Real-Time Water Quality Deployment Report

Teck: Duck Pond Operations

July 24, 2019 to September 24, 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 two real-time water quality monitoring stations at TECK Duck Pond, East Pond Brook and Tributary to Gills Pond Brook for the duration of July 24th through to September 24th, 2019.

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 retrieved from the weather station located in Millertown. The Millertown weather station is the closest to the Teck Duck Pond Real-Time water quality monitoring sites.

Data for air temperature and precipitation data was retrieved from the Climate Change Canada website 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	July 24 2019	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Sept 24 2019	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
East Pond Brook below East Pond	July 24 2019	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	Sept 24 2019	Removal	Excellent	Excellent	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 6.33°C and East Pond Brook recorded the highest maximum value for water temperature at 28.63°C (Table 2).

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 Summer to the cooler Fall temperatures. Water temperature graphs also display the natural diurnal pattern across the deployment.

Stage level can influence water temperatures; this is evident on Figure 1 on August 2nd the stage level dips for a couple of days as water temperatures decrease slightly. Both Figure 1 and Figure 2 show increases in stage toward the end of the deployment, coinciding with decreases in water temperature. This was likely a result of rainfall during the Fall season which lowered the temperatures in the brook during this time.

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 July to September 2019

Station	Mean	Median	Min	Max
East Pond Brook	16.78	16.83	6.60	28.63
Tributary to Gills Pond Brook	17.25	17.98	6.33	26.84

