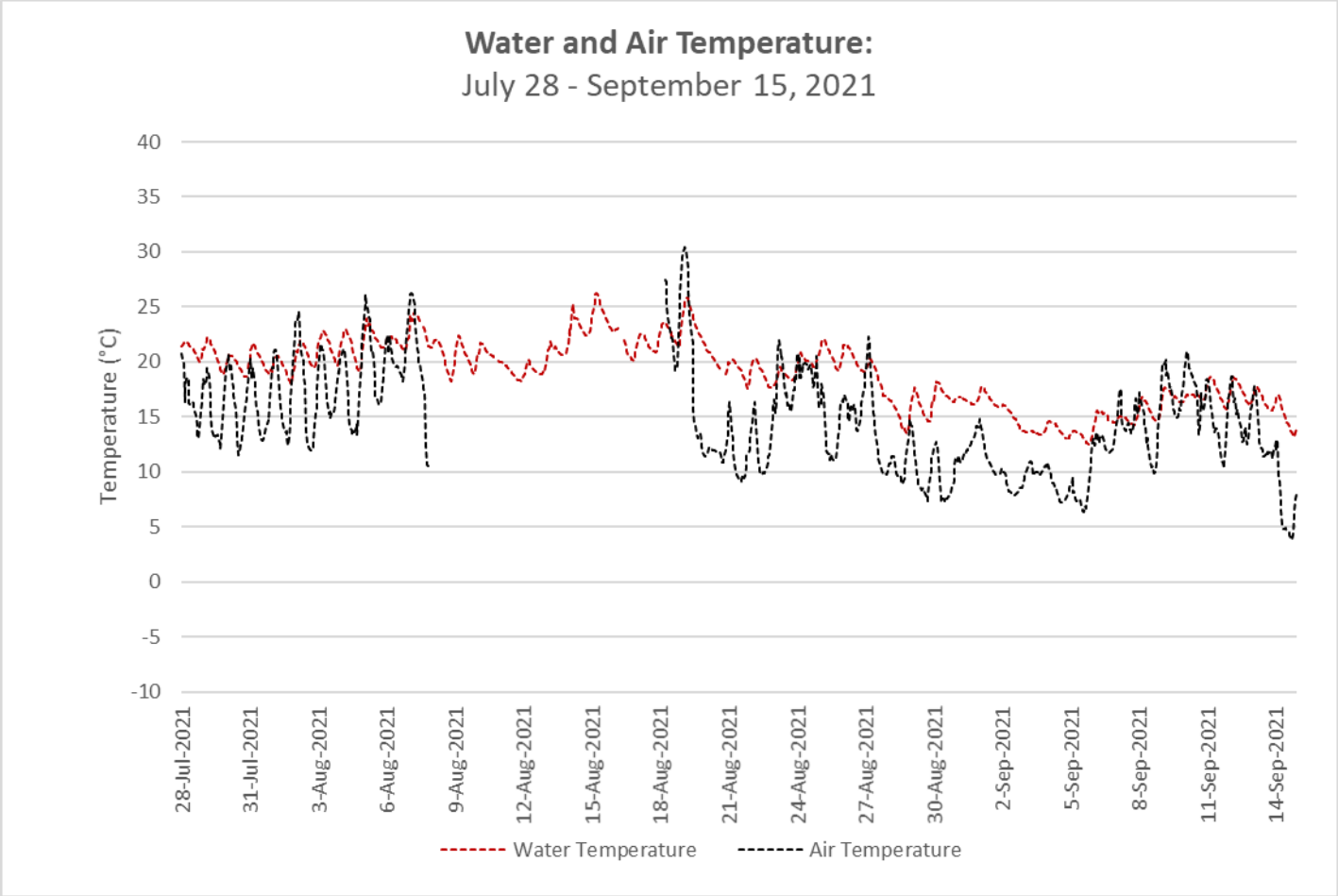

Figure 2: Water and Air Temperature – Outflow of the Steady

(Weather data collected at La Scie)

- pH ranged between 6.95 and 7.46 pH units throughout the deployment period, with a median value of 7.22 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 entering a system 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. There is one such dip on September 4th after significant rainfall.
- Overall, pH was stable during the deployment.

