Real-Time Water Quality Deployment Report

Teck: Duck Pond Operations

September 24, 2019 to December 3, 2019

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs and Environment
Water Resources Management Division
St. John's, NL, A1B 4J6 Canada

General

This report will review the water quality data for the following two real-time water quality monitoring stations at TECK Duck Pond, Tributary to Gills Pond Brook and East Pond Brook below East Pond for the duration of September 24th through to December 3rd, 2019.

From November 11th, 2019 through to November 19th 2019, East Pond Brook below East Pond had intermittent transmission issues and data was not collected during this time. Therefore the parameter graphs for East Pond brook display gaps for that timeframe. During the QAQC check of the pH data from November 19th 2019 to the end of deployment, it was evident that the pH data was inaccurate and did not represent the brook. This data was removed from the statistical analysis for East Pond Brook and is not included in the report.

These stations are a part of the Real-Time Water Quality Network. The stations are maintained by the Department of Municipal Affairs and Environment, Water Resources Management Division (WRMD). WRMD staff are responsible for the maintenance and calibration of the water quality instruments deployed at these sites.

The data recorded by the real-time water quality stations is available on the real-time website: www.gov.nl.ca/eccm/waterres/rti/stations/

Please note that the hydrometric data (stage and streamflow) included in this report is provisional and used only for illustrative purposes. Corrected and finalized data may be retrieved from Environment and Climate Change Canada, Water Survey of Canada website https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey.html

For the purposes of this report, air temperature and total precipitation data was obtained from the weather station located in Millertown. This weather station is the closest to the Teck Duck Pond Real-Time water quality monitoring sites and the data was retrieved from:
https://climate.weather.gc.ca/climate_data/daily_data_e.html?hlyRange=2013-01-21%7C2020-05-28&dlyRange=2013-01-21%7C2020-05-28&mlyRange=%7C&StationID=50678&Prov=NL&urlExtension=_e.html&searchType=stnName&optLimit=yearRange&StartYear=2020&EndYear=2020&selRowPerPage=25&Line=0&searchMethod=contains&Month=5&Day=28&txtStationName=Millertown&timeframe=2&Year=2020

Maintenance and Calibration of Instrument

As part of the Quality Assurance and Quality Control protocol (QAQC), 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.

Upon deployment, a QA/QC Sonde is temporarily deployed *in situ*, adjacent to the Field Sonde. Depending on the degree of difference between each parameter from the Field and QAQC sondes a qualitative rank is assigned (See Table 1). The possible ranks, from most to least desirable, are: Excellent, Good, Fair, Marginal, and Poor. A grab sample is also taken for additional confirmation of conditions at deployment and to allow for future modelling studies.

At the end of a deployment period, a freshly cleaned and calibrated QAQC Sonde is placed *in situ*, adjacent to the Field Sonde. Values are again compared between all parameters and differences are ranked for placement in Table 1.

Table 1: Qualitative QAQC Ranking

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Tributary to Gill's Pond Brook	Sept 24 2019	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	Dec 3 2019	Removal	Good	Excellent	Excellent	Marginal	Excellent
East Pond Brook below East Pond	Sept 24 2019	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	Dec 3 2019	Removal	Excellent	Fair	Excellent	Good	Excellent

Data Interpretation

Water Temperature

Water Temperature is a major factor used to describe water quality. Temperature has major implications on both the ecology and chemistry of a water body, governing processes such as the metabolic rate of aquatic plants and animals and the degree of dissolved oxygen saturation.

The statistical data for both sites display similar ranges with Tributary to Gills Pond Brook recording the lowest minimum value for water temperature at -0.41°C and East Pond Brook recorded the highest maximum value for water temperature at 14.96°C (Table 2). This is expected, as Tributary to Gills Pond Brook is much shallower than East Pond brook and shaded by vegetation cover. Water temperatures are noticeably lower than the previous deployment due to the seasonal changes that occurred as winter approached.

Water temperature decreased over the course of the deployment period at both Tributary to Gills Pond Brook and East Pond Brook stations. This change in water temperature is a natural process as the seasons change from Fall to Winter temperatures. Water temperature graphs also display the natural diurnal pattern that occurs with water temperature, as the temperatures are higher in the day light hours and then lower in the nighttime hours.

Stage Level data is raw data, and the data has not been corrected. Corrected and finalized data may be retrieved from the Environment Climate Change Canada, Water Survey of Canada website https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey.html

Table 2. Table of the statistical data for East Pond Brook and Tributary to Gills Pond Brook for September to December 2019

Station	Mean	Median	Min	Max
East Pond Brook	6.92	7.47	0.31	14.96
Tributary to Gills Pond Brook	4.90	4.99	-0.41	14.17