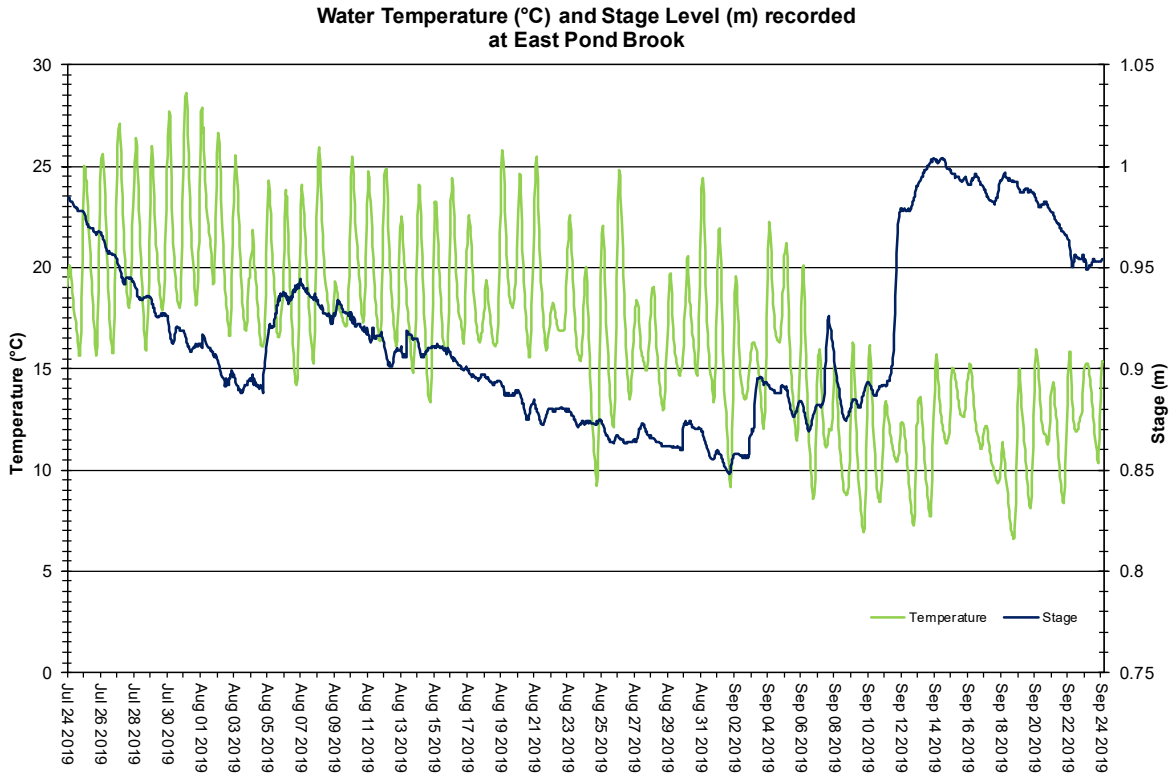

Figure 1. Water Temperature (°C) and Stage Level (m) at East Pond Brook

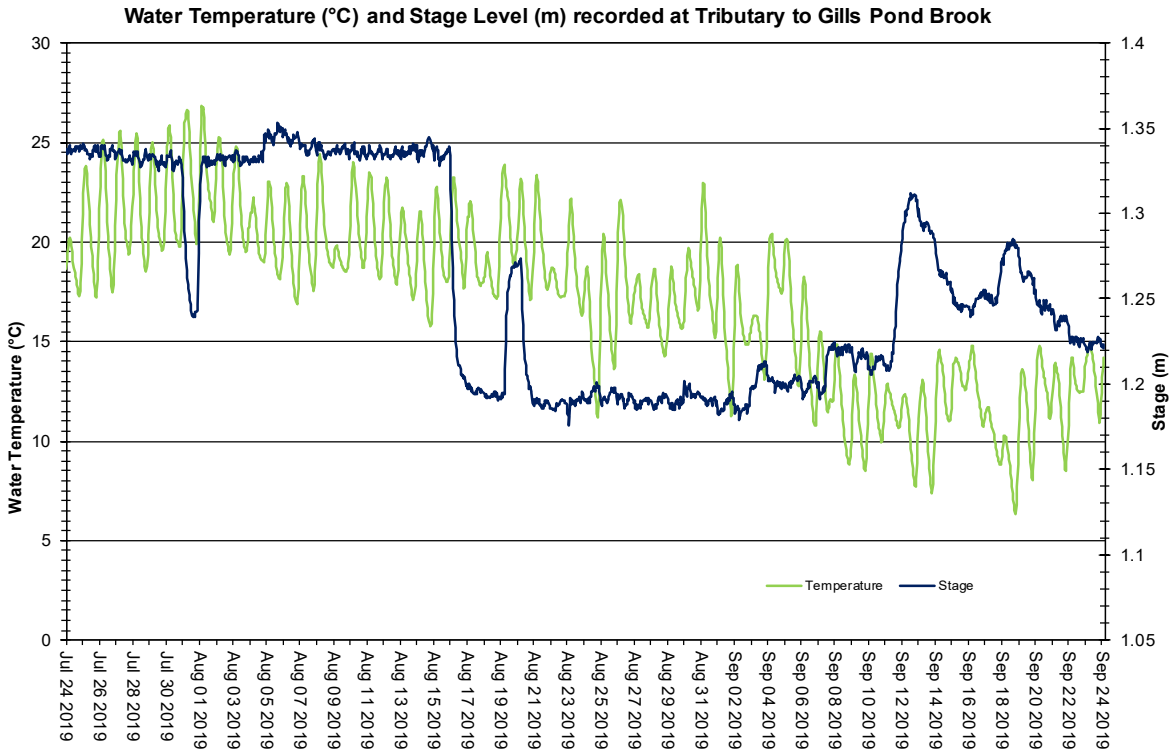

Figure 2. Water Temperature (°C) and Stage Level (m) at Tributary at Gills Pond Brook

pH

pH is used to give an indication of the acidity or basicity of a solution. A pH of 7 denotes a neutral solution while lower values are acidic and higher values are basic.

The pH levels ranged within a minimum of 5.71 (pH units) recorded at Tributary to Gills Pond Brook and a maximum of 7.40 (pH units) also recorded at Tributary to Gills Pond Brook (Table 3). pH data at East Pond Brook remained stable, hovering around the minimum pH (CCME protection of aquatic life) guideline. An increase in stage level at the end of deployment resulted in pH levels dropping to around 5.73 pH units (Figure 3), which was just below the guideline.

This event was also evident at Tributary to Gills Pond Brook (Figure 4). The stage level peaks around September 12th, and the pH levels dip down to sit below the CCME guideline. This guideline is a basis by which to compare pH levels across Canada. It does not indicate the health of the brook. Many brooks and waterways in Newfoundland and Labrador have naturally lower pH ranges due to the acidic nature of the rivers and ponds.

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

Station	Mean	Median	Min	Max
East Pond Brook	6.34	6.35	5.73	6.82
Tributary to Gills Pond Brook	6.83	6.97	5.71	7.40