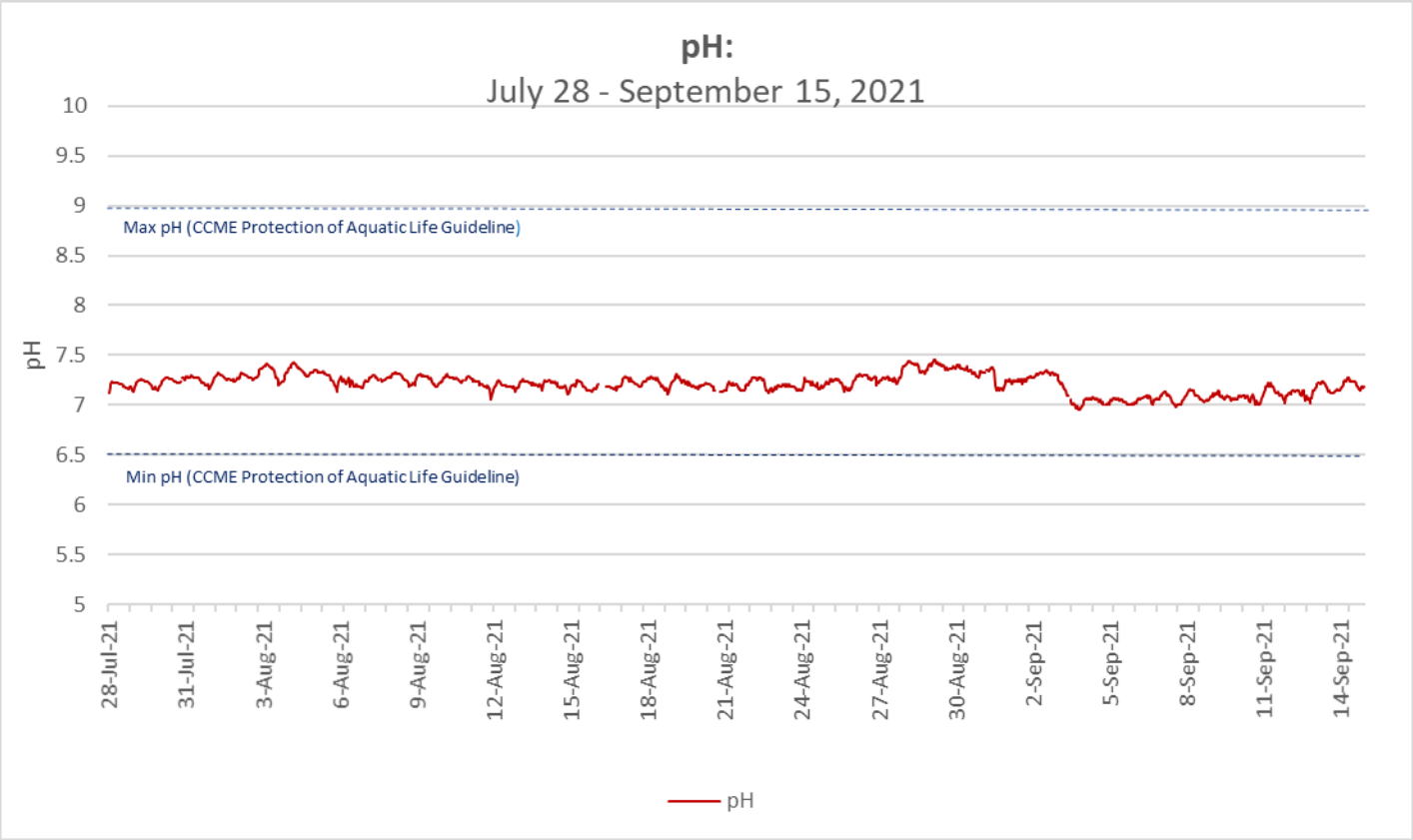

Figure 3: Water pH – Outflow of the Steady

- Specific conductivity ranged from 145.0 to 195.2 µs/cm (Figure 4).
- Specific conductivity was stable for the majority of the deployment with one sharp decrease towards the end of the deployment, coinciding with a drop in pH values and high precipitation. This decrease indicates the system was diluted by the addition of precipitation.
- 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.

