



# Real-Time Water Quality 2021 Annual Report

## Voisey's Bay Network

May 30 to October 19, 2021



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

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## **Acknowledgements**

The Real-Time Water Quality Monitoring Network in Voisey's Bay is successful in tracking emerging water quality issues due to the hard work and diligence of certain individuals. The management and staff of Vale work in cooperation with the management and staff of the Department of Environment and Climate Change (ECC) Water Resources Management Division (WRMD), as well as Environment and Climate Change Canada (ECCC), to ensure the protection of ambient water resources in Voisey's Bay, Labrador.

Vale Environmental Coordinators are acknowledged for their hard work during the 2021 deployment period, and ensuring the Real-Time Water Quality Monitoring Network is operating to the standards set by ECC. It is only through their dedication to properly maintain and calibrate the equipment and perform acceptable quality control measures that the data can be viewed as reliable and accurate.

Various individuals from WRMD have been integral in ensuring the smooth operation of such a technologically advanced network. WRMD staff played a lead role in coordinating and liaising between the major agencies involved, thus, ensuring open communication lines at all times. In addition, WRMD is responsible for the data management/reporting, troubleshooting, along with ensuring the quality assurance/quality control measures are satisfactory. WRMD provides data to the general public on a near real-time basis through the departmental web page.

Environment and Climate Change Canada staff of the Meteorological Service of Canada: Water Survey Canada play an essential role in the data logging/communication aspect of the network. These individuals visit the site often to ensure the data logging equipment is operating properly and transmitting the data efficiently. Finally, they play the lead role in dealing with hydrological quantity and flow issues.

Staff with ECC, ECCC, and Vale are fully committed to improving this network and ensuring it provides meaningful and accurate water quality/quantity data that can be used in the decision-making process. This network is only successful due to the cooperation of all three agencies involved.

## **Abbreviations**

ECCC	Environment and Climate Change Canada
WSC	Water Survey of Canada
ECC	Department of Environment and Climate Change
DO	Dissolved Oxygen
NL	Newfoundland and Labrador
QA/QC	Quality Assurance and Quality Control
RTWQ	Real-time Water Quality
WRMD	Water Resources Management Division
%Sat	Percent Saturation
PTE	Performance Testing and Evaluation

## Introduction

The RTWQ network in Voisey's Bay was successfully established by ECC and ECCC in cooperation with Vale in 2003 and further expanded in 2006. The objective of the network is to identify and track emerging water quality or quantity management issues and ensure protection of ambient water resources in and around the Voisey's Bay operations.

The RTWQ network consists of four water quality monitoring stations: Reid Brook at Outlet of Reid Pond, Camp Pond Brook below Camp Pond, Tributary to Reid Brook, and Reid Brook below Tributary. These stations measure water quality parameters including water temperature, pH, specific conductivity, dissolved oxygen, and turbidity. Two additional parameters, total dissolved solids and percent saturation are calculated from measured parameters.

These stations also record continuous stage level and streamflow rate data. These parameters are the responsibility of ECCC; however, if needed, WRMD staff reporting on water quality will have access to water quantity information to understand and explain water quality fluctuations.

Four new Hydrolab Datasonde 5X instruments were purchased in the spring 2012 season for this network, as well as a new Hydrolab Minisonde 5 for QA/QC measurements and an