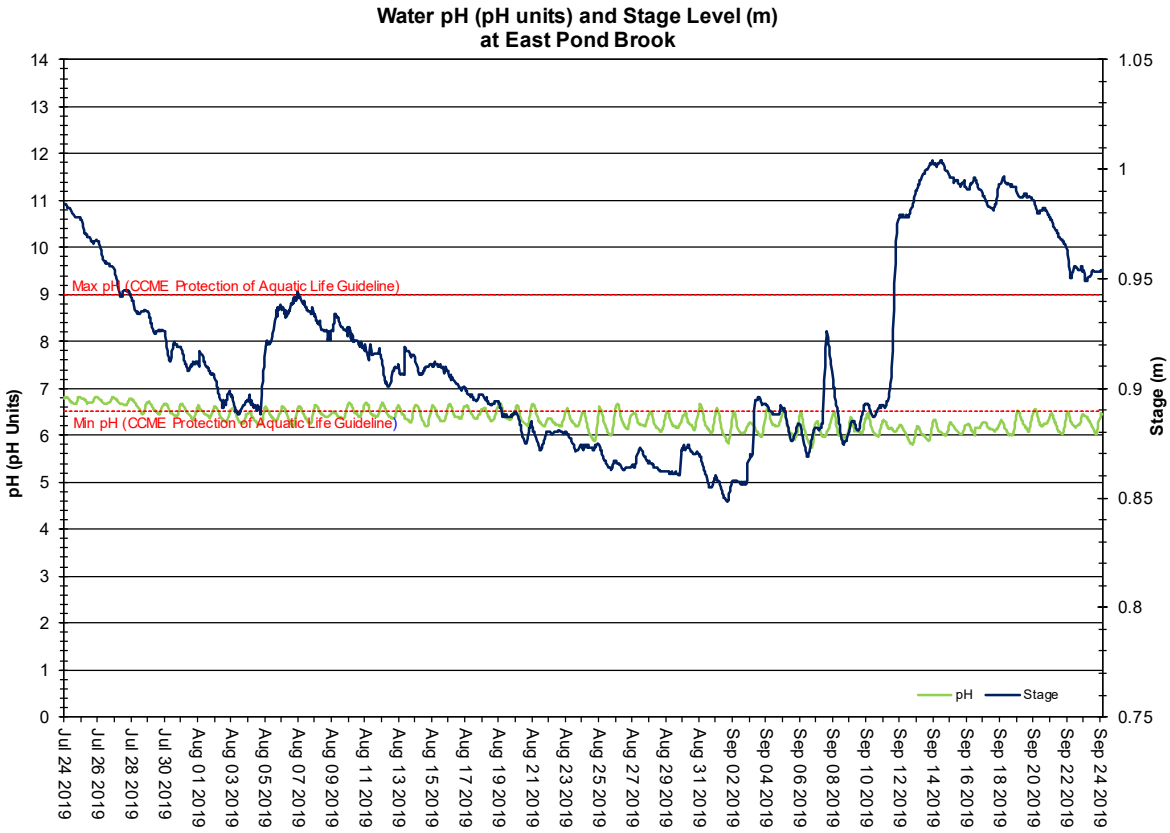

Figure 3. pH (pH units) and Stage Level (m) at East Pond Brook

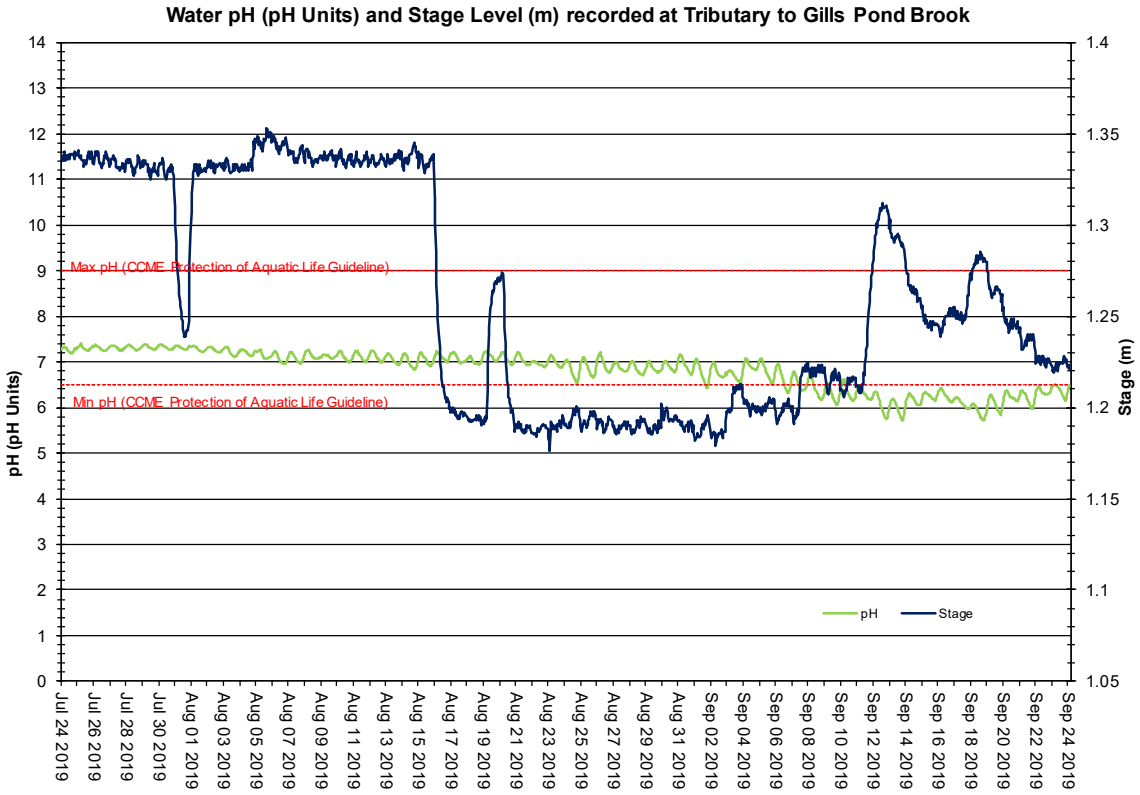

Figure 4. pH (pH units) and Stage Level (m) at Tributary at Gills Pond Brook

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.

The deployment of these instruments captured the changes in the brooks during the Summer as well as into the early Fall season. As the deployment interval progressed, specific conductivity increased at both stations, especially Tributary to Gills Pond Brook station. This occurrence is a result of the naturally lower stage levels during the summer, as well as evaporation of water from the brook. The lower water content in the brook can concentrate the particle matter in the water column increasing specific conductivity (Figure 5 & 6).

East Pond Brook station recorded the minimum for Specific Conductivity at 27µS/cm and Tributary to Gills Pond Brook recorded the maximum for Specific Conductivity at 1102.8 µS/cm. Tributary to Gills Pond Brook is influenced by water from the Duck Pond Tailings Management Facility, which accounts for the high conductivity (Table 4).

Both stations displayed an increase in stage level on or around September 11, 2019, both stations recorded decreases in Specific Conductivity as stage levels rose, with Tributary to Gills Pond Brook having a large magnitude decrease. At both stations, specific conductivity quickly rose again. An abnormal increase at East Pond Brook on September 18, 2019 may be indicative of sediment or other material entering the system at this time.

