Real-Time Water Quality Deployment Report

Outflow of the Steady at Rambler Mine

September 6 to November 27, 2019

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs and Environment
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 September 6, 2019, a real-time water quality monitoring instrument was deployed at the station Outflow of the Steady. The instrument was deployed for a period of 81 days. This was the second deployment for this station in 2019. The instrument was then removed for the winter to prevent damage and will be reinstalled as soon as ice conditions permit in the spring.
- Water Resources Management Division staff monitor the real-time web pages regularly.

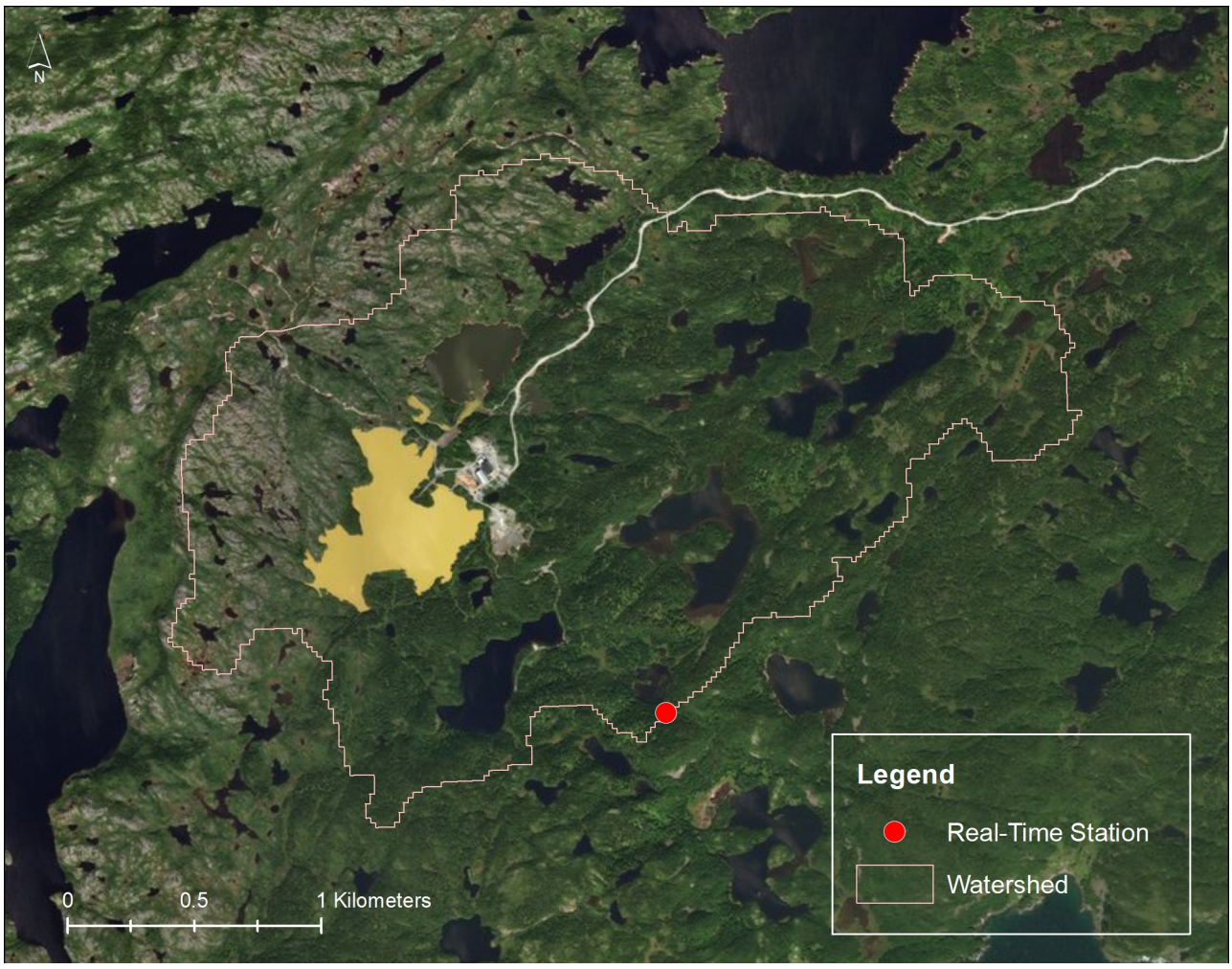

Figure 1: Location of the real-time station downstream of Rambler's Nugget Pond Mill tailings management facility

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 September 6 and November 27, 2019 are summarized in Table 2.