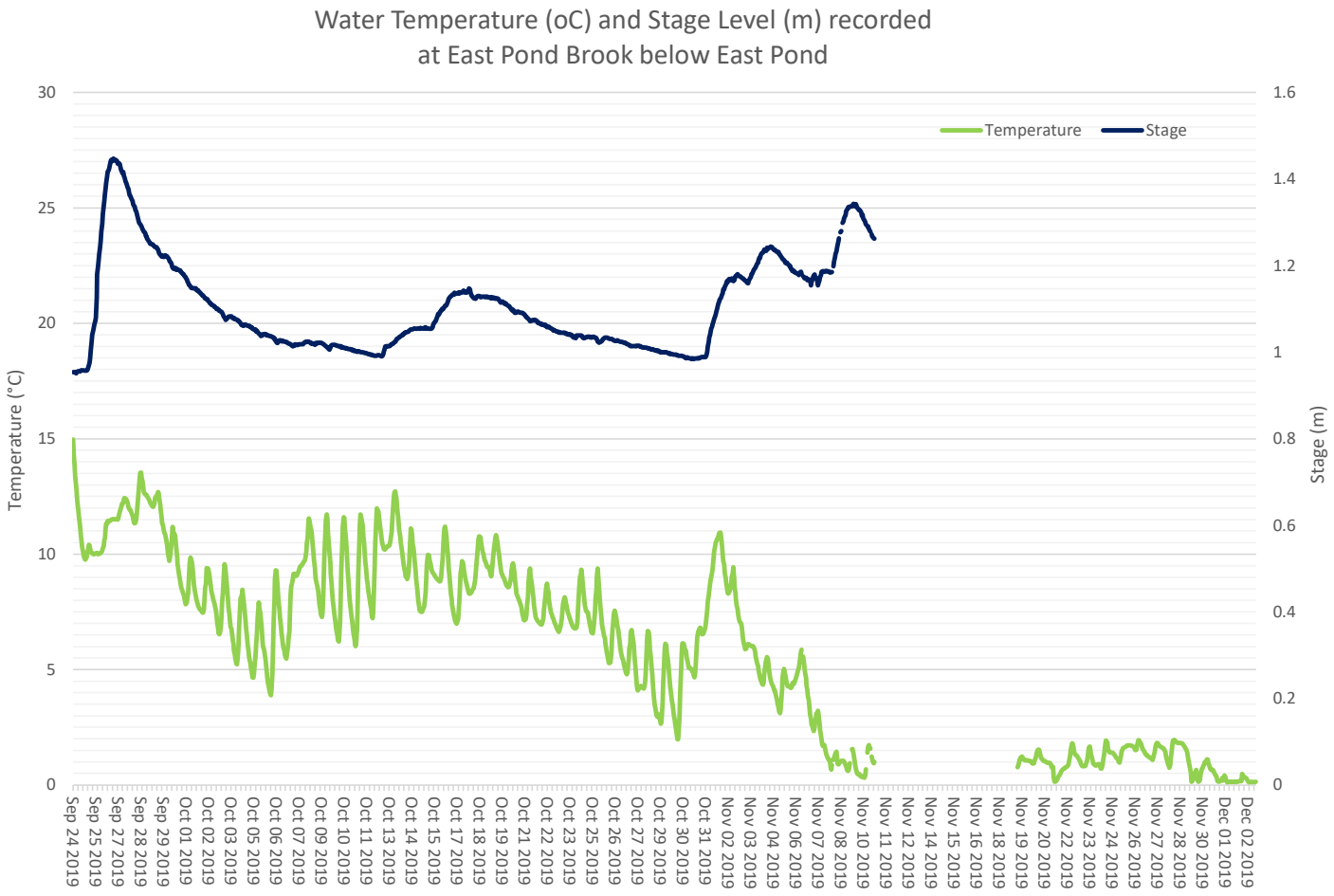

Figure 1. Water Temperature (°C) and Stage Level (m) at East Pond Brook

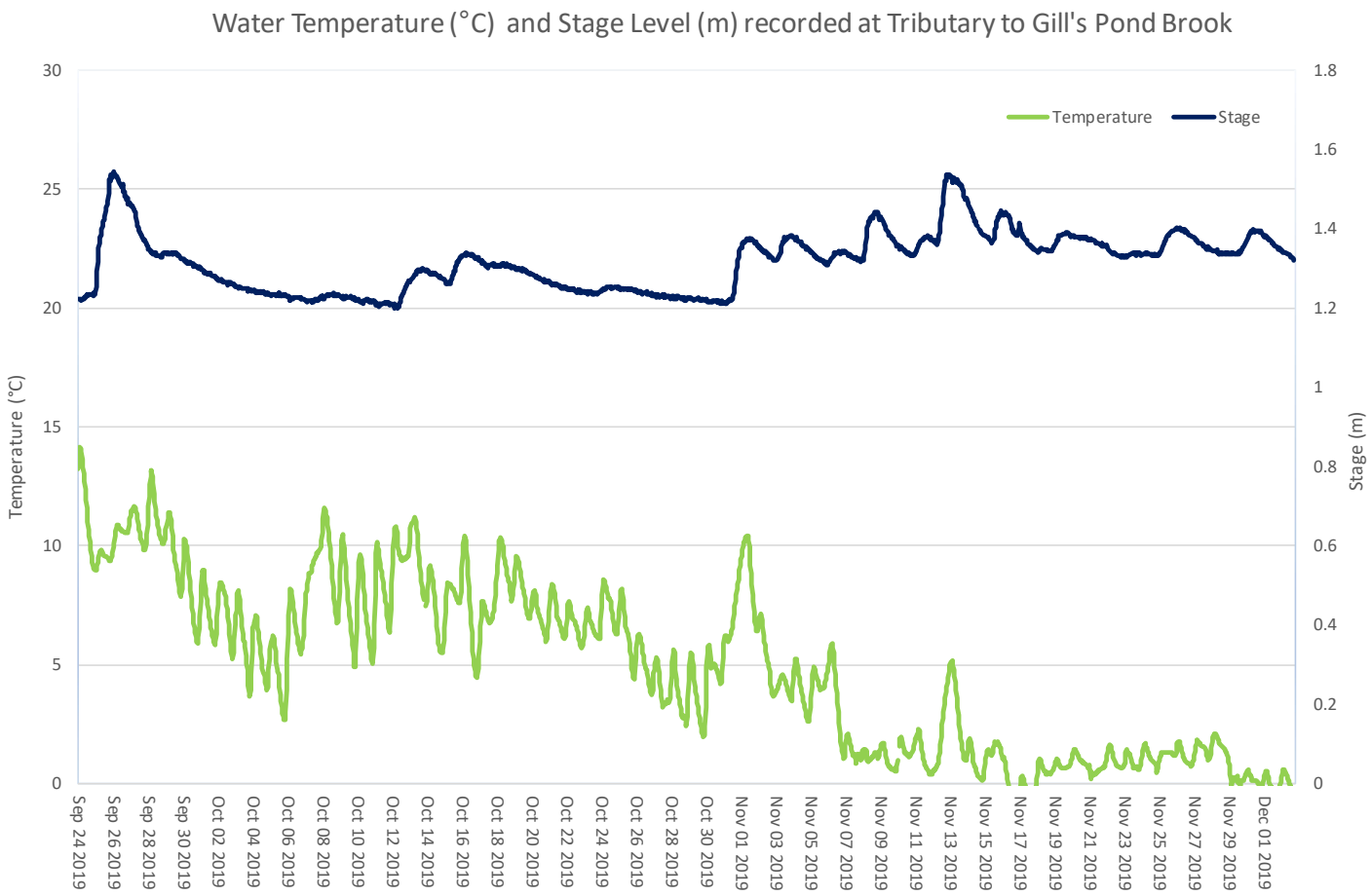

Figure 2. Water Temperature (°C) and Stage Level (m) at Tributary at Gills Pond Brook

pH

pH indicates the acidity or alkalinity of a solution. A value of 7.00 pH units denotes a neutral solution while lower values are acidic and higher values are basic.

The pH levels ranged within a minimum of 5.60 (pH units) recorded at East Pond Brook below East Pond and a maximum of 7.24 (pH units) recorded at Tributary to Gills Pond Brook (Table 3). pH data at East Pond Brook remained relatively stable, until an increase in stage at the end of October, when the pH dropped to below the minimum guideline for CCME. During the QAQC check at removal of the instrument at East Pond, it was evident that the pH data from November 19th to the end of deployment was inaccurate and did not represent the brook. The data was not included in the statistical analysis of the data.

pH data at Tributary to Gills Pond Brook indicated the influence of stage level on pH. As the stage increased due to precipitation, pH acidity increased and as stage decreased, pH increased. Outside of the changes that stage has on the pH, the pH remained within a neutral range.

The CCME guideline noted on the pH graph is a basis by which to compare pH levels across Canada. It does not indicate the health of the brook. Due to the soil composition and natural geology of Newfoundland and Labrador, many of the brooks and waterways in the province have naturally lower pH ranges.