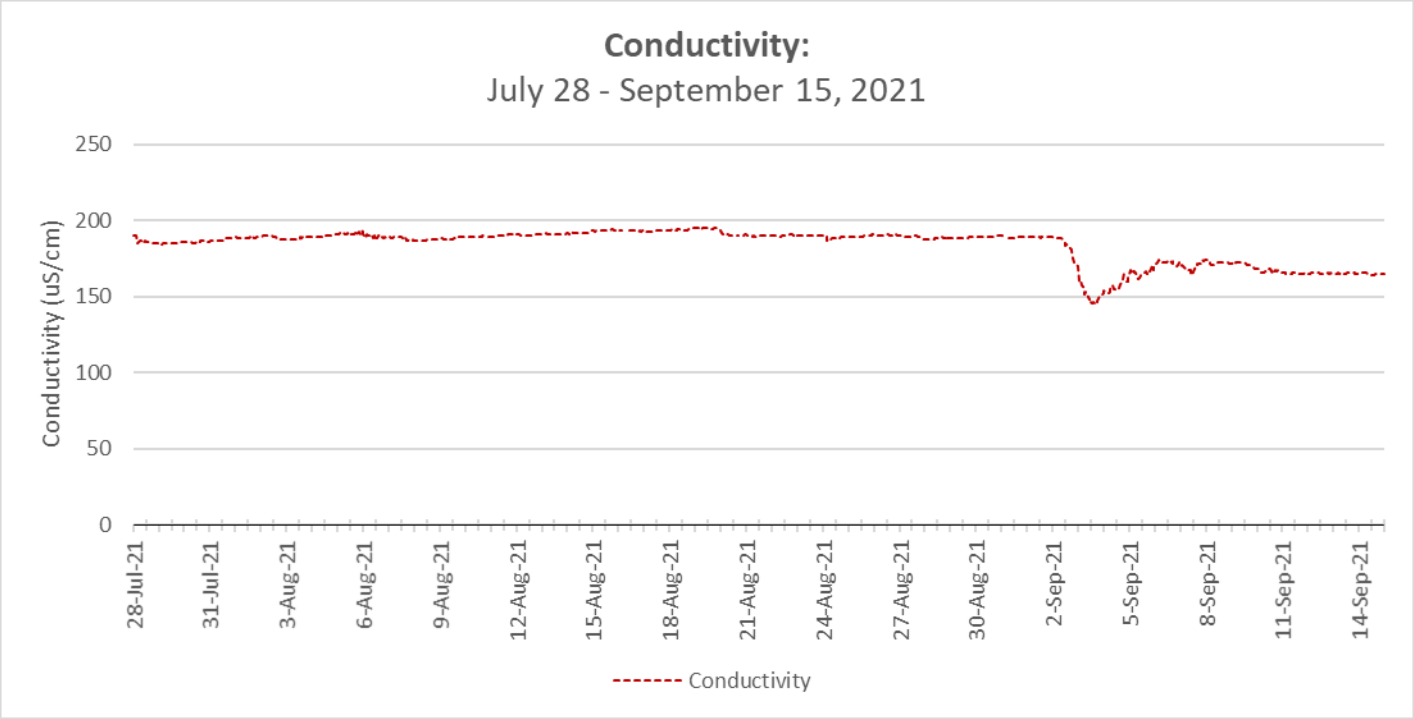

Figure 4: Specific Conductivity of Water - Outflow of the Steady

- The saturation of dissolved oxygen ranged from 88.9% to 109.3% and a range of 8.15 to 10.22 mg/l was recorded for the concentration of dissolved oxygen with a median value of 9.02 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 when water temperatures were warmest but rose again as temperatures begin to cool in September. The guidelines are indicated in dark blue on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature. Dissolved oxygen increased during this deployment period as water temperatures cooled and continued to fluctuate throughout the deployment period.