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

Station	Mean	Median	Min	Max
East Pond Brook	40.4	40.6	27.8	56.7
Tributary to Gills Pond Brook	921.7	1007.0	362.0	1102.0

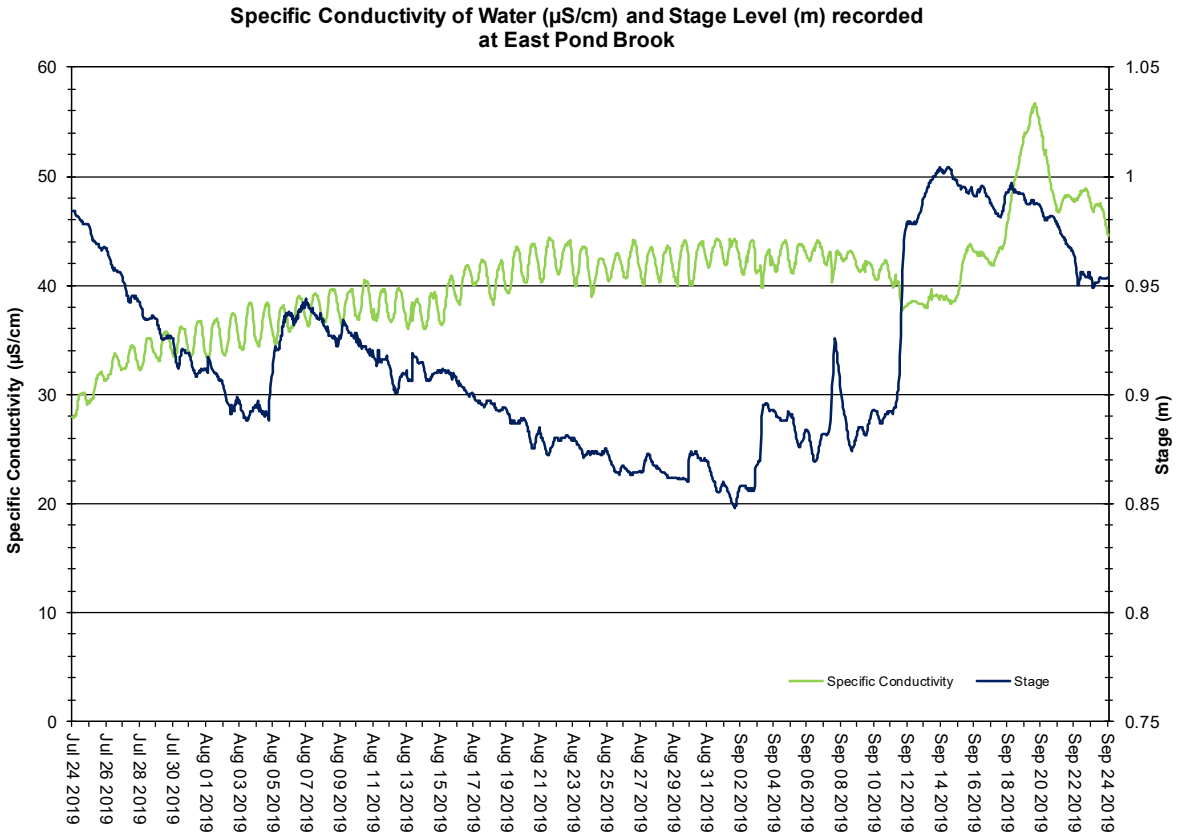

Figure 5. Specific Conductivity (µS/cm) and Stage Level (m) at East Pond Brook

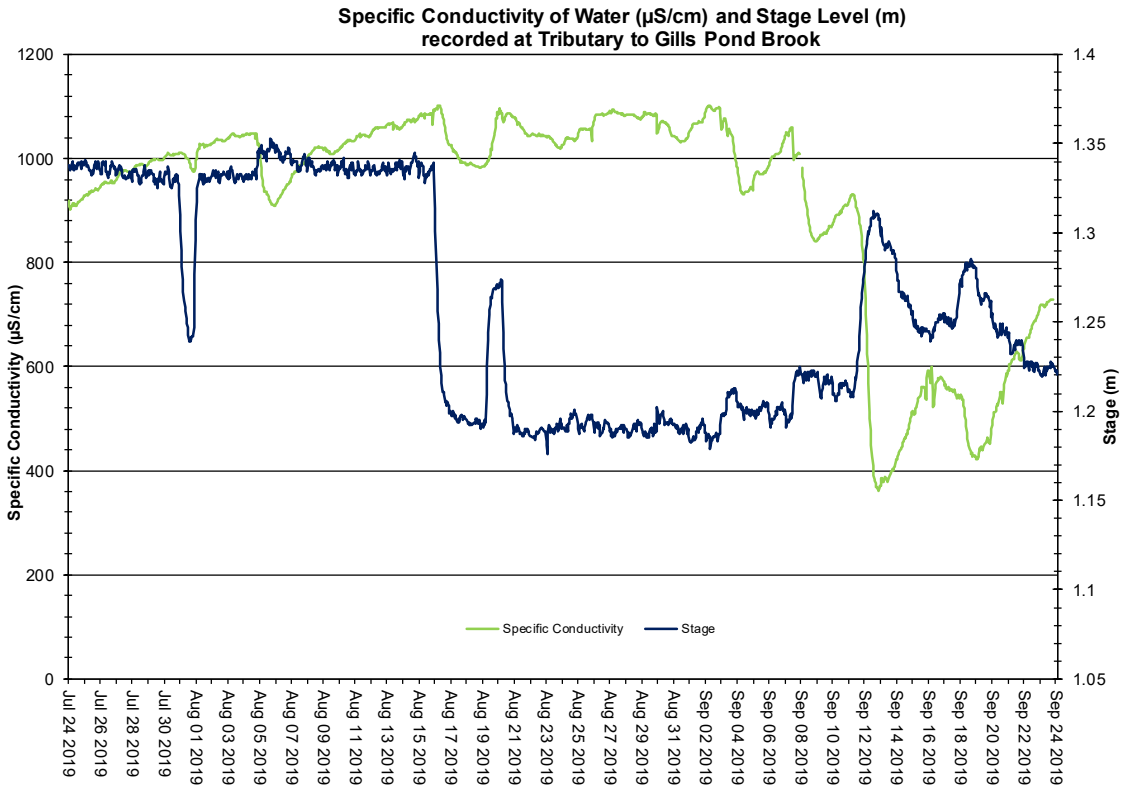

Figure 6. Specific Conductivity (µS/cm) and Stage Level (m) at Tributary at Gills Pond Brook