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Table 3. Table of the statistical data for East Pond Brook and Tributary to Gills Pond Brook for September to December 2019

Station	Mean	Median	Min	Max
East Pond Brook	6.53	6.62	5.60	7.20
Tributary to Gills Pond Brook	6.62	6.60	5.94	7.24

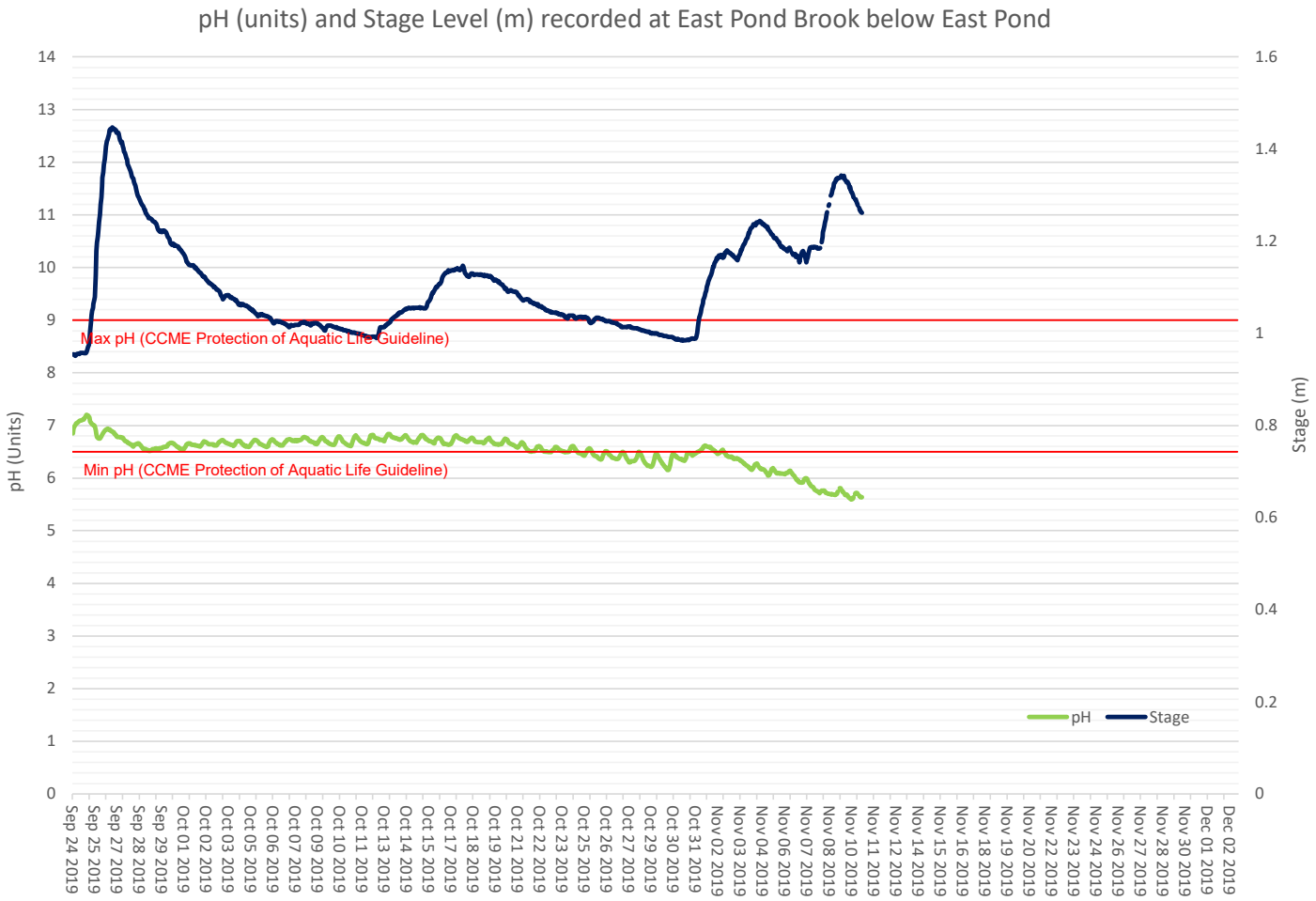


Figure 3. pH (pH units) and Stage Level (m) at East Pond Brook

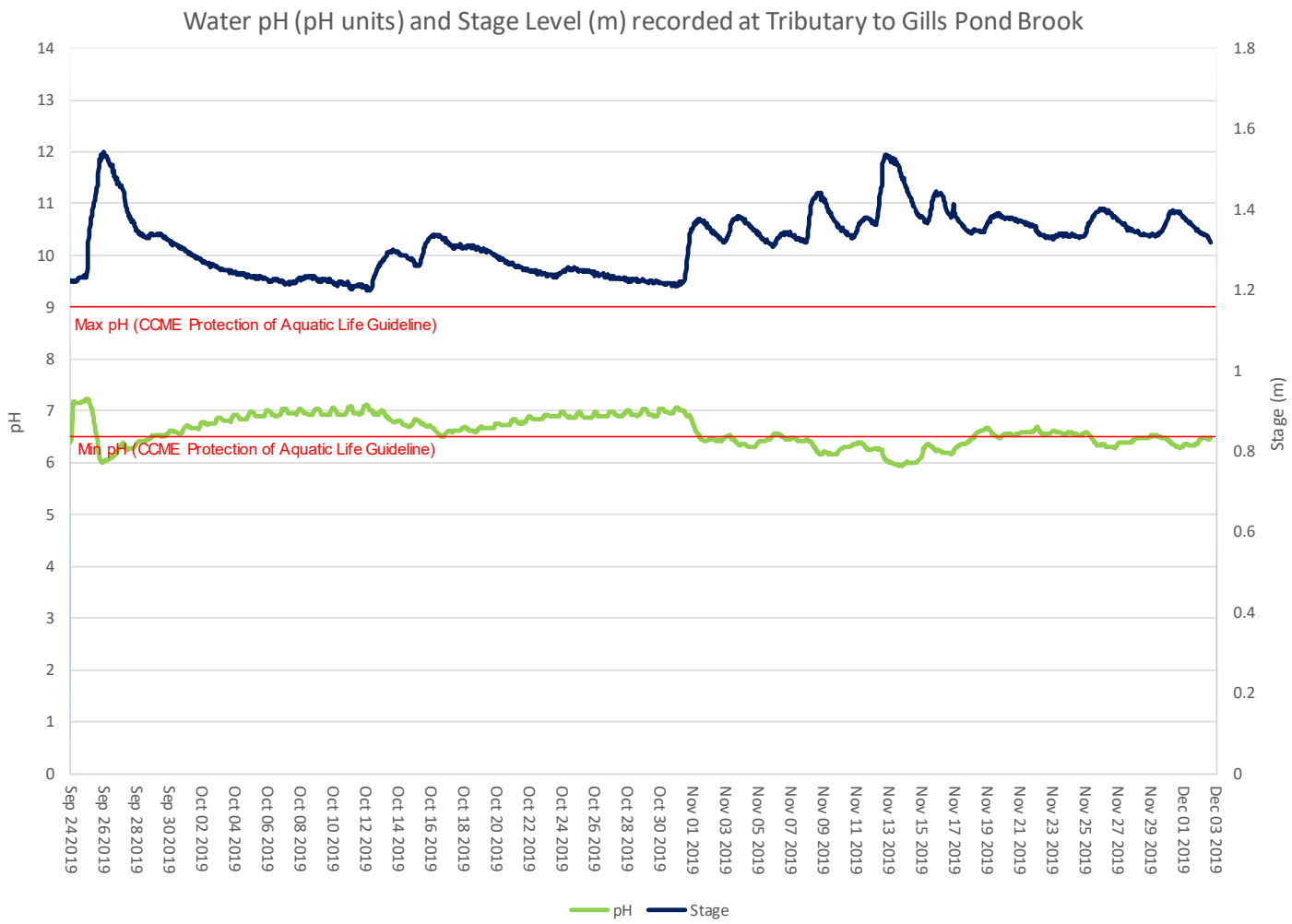


Figure 4. pH (pH units) and Stage Level (m) at Tributary at Gills Pond Brook

Specific Conductivity

Conductivity relates to the ability of an electric charge – or resistance – to pass through a solution. Conductivity is highly influenced by the concentration of dissolved ions in solution: distilled water has zero conductivity (infinite resistance) while salty solutions have high conductivity (low resistance). Specific Conductivity is corrected to 25^{o}C to allow comparison across variable temperatures.