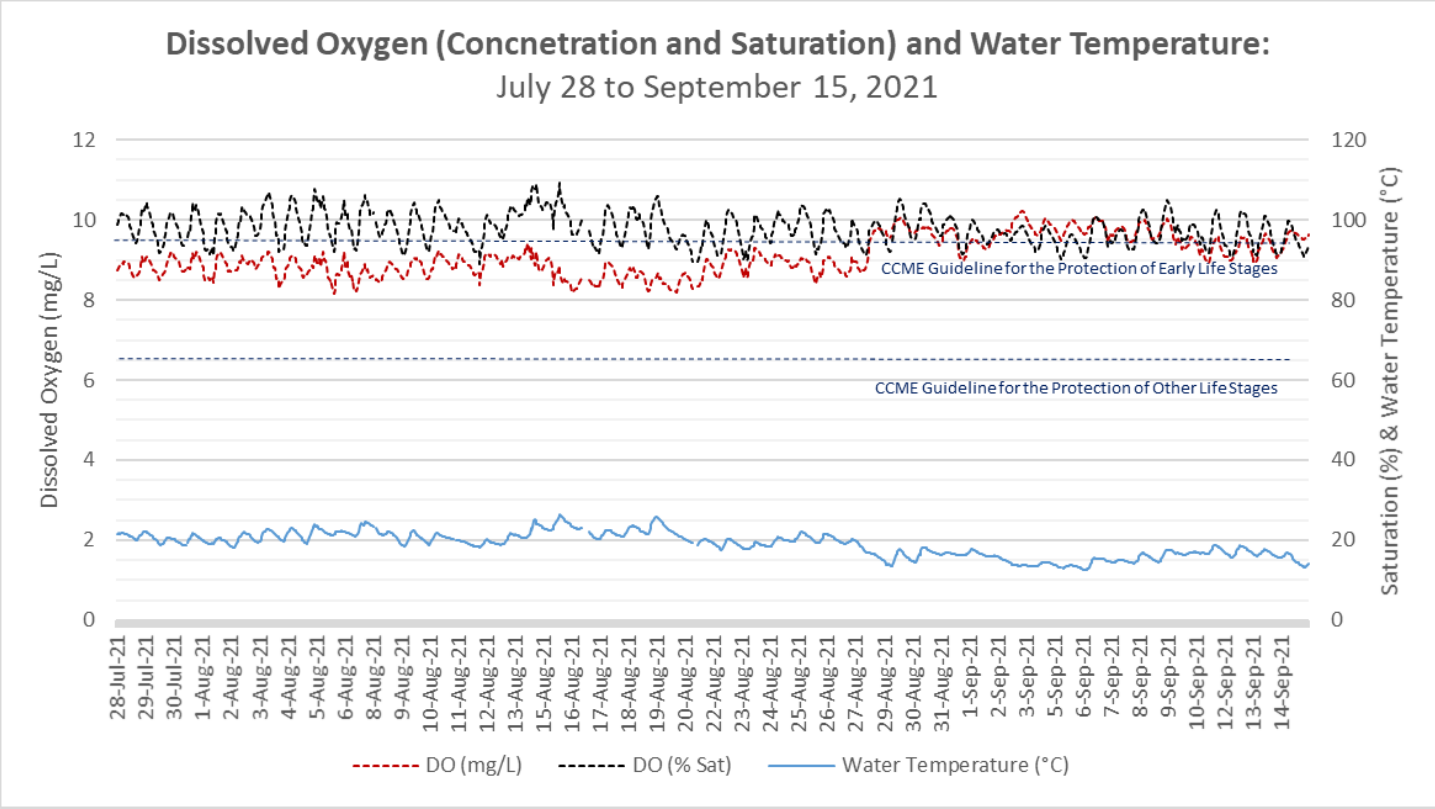

Figure 5: Dissolved Oxygen and Water Temperature – Outflow of the Steady

- Turbidity values range from -0.8NTU to 1.7 NTU with a median of -0.4, indicating very clear background turbidity.
- Turbidity increased when significant precipitation was added to the system, notably on September 4th, indicating sediments became suspended within the water column (Figure 6). Turbidity then decreased again, indicating rainfall may assist in flushing out sediment from the brook.