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 slightly toward the end of the deployment (Figure 7 & 8). This was a result of water temperatures dropping with the cooler Fall air temperatures (Appendix I). By early September the dissolved oxygen concentration remained above the upper CCME guideline of 9.5 mg/l DO for the protection of early life stage aquatic life this is typical for this time of year.

Although East Pond Brook maintained the highest maximum for dissolved oxygen concentration (mg/L) at 11.65 mg/L, and the lowest minimum for dissolved oxygen concentration (mg/L) at 7.51 mg/L, both sites had similar averages (Table 5).

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

Station	Mean	Median	Min	Max
Dissolved Oxygen (mg/L)				
East Pond Brook	9.16	9.00	7.51	11.65
Tributary to Gills Pond Brook	9.17	8.93	7.68	11.42
Dissolved Oxygen (%Sat)				
East Pond Brook	93.5	93.0	86.7	102.0
Tributary to Gills Pond Brook	94.8	94.5	91.2	99.1

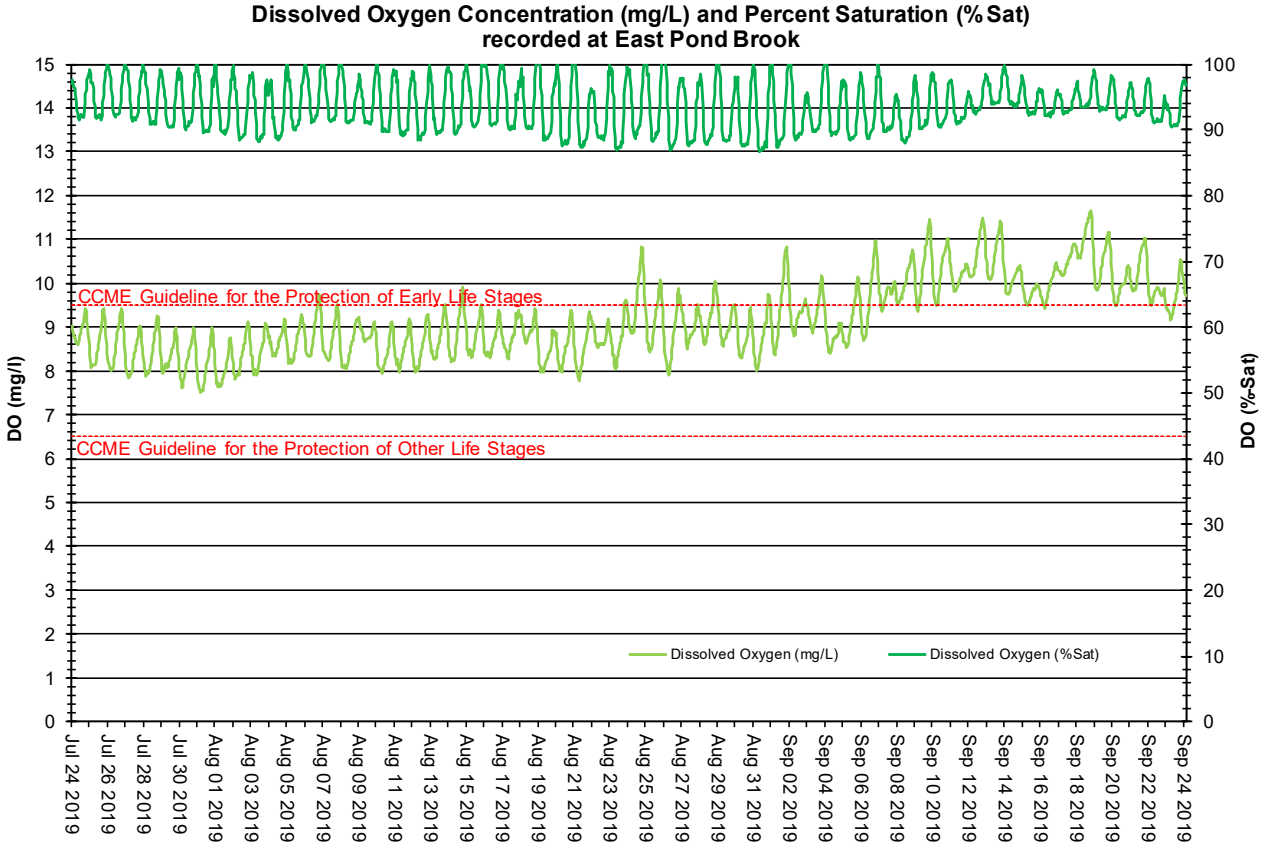