East Pond Brook station recorded the minimum for Specific Conductivity at 21.6µS/cm and Tributary to Gills Pond Brook recorded the maximum for Specific Conductivity at 895.0 µS/cm (Table 4).

This deployment period captured the change in the brooks during the Fall into the Winter season. As the deployment interval progressed into Winter, conductivity decreased at both sites. This was a result of lower stage levels and less runoff from surrounding environment as the ground starts to freeze (Figure 5 & 6).

Tributary to Gills Pond Brook did continue to have peaks of conductivity during the colder temperatures. Conductivity events on September 25th and November 15th were related to the discharge of effluent into the brook (Figure 7) as both stage and specific conductivity increased at the same time. The drops in conductivity October 14th and again November 1st, were likely a result of rainfall because stage increased and specific conductivity decreased. Rainfall will flush the brook and reduce the conductivity for a short period of time (Appendix I).

Stage Level data is raw data. This data has not been corrected. Corrected and finalized data may be retrieved from the Environment Climate Change Canada, Water Survey of Canada website https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey.html

Table 4. Table of the statistical data for East Pond Brook and Tributary to Gills Pond Brook for September to December 2019

Station	Mean	Median	Min	Max
East Pond Brook	29.5	29.4	21.6	44.7
Tributary to Gills Pond Brook	207.8	177.3	39.4	895.0