Table 2: Comparison rankings for Outflow of the Steady station September 6 – November 27, 2019.

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Outflow of the Steady	Sept 6, 2019	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Nov 27, 2019	Removal	Excellent	Good	Fair	Good	Excellent

- Upon deployment, all sensors ranked ‘good’ or ‘excellent’ when compared to the adjacent QAQC sonde.

- At removal, temperature and turbidity ranked 'excellent', pH and dissolved oxygen ranked 'good', while conductivity 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 September 6 to November 27, 2019 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 0.70 °C to 17.37°C during this deployment period (Figure 2).
- Water temperature decreased steadily during this deployment, consistent with decreasing air temperatures as air and water cooled into the fall (Figure 2).

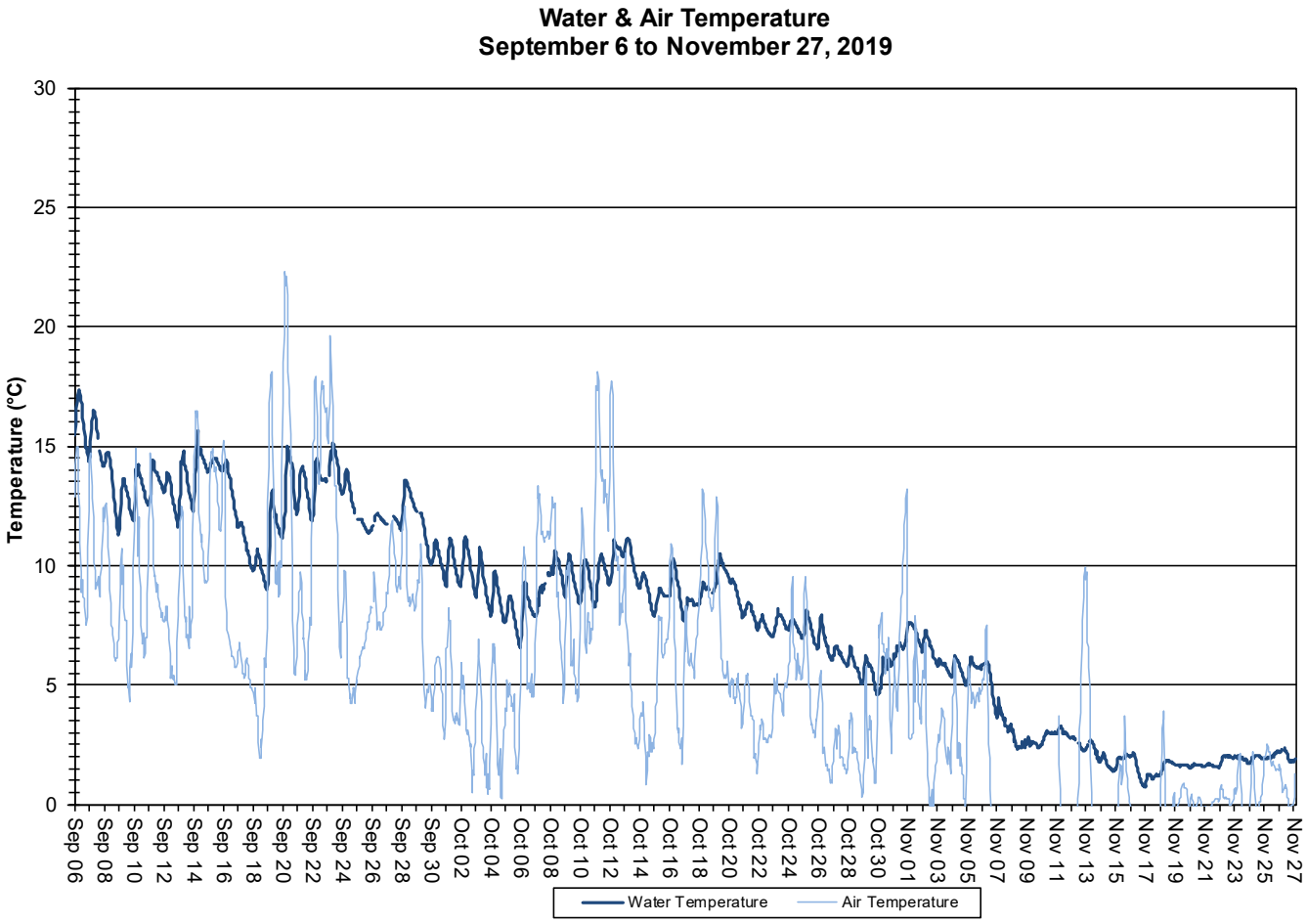

Figure 2: Water and Air Temperature – Outflow of the Steady

(Weather data collected at La Scie)

- pH ranged between 6.81 and 7.21 pH units throughout the deployment period, with a median value of 7.02 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 on September 25th and November 12th (evident as a rise in stage levels) caused slight dips 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.
- Overall, pH remained relatively stable for the duration of this deployment.