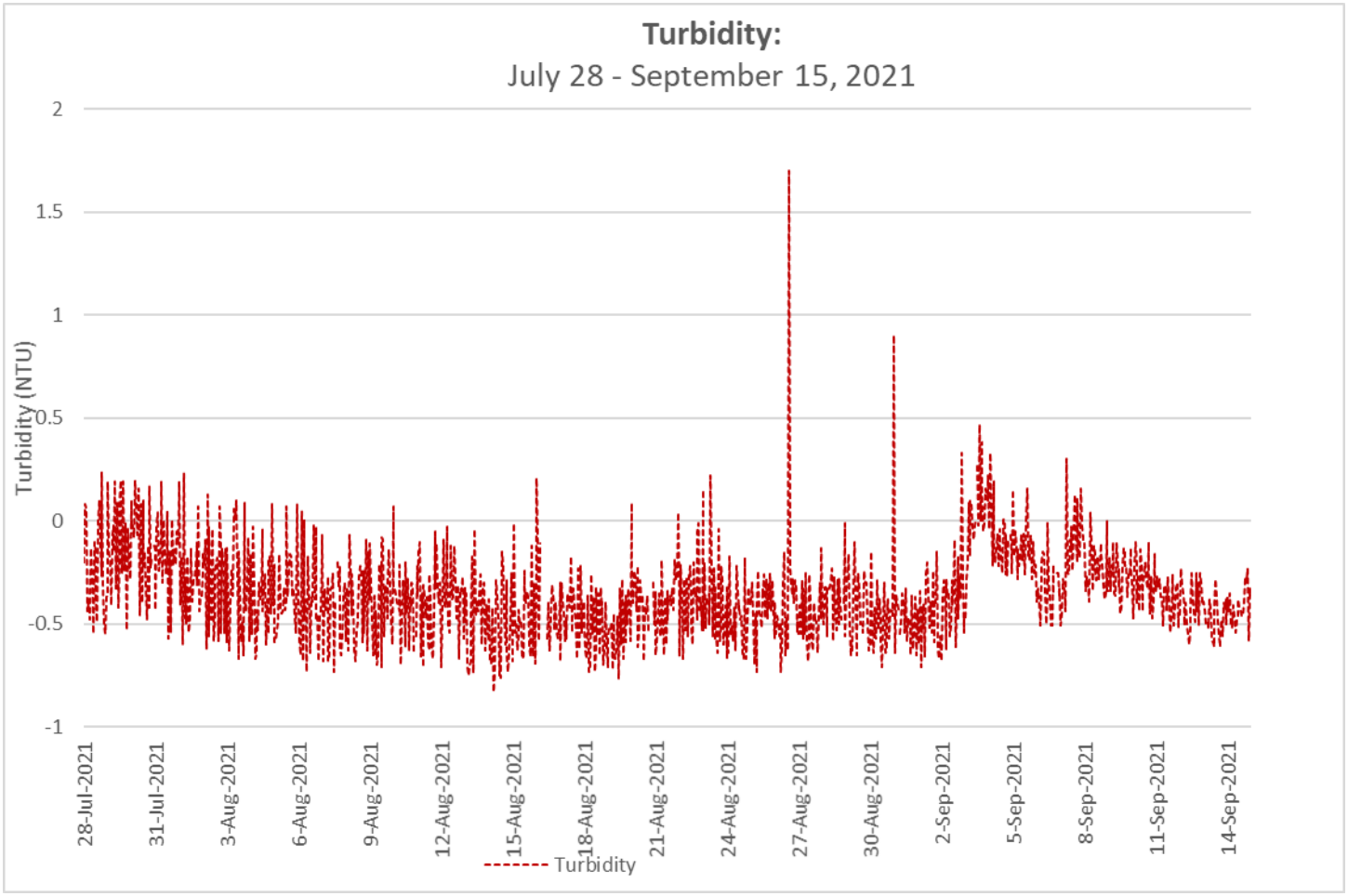

Figure 6: Turbidity– Outflow of the Steady

- Precipitation during the deployment period is graphed below (Figure 7). However, due to a sensor failure, stage data for the deployment period was unavailable.
- 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.