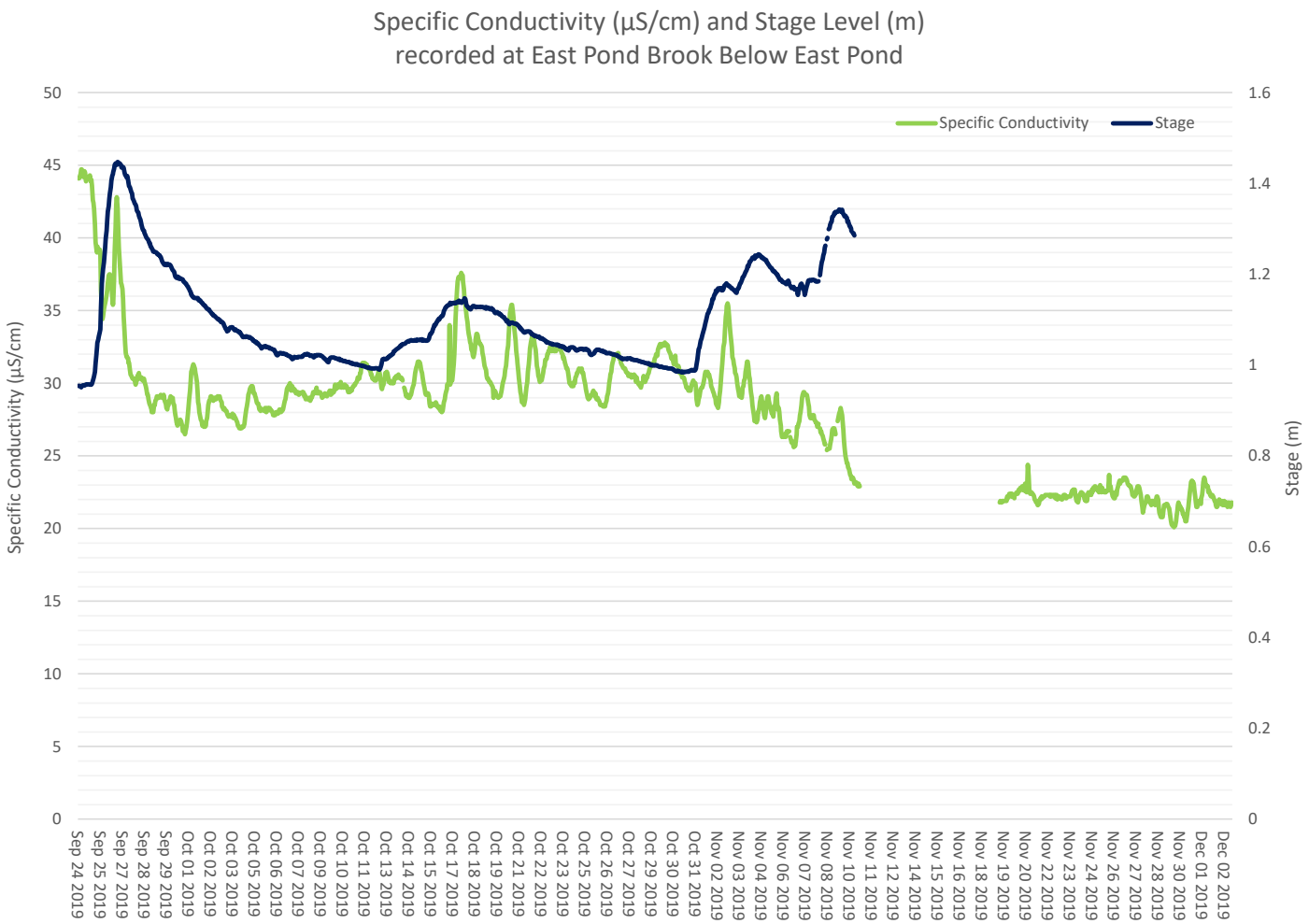


Figure 5. Specific Conductivity (µS/cm) and Stage Level (m) at East Pond Brook

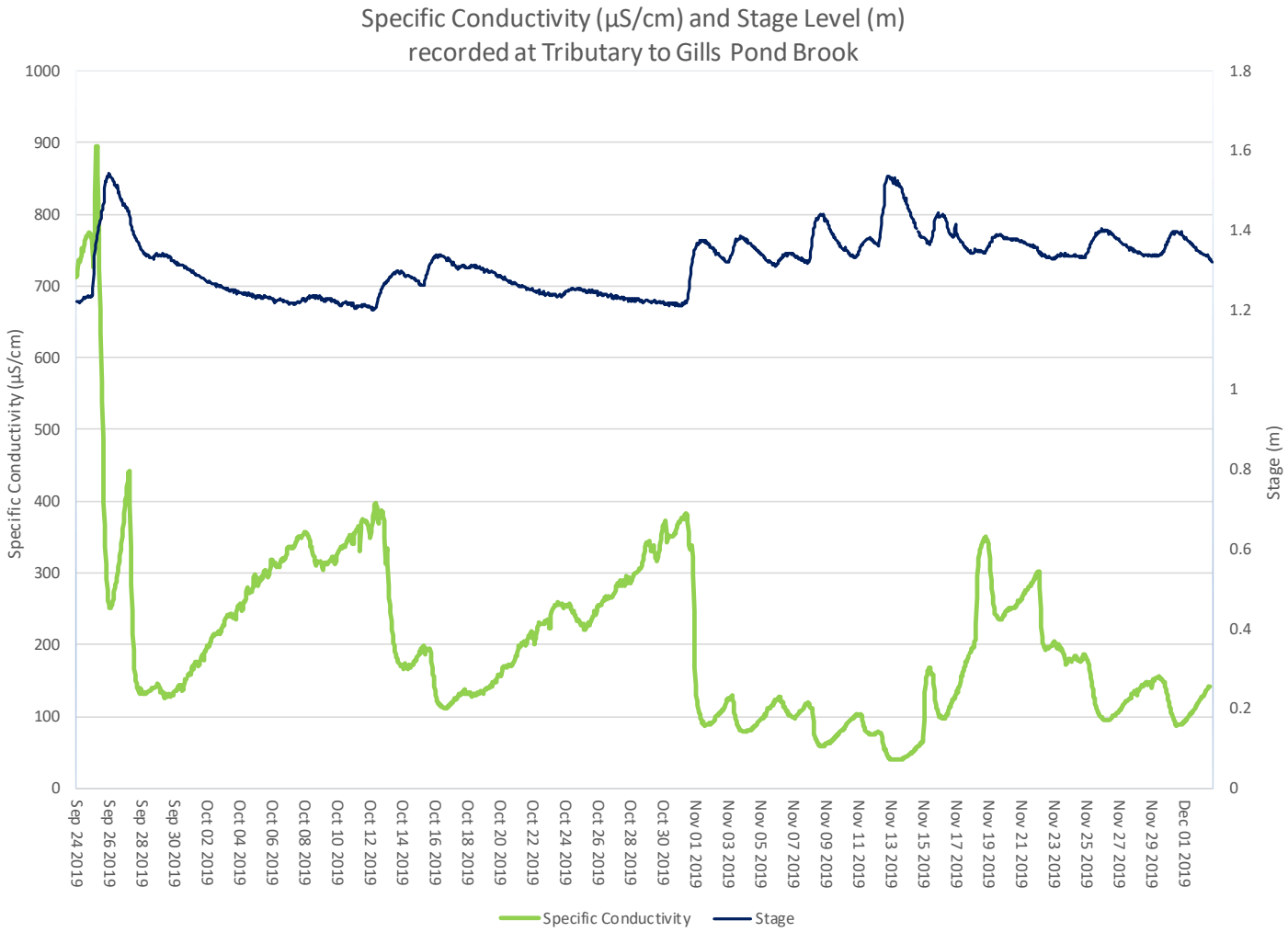


Figure 6. Specific Conductivity (µS/cm) and Stage Level (m) at Tributary at Gills Pond Brook

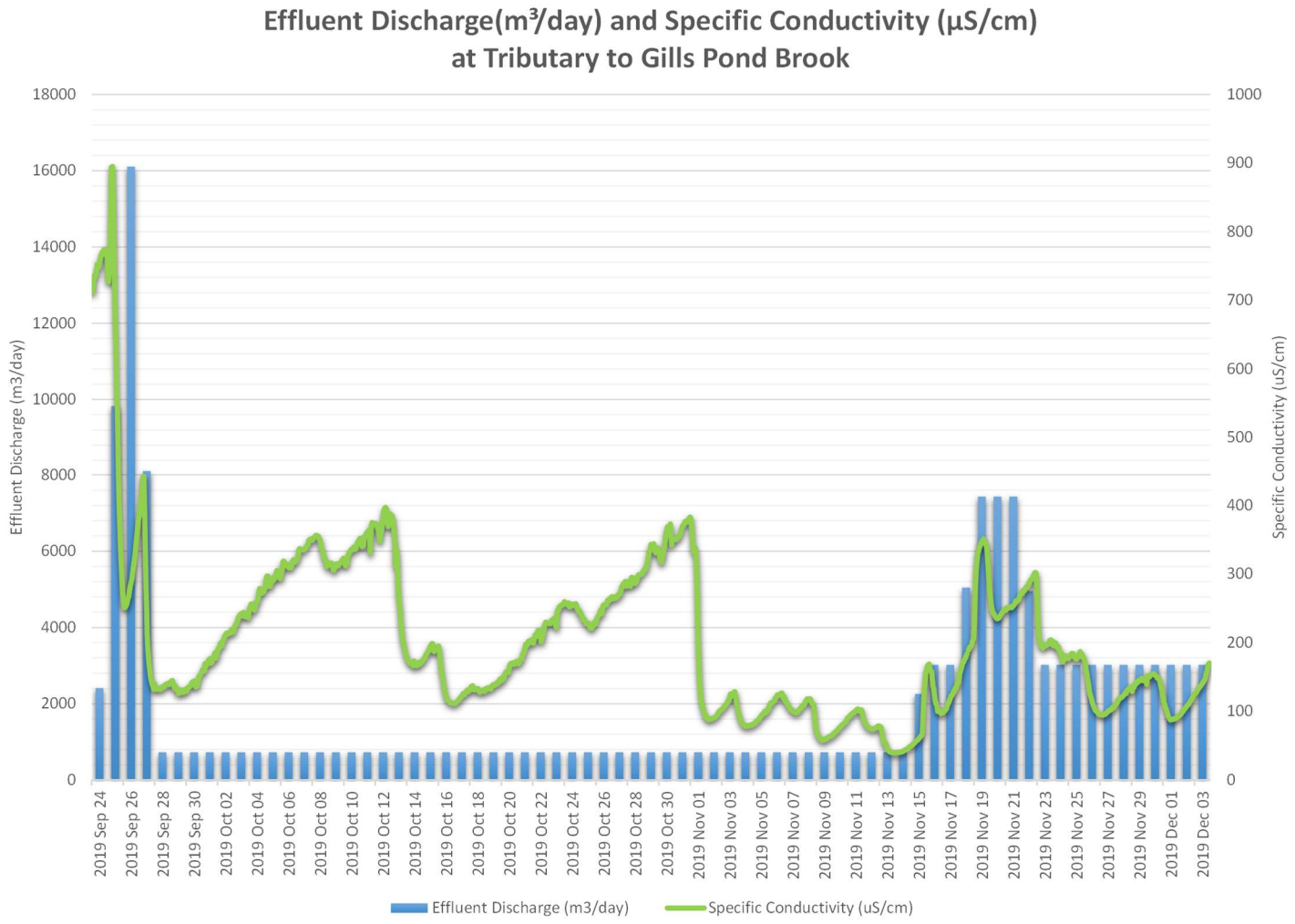


Figure 7. Effluent Discharge (m³/day) and Specific Conductivity (µS/cm) at Tributary at Gills Pond Brook

Dissolved Oxygen

Dissolved oxygen is a metabolic requirement of aquatic plants and animals. The concentration of oxygen in water depends on several factors, particularly temperature. The saturation of oxygen in water is inversely proportional to water temperature of the water body. Oxygen concentrations also tend to be higher in flowing water compared to still, lake environments. Low oxygen concentrations can give an indication of excessive decomposition of organic matter or the presence of oxidizing materials.