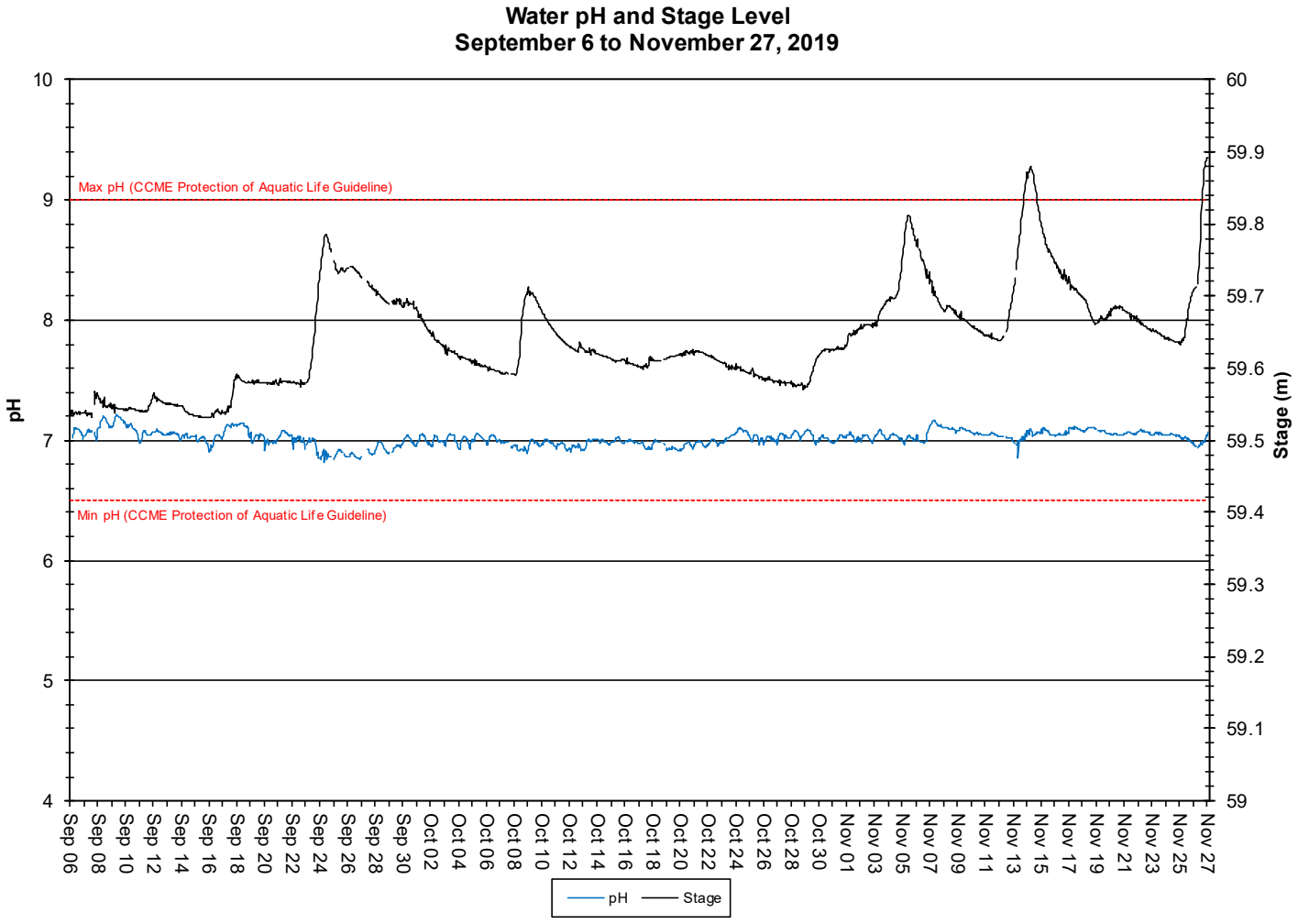

Figure 3: Water pH and Stage – Outflow of the Steady

- Specific conductivity ranged from 181.0 to 228.8 µs/cm (Figure 4).
- Specific conductivity steadily increased into early October then remained relatively stable for the remainder of the deployment period. High precipitation on November 12th coincided with a drop in conductivity as the additional freshwater added to the system diluted the waterbody.
- 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.