Figure 7. Dissolved Oxygen (mg/L & sat %) and Stage Level (m) at East Pond Brook

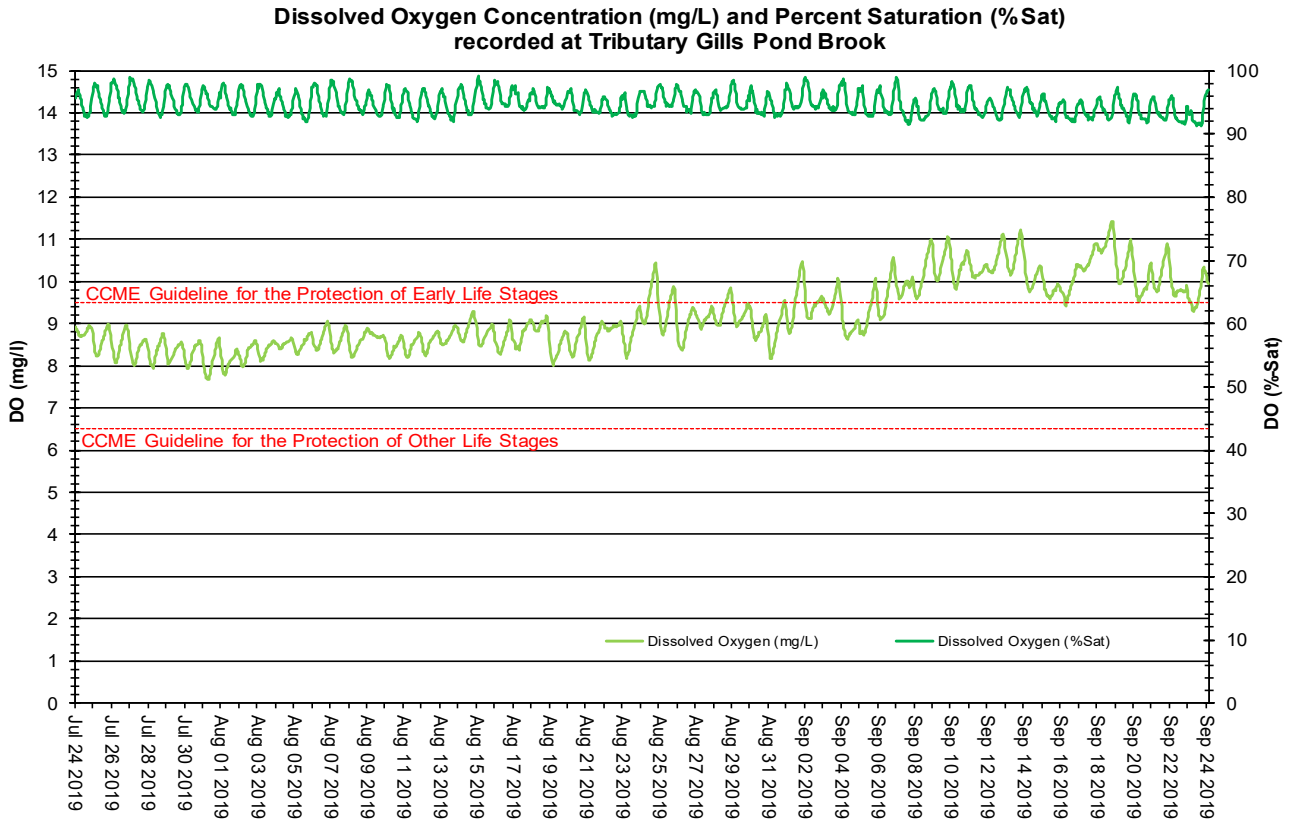

Figure 8. Dissolved Oxygen (mg/L & % Sat) at Tributary at Gills Pond Brook

Turbidity

Turbidity 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 9 & 10). Tributary to Gills Pond Brook had the highest maximum at 10.4 NTU which was recorded on September 13th 2019 during a peak in stage level. There were periodic spikes, likely related to weather conditions during deployment, however for the most part turbidity remained below 10 NTU (Table 6).

Toward the end of the deployment period at East Pond brook there was an increase in stage level, turbidity values increased and remain irregular for a period of time. This was likely due to an increase in organic matter suspended in the water after a period of rainfall (Appendix I).

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

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

Station	Mean	Median	Min	Max
East Pond Brook	0.3	0.0	0.0	3.2
Tributary to Gills Pond Brook	0.1	0.0	0.0	10.4