Dissolved oxygen levels increased gradually throughout the end of the deployment (Figure 8 & 9), because of water temperatures dropping with the cooler air temperatures (Appendix I). Both stations recorded large decreases in dissolved oxygen (mg/L) on November 2nd, 2019. Analysis of water and air temperature shows a spike in temperature at this time, which correlates to the large dissolved oxygen decrease.

East Pond Brook maintained the highest maximum for dissolved oxygen concentration (mg/L) at 13.14 mg/L, and Tributary to Gills Pond Brook had the lowest minimum for dissolved oxygen concentration (mg/L) at 9.29 mg/L. Both sites indicated similar ranges across the deployment (see table 5). Nearly all values were above the CCME guideline for aquatic life at both stations.

Table 5. Table of the statistical data for East Pond Brook and Tributary to Gills Pond Brook for September to December 2019

Station	Mean	Median	Min	Max
Dissolved Oxygen (mg/L)				
East Pond Brook	11.16	10.99	9.43	13.14
Tributary to Gills Pond Brook	11.85	11.85	9.29	13.65
Dissolved Oxygen (%Sat)				
East Pond Brook	91.2	91.1	87.9	96.5
Tributary to Gills Pond Brook	92.0	92.2	83.6	97.8

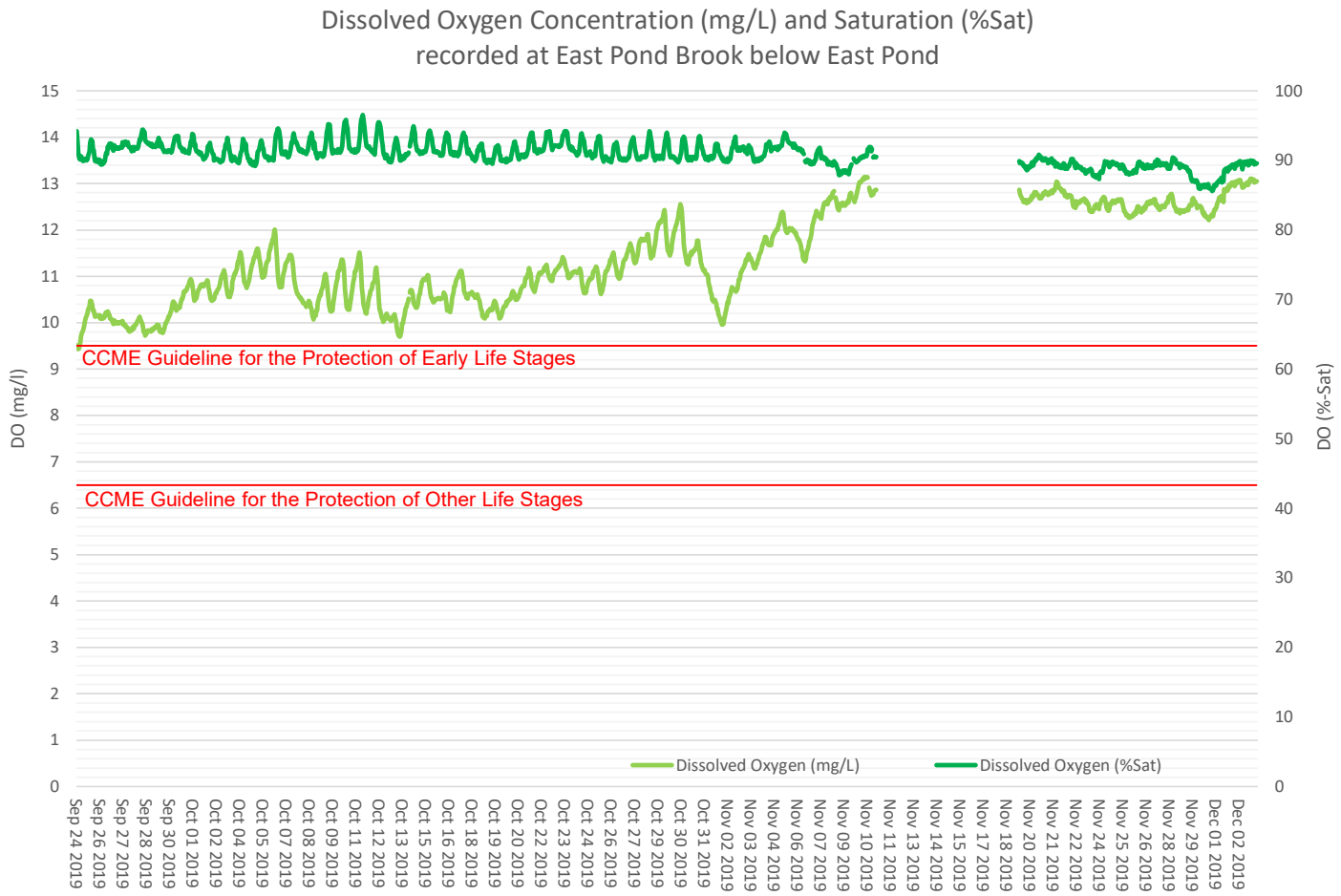


Figure 8. Dissolved Oxygen (mg/L & sat %) and Stage Level (m) at East Pond Brook

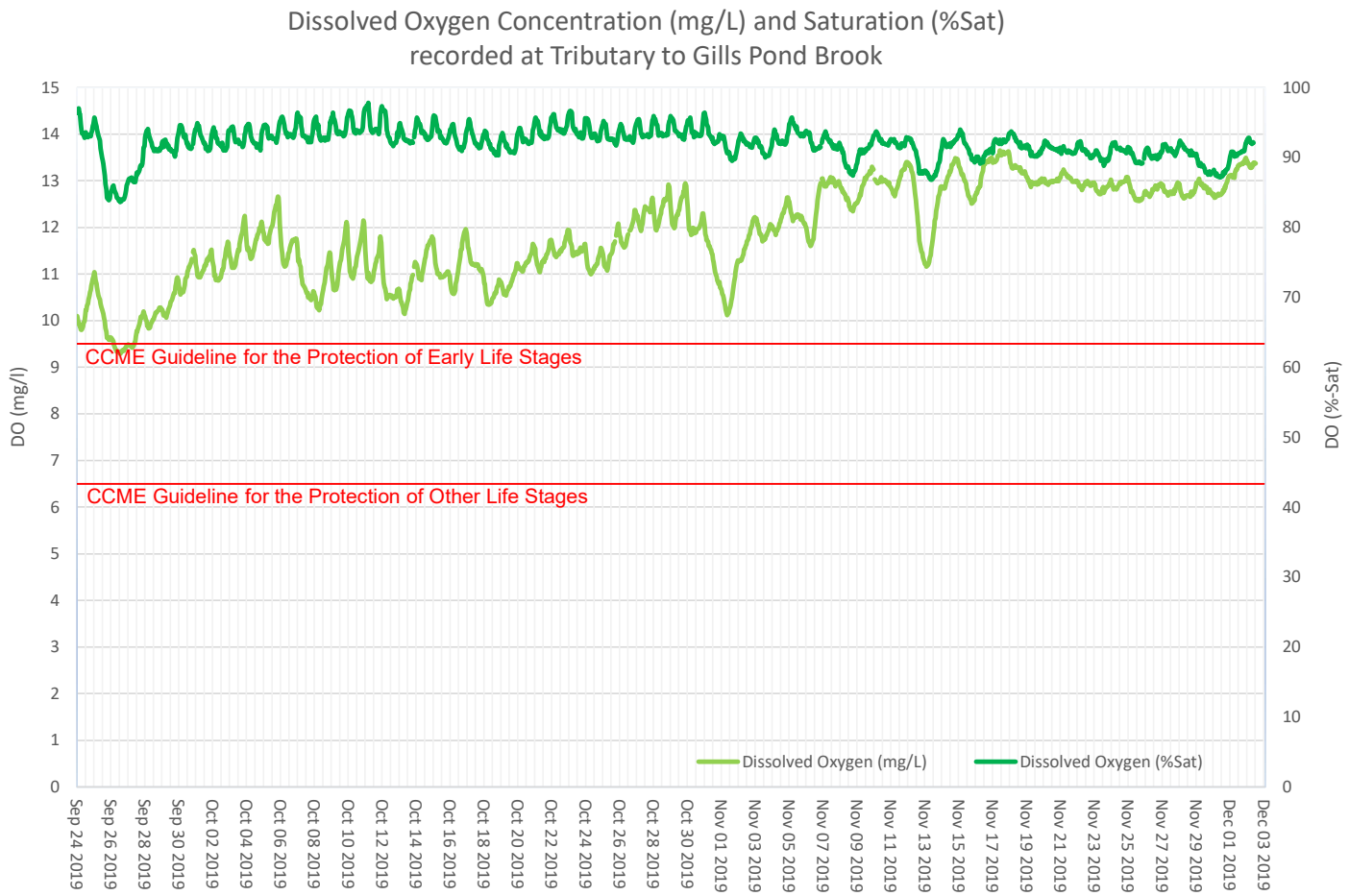


Figure 9. Dissolved Oxygen (mg/L & % Sat) at Tributary at Gills Pond Brook

Turbidity

Turbid water is typically caused by fine suspended solids such as silt, clay, or organic material. Consistently high levels of turbidity tend to block sunlight penetration into a waterbody, discouraging plant growth. High turbidity can also damage the delicate respiratory organs of aquatic animals and cover spawning areas.

Turbidity levels were generally low across deployment at both sites (Figure 10 & 11). East Pond Brook had the highest maximum at 19.7 NTU, recorded on November 2nd during a peak in stage level. There were periodic spikes, likely related to weather conditions during deployment, stirring up particulate matter. Generally turbidity remained below 10 NTU (Table 6).

The maximum turbidity recorded at Tributary to Gills Pond Brook was 4.9NTU, indicating very little to no turbidity disturbance occurring at this site. The small peaks in turbidity noted on the graph correlated with high stage flow.

The turbidity values recorded at both of the Real-Time stations at TECK would be considered low and not of concern. It is expected that the turbidity levels in a natural waterway would vary and be influenced by its surroundings.

Stage Level data is raw data. This data has not been corrected. Corrected and finalized data may be retrieved from the Environment Climate Change Canada, Water Survey of Canada website https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey.html

Table 6. Table of the statistical data for East Pond Brook and Tributary to Gills Pond Brook for September to December 2019

Station	Mean	Median	Min	Max
East Pond Brook	0.0	0.0	0.0	19.7
Tributary to Gills Pond Brook	0.0	0.0	0.0	4.9