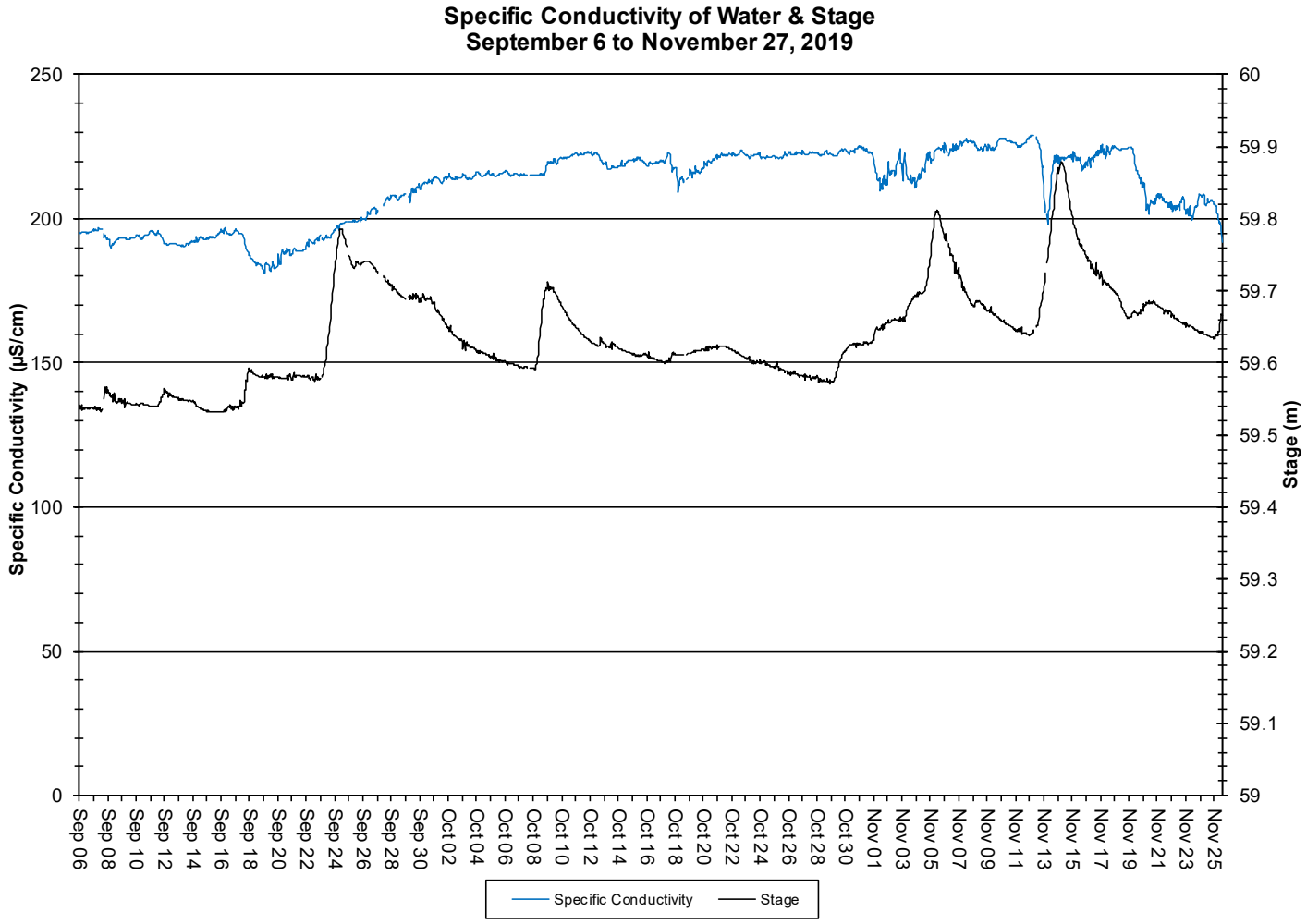

Figure 4: Specific Conductivity of Water and Stage - Outflow of the Steady

- The saturation of dissolved oxygen ranged from 87.8% to 100.7% and a range of 8.98 to 13.56 mg/l was found for the concentration of dissolved oxygen with a median value of 10.86 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 above 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 red on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature. Dissolved oxygen increased steadily during the deployment period as water temperatures cool into fall.