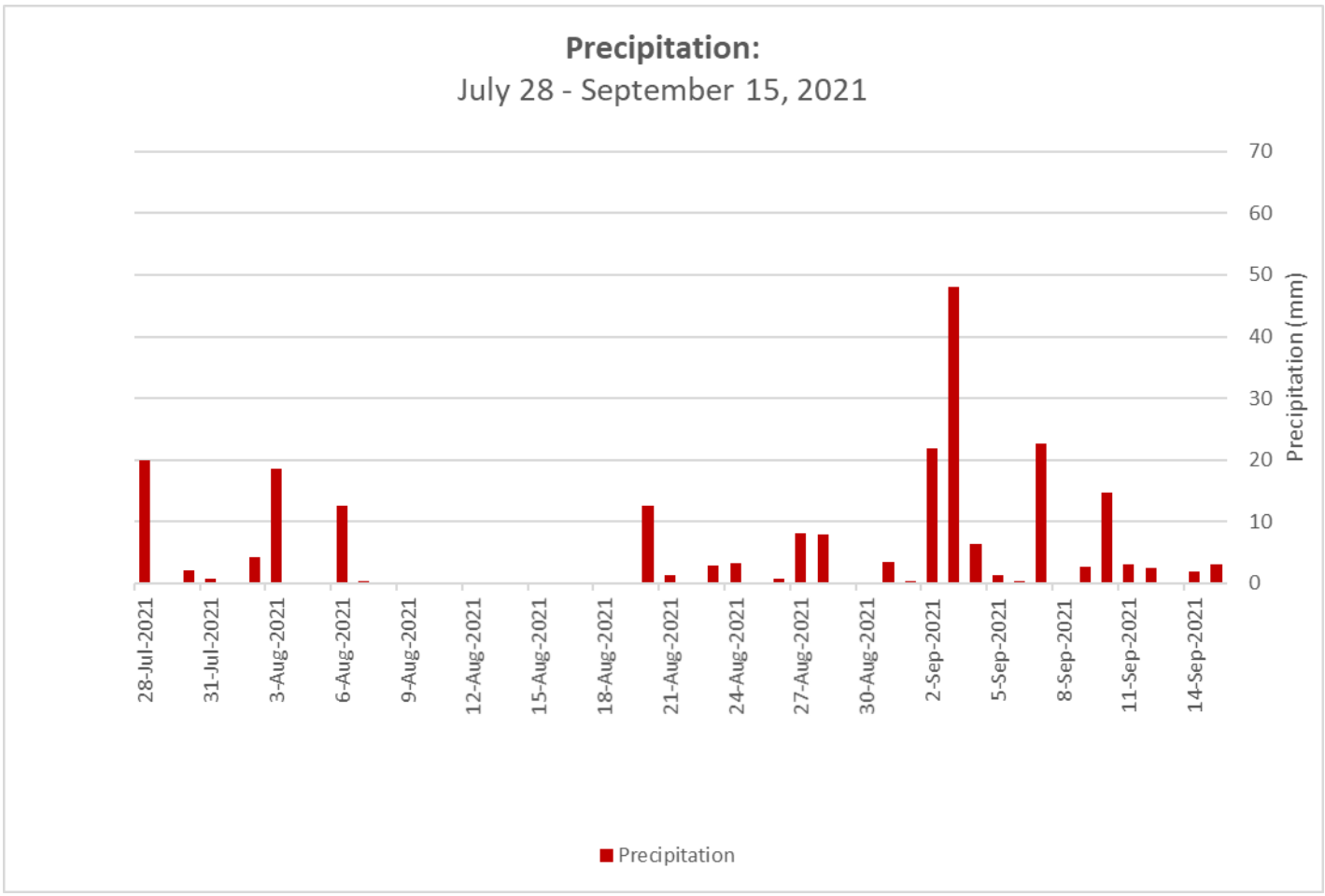

Figure 7: Precipitation – Outflow of the Steady

Conclusions

- An instrument was deployed at the Outflow of the Steady water quality monitoring station on July 28 and removed on September 15, 2021. This was the second deployment of the 2021 season.
- In most cases, weather related events (precipitation) explain parameter fluctuations.
- Water temperature decreased during the deployment period, ranging from 26.28 to 12.52°C. The data confirmed water temperature was corresponding with ambient air temperatures.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.95 and 7.46. The brook is influenced by high precipitation events which decrease pH values for a short time.
- Specific conductivity ranged from 145.0 to 195.2 µs/cm, showing a slight increasing trend during the deployment until it dropped after a heavy precipitation event.
- 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 when water was warmest. The values were increasing as water was cooling into fall.
- Turbidity values of -0.8 NTU to 1.7 NTU indicated low background turbidity. Increasing turbidity corresponded to precipitation events near this site.
- Stage data was unavailable for this deployment due to a sensor failure.
- 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.