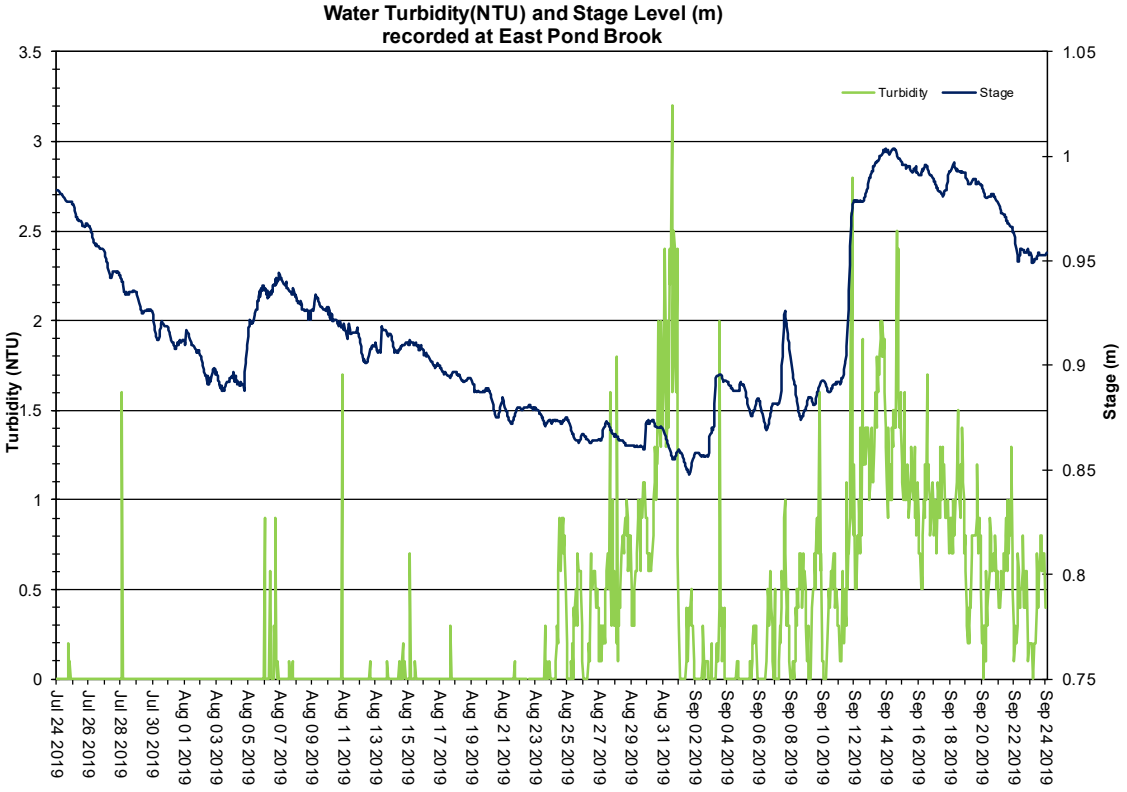


Figure 9. Turbidity (NTU) and Stage Level (m) at East Pond Brook

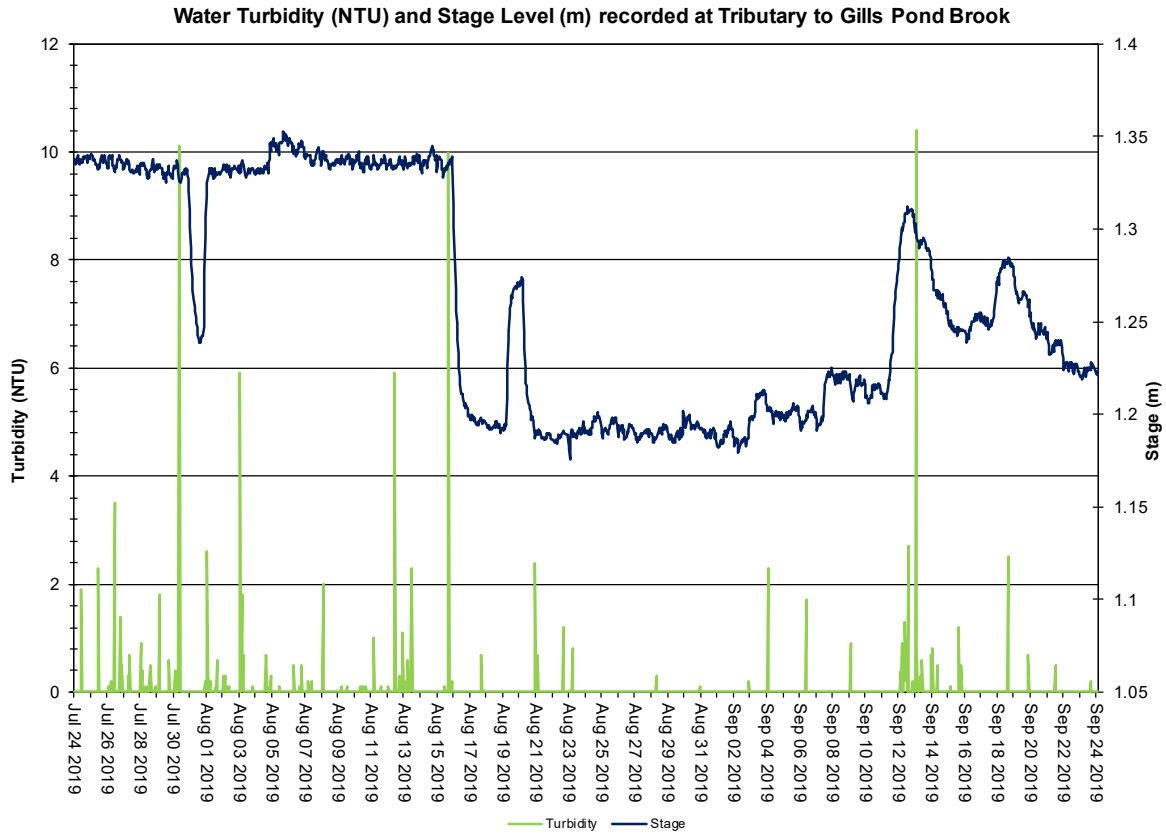


Figure 10. Turbidity (NTU) and Stage Level (m) at Tributary to Gills Pond Brook

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 July to September deployment. Water temperatures remained above 15˚C for most of the deployment until around September 7 - 8, 2019 when the water temperature dropped to lower than 15˚C.