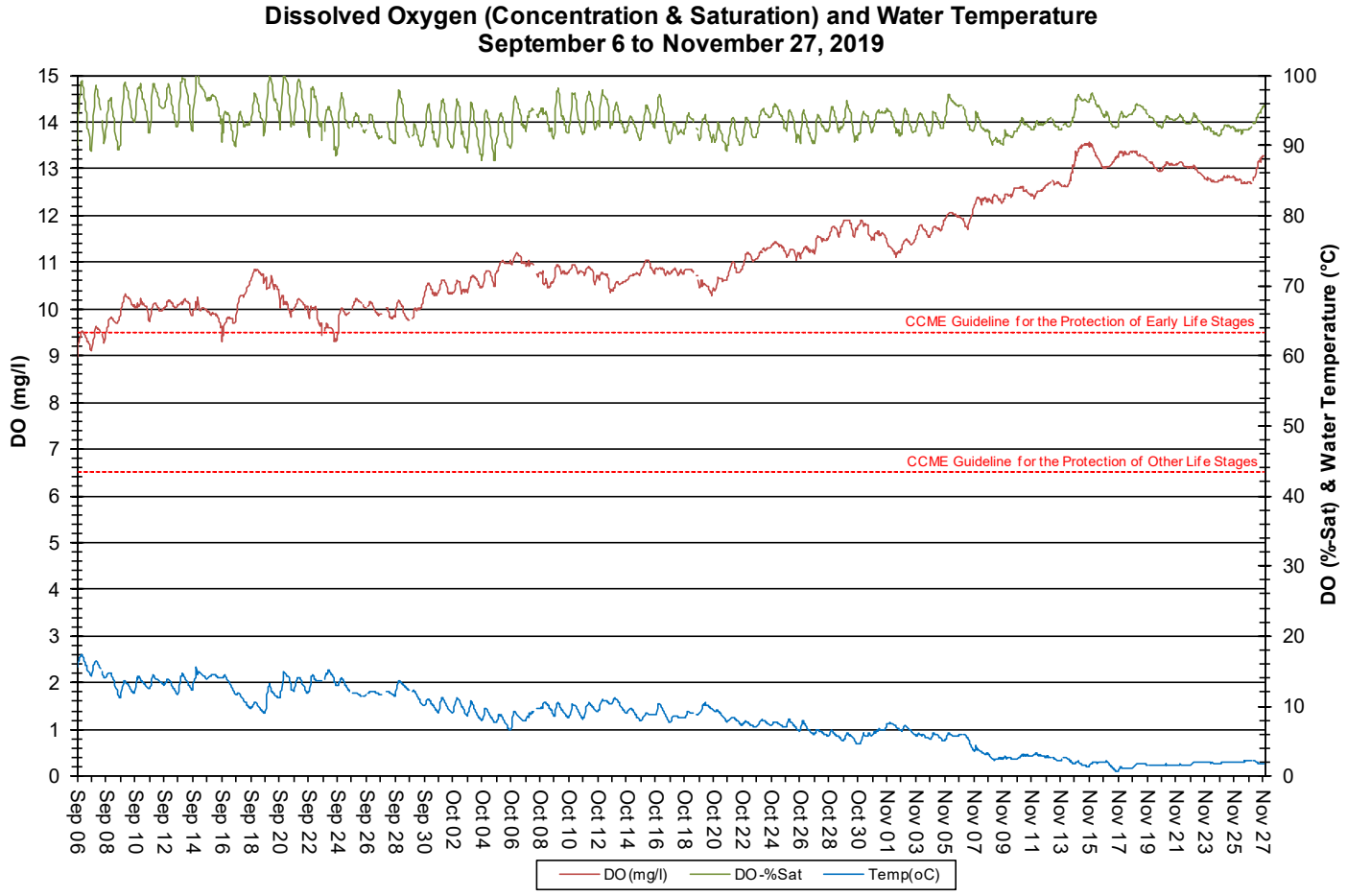

Figure 5: Dissolved Oxygen and Water Temperature – Outflow of the Steady

- Turbidity values range from 0.0 NTU to 4.6 NTU with a median of 0.3, indicating very clear background turbidity.
- The majority of turbidity increases correlate to stage increases from large precipitation events (Figure 6).
- Overall, turbidity was trending upwards during the deployment, indicating minor biofouling may be an issue at this location.