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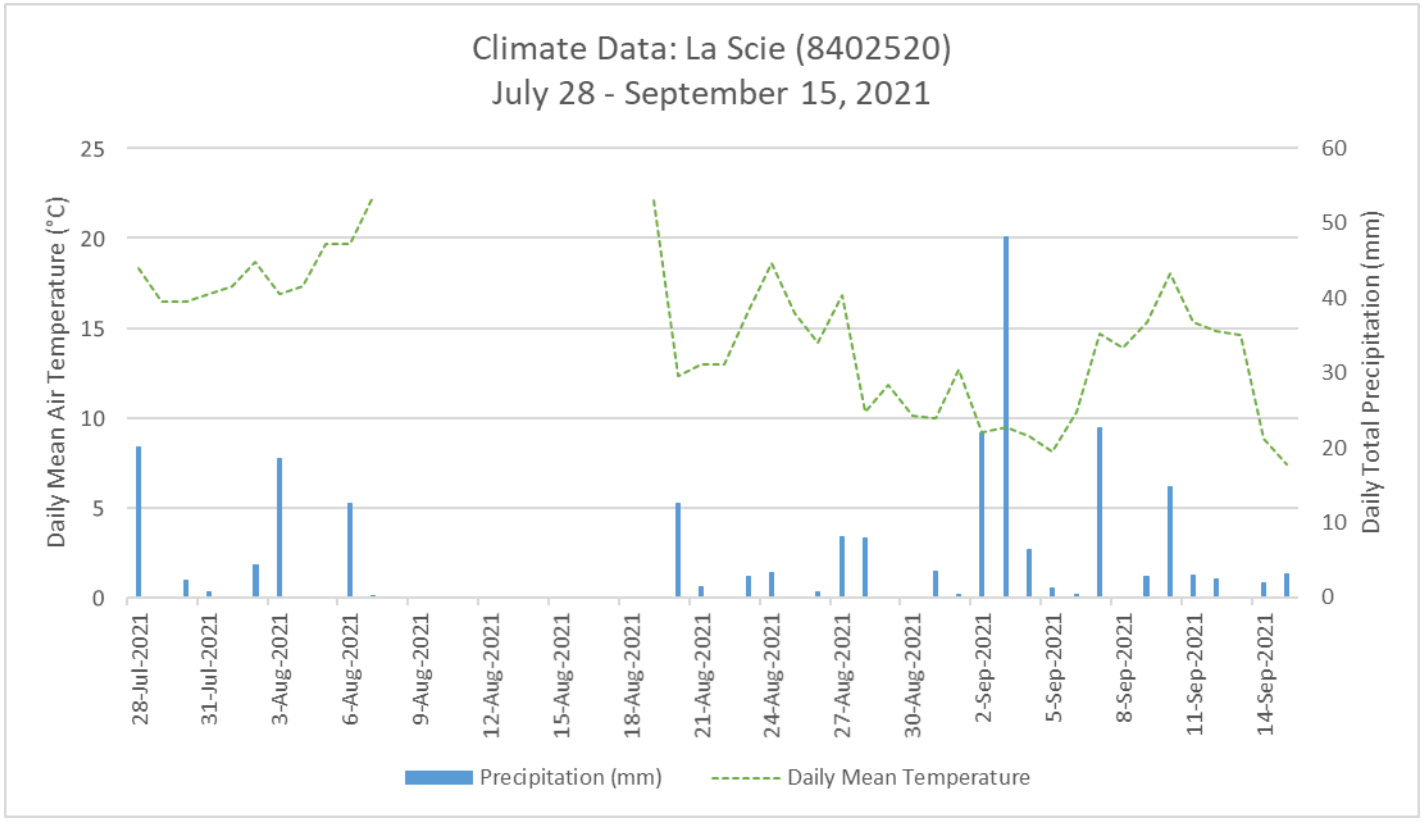
Appendix 1


Climate Data: La Scie (8402520)
July 28 - September 15, 2021
Daily Mean Air Temperature (°C)
Daily Total Precipitation (mm)
25
20
15
10
5
0
60
50
40
30
20
10
0
28-Jul-2021
31-Jul-2021
3-Aug-2021
6-Aug-2021
9-Aug-2021
12-Aug-2021
15-Aug-2021
18-Aug-2021
21-Aug-2021
24-Aug-2021
27-Aug-2021
30-Aug-2021
2-Sep-2021
5-Sep-2021
8-Sep-2021
11-Sep-2021
14-Sep-2021
Precipitation (mm)
Daily Mean Temperature