The pH values across both stations remained consistent. Both stations had pH decreases after a stage increase on September 10, 2019. pH was representative at both sites during the July to September deployment.

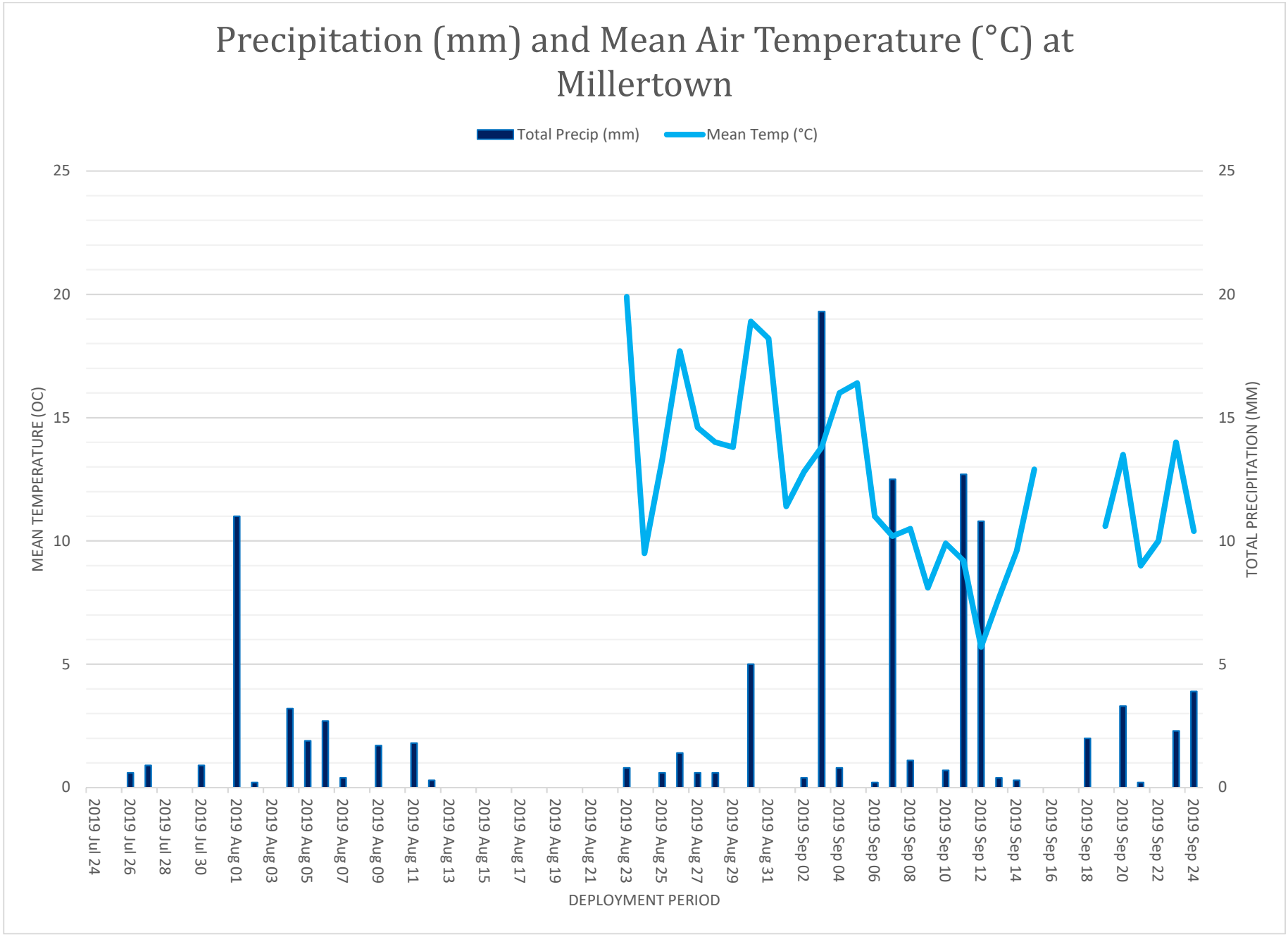
Conductivity levels respond to stage fluctuations by decreasing during high stage events and increasing during periods of low stage. Tributary to Gills Pond Brook had higher conductivity levels than East Pond brook during the deployment period. However, after a large stage increase on September 10, 2019, Tributary to Gills Pond Brook conductivity remained low for the reminder of the deployment. The same large stage increase was recorded at East Pond Brook below East Pond, however, conductivity remained stable before peaking on September 20, 2019.

The dissolved oxygen levels for both sites were representative of the climatic conditions during the July to September deployment. The dissolved oxygen concentration was consistent until September 7 or 8, 2019 when cooler water temperatures resulted in higher oxygen levels until the end of deployment.

Both sites had low turbidity from July to September. Changes in the stage level on September 12, 2019 influenced the turbidity data to increase. However, conditions returned to back ground levels shortly after.

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 Precip (mm)
Mean Temp (°C)
MEAN TEMPERATURE (OC)
TOTAL PRECIPITATION (MM)
DEPLOYMENT PERIOD
0
5
10
15
20
25
2019 Jul 24
2019 Jul 26
2019 Jul 28
2019 Jul 30
2019 Aug 01
2019 Aug 03
2019 Aug 05
2019 Aug 07
2019 Aug 09
2019 Aug 11
2019 Aug 13
2019 Aug 15
2019 Aug 17
2019 Aug 19
2019 Aug 21
2019 Aug 23
2019 Aug 25
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2019 Sep 24