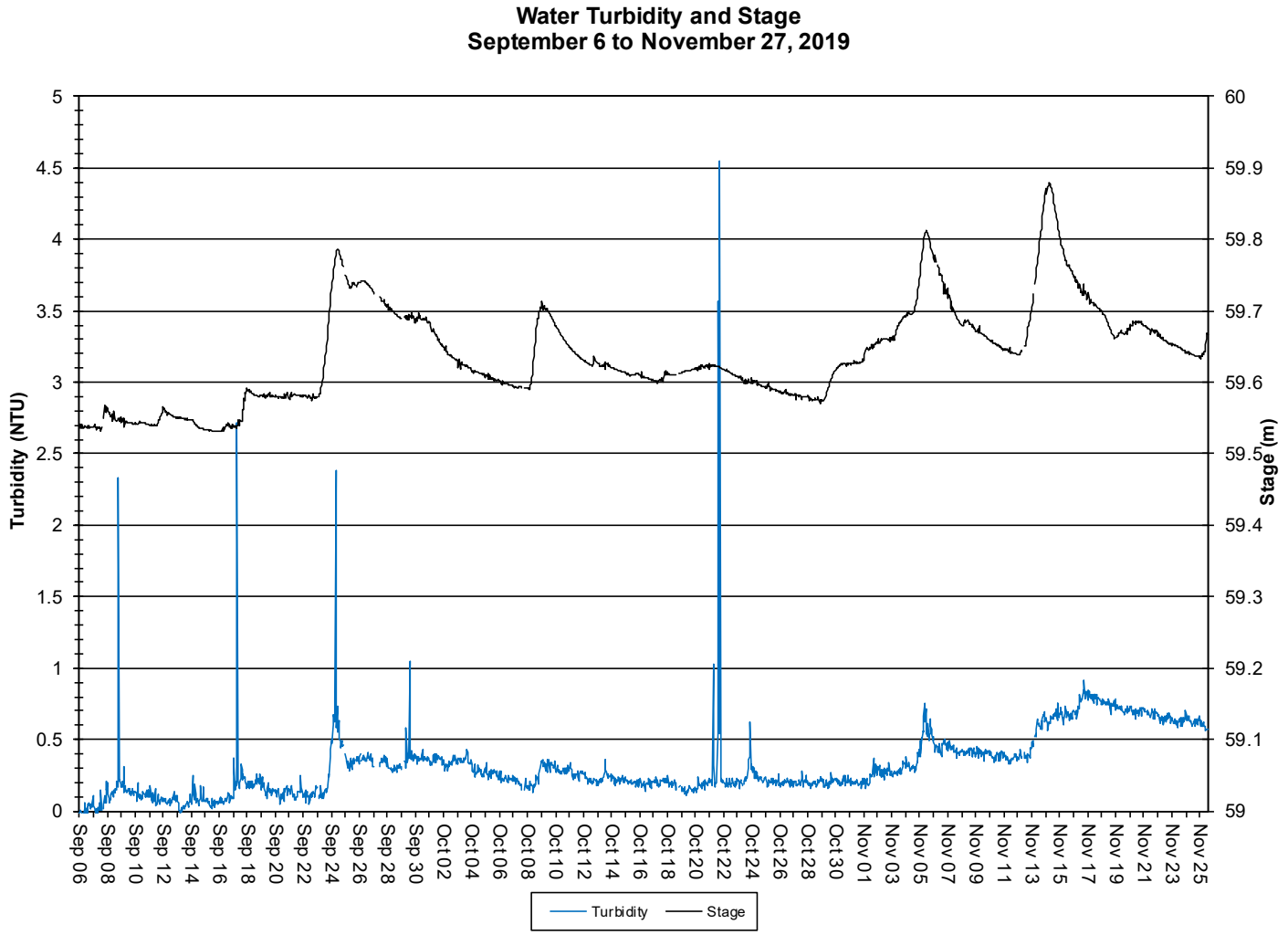

Figure 6: Turbidity and Stage – Outflow of the Steady

- Precipitation and stage during the deployment period are graphed below (Figure 7). Stage was relatively stable throughout the deployment, but was often influenced by large precipitation events which led to stage increases.
- It is notable from the data that precipitation did not always lead to an increase in stage at this location.
- The sharp decrease at the beginning of the deployment is incorrect and the result of a correction factor being applied to the data during maintenance.
- 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.