Figure 10. Turbidity (NTU) and Stage Level (m) at East Pond Brook

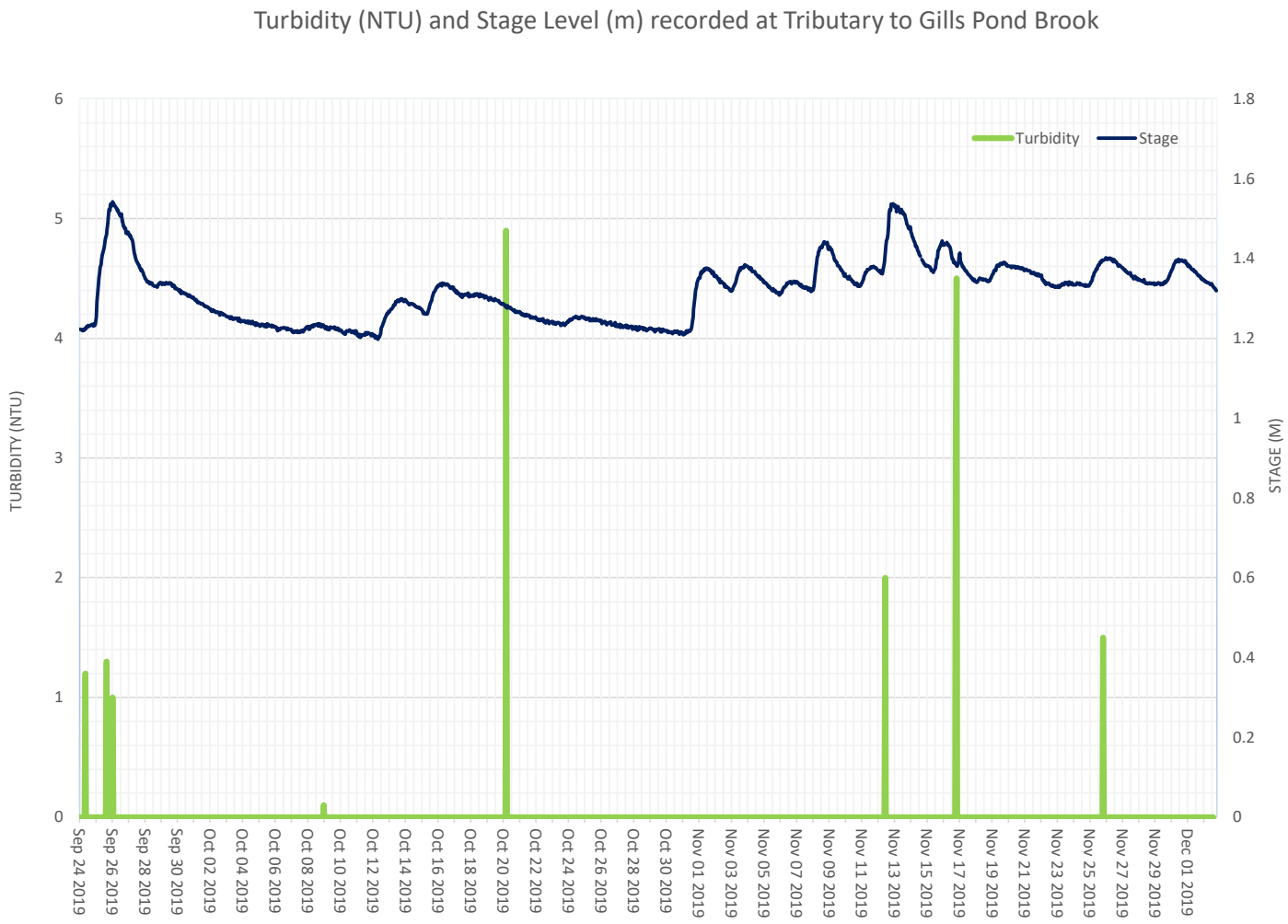


Figure 11. Turbidity (NTU) and Stage Level (m) at Tributary to Gills Pond Brook

Conclusion

Tributary to Gills Pond Brook station was established downstream of the Tailings Management Facility to assist in capturing any emerging water quality issues with the management of the tailings facility. Tributary to Gills Pond Brook is a smaller, shallower brook compared to East Pond Brook. East Pond Brook below East Pond is the larger of the two brooks and can be significantly altered by high and low stage levels. Both brooks can be impacted by natural climatic events or runoff from natural wetlands and marshlands.

Air temperature significantly influences water temperature in ambient water sources. Water temperatures at both stations reflect the climate expected across the September to December deployment. Water temperatures remained below 15˚C for most of the deployment until around early November when temperatures dropped to below 5˚C for the remainder of the deployment.

The pH values across both stations remained consistent, until early November when the pH levels dipped below the min pH CCME guideline for protection of aquatic life. pH was representative of both sites during the September to December deployment.

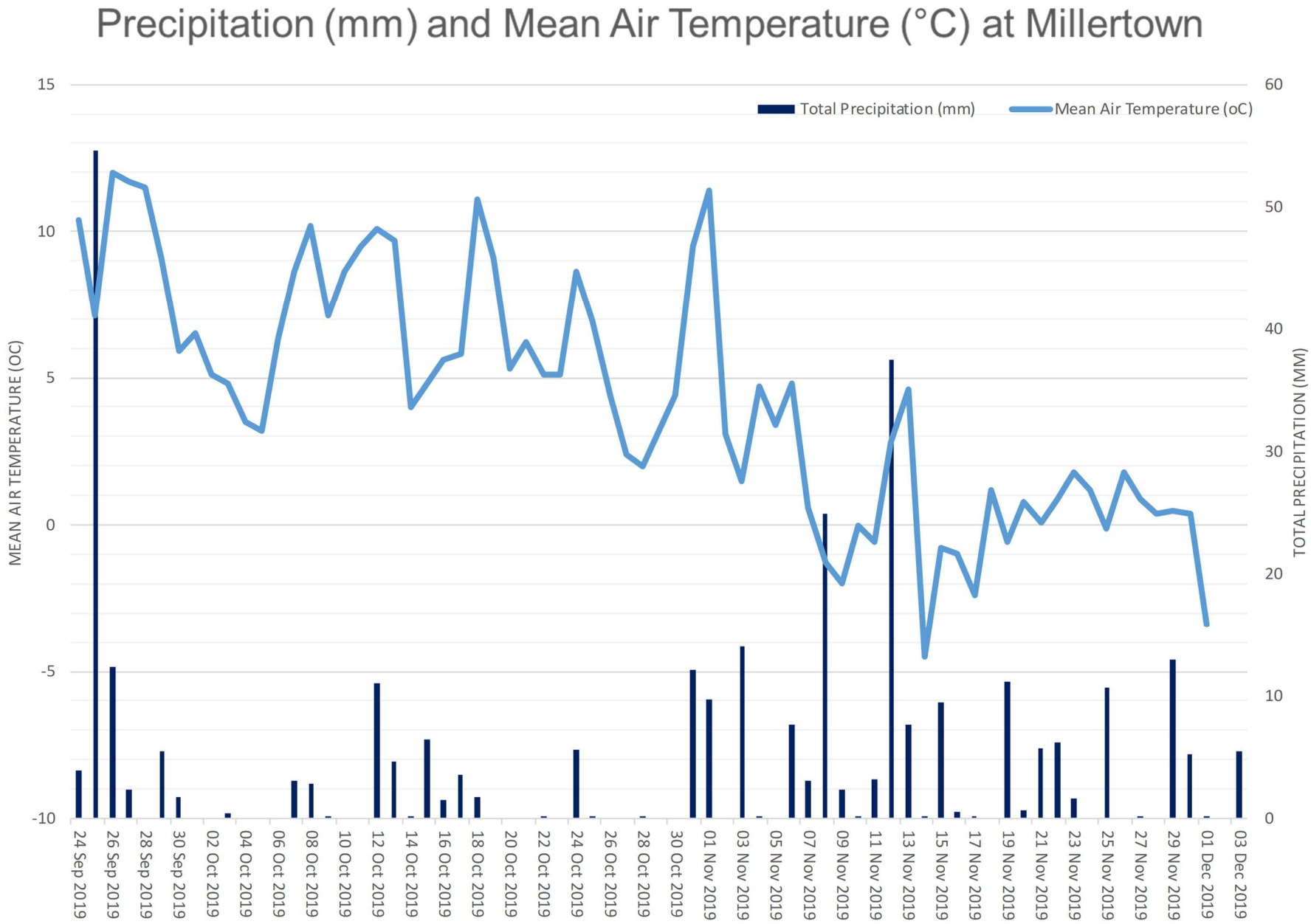
Conductivity levels respond to stage fluctuations by decreasing during high stage events and increasing during periods of low stage. Tributary to Gills Pond Brook had the higher conductivity levels for the deployment; this corresponds with the effluent discharge that occurs at this site. At the beginning of the deployment a large stage increase flushed both East Pond Brook below East Pond and Tributary to Gills Pond Brook, the conductivity levels decreased.

The dissolved oxygen levels for both sites were representative of the climatic conditions during the September to December deployment. The dissolved oxygen concentration was consistent across deployment, as both sites had increasing concentration as the cooler temperatures approached. The dip in concentration recorded on November 2-3 for both sites corresponds with a precipitation event that occurred within the same dates and brought warm air and water temperature to the systems.

Both sites had low turbidity from September to December, with turbidity not recording higher than 20 NTU. Changes in the stage level on September 26-27, 2020 influenced an increase in turbidity for a short period of time.

Most of these changes are natural, quick adjustments in levels before the data returns to background levels. The health of a brook can be determined by how quickly it returns to its background data range after a water quality event.

APPENDIX I


Precipitation (mm) and Mean Air Temperature (°C) at Millertown
Total Precipitation (mm)
Mean Air Temperature (oC)
MEAN AIR TEMPERATURE (OC)
TOTAL PRECIPITATION (MM)
15
10
5
0
-5
-10
60
50
40
30
20
10
0
24 Sep 2019
26 Sep 2019
28 Sep 2019
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