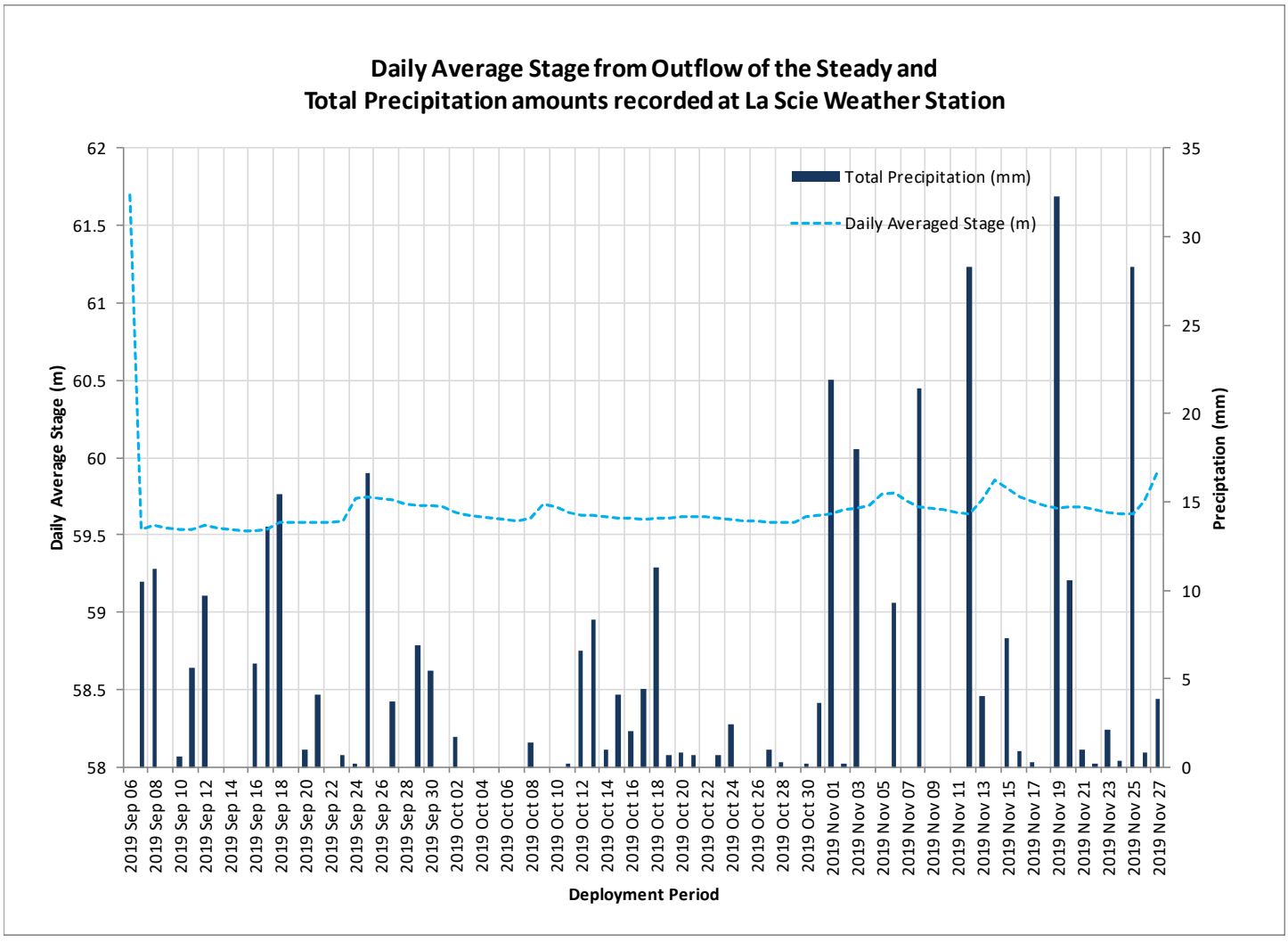

Figure 7: Precipitation and Stage – Outflow of the Steady

Conclusions

- An instrument was deployed at the Outflow of the Steady water quality monitoring station on September 6th and removed on November 27th, 2019. This was the second deployment of the 2019 season. The instrument was removed for the winter season.
- In most cases, weather related events or increases/decreases in water level explain parameter fluctuations.
- Water temperature decreased steadily throughout the deployment period as temperatures dropped into fall, ranging from 17.37°C down to 0.70°C. This is expected due to the influence of the ambient air temperature as it changes between seasons.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.81 and 7.21. The brook is influenced by large precipitation events which decrease pH values for a short time.
- Specific conductivity ranged from 181.0 to 228.8 µs/cm, showing a slight increasing trend during the deployment.
- Dissolved oxygen values were all 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 above the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l, dipping below during periods of warm water temperatures.
- Turbidity values of 0.0 NTU to 4.6NTU indicate low background turbidity. Spikes in turbidity correlated with increased stage from precipitation as sediments are suspended and washed through the system. An increasing trend during the deployment may be indicative of biofouling conditions at the location.
- Stage remained relatively stable during this deployment period, increasing occasionally after high precipitation events. It is noted that precipitation does not always affect stage at this location.
- 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.

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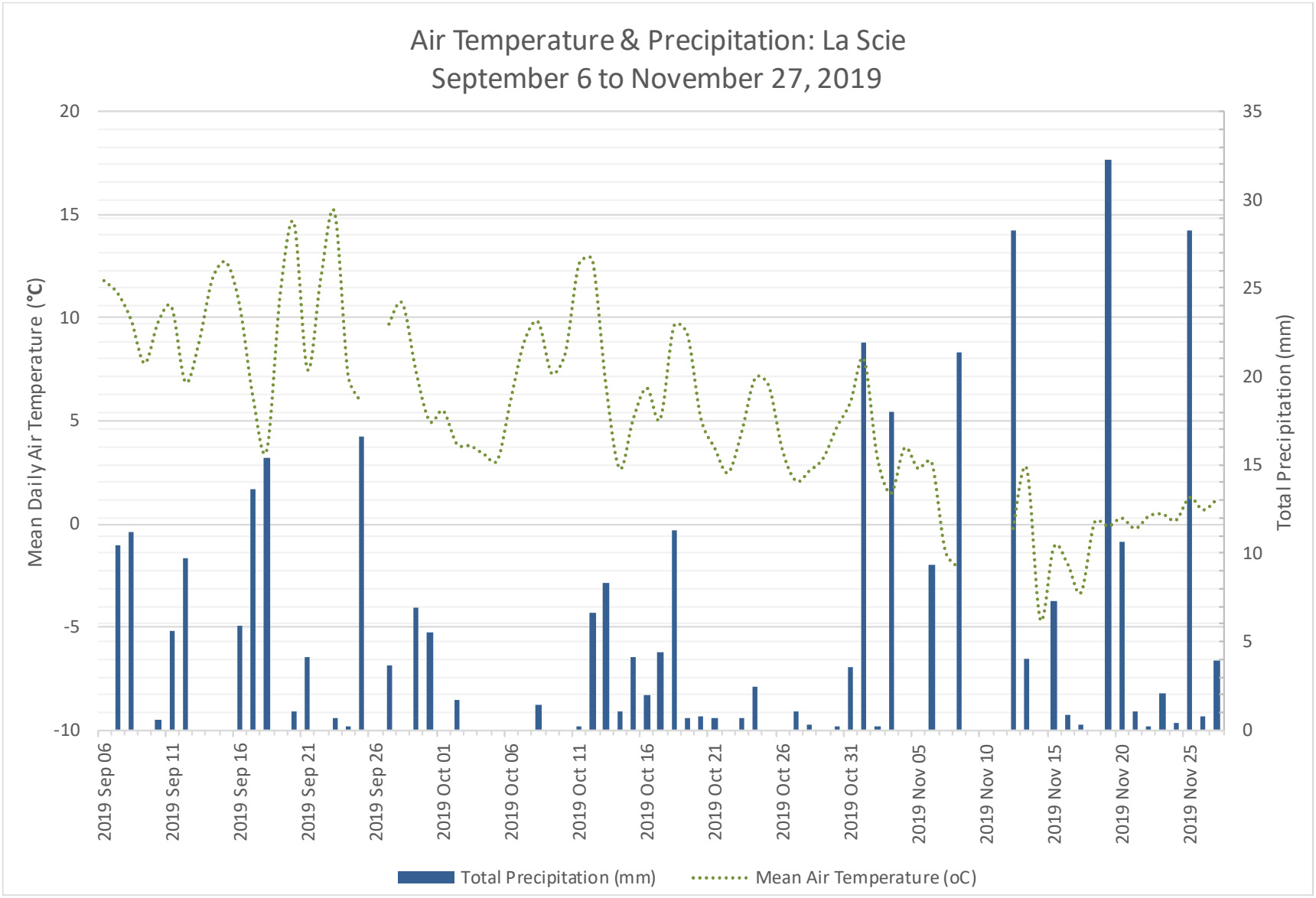
Appendix 1


Air Temperature & Precipitation: La Scie
September 6 to November 27, 2019
Mean Daily Air Temperature (°C)
Total Precipitation (mm)
20
15
10
5
0
-5
-10
35
30
25
20
15
10
5
0
2019 Sep 06
2019 Sep 11
2019 Sep 16
2019 Sep 21
2019 Sep 26
2019 Oct 01
2019 Oct 06
2019 Oct 11
2019 Oct 16
2019 Oct 21
2019 Oct 26
2019 Oct 31
2019 Nov 05
2019 Nov 10
2019 Nov 15
2019 Nov 20
2019 Nov 25
Total Precipitation (mm)
Mean Air Temperature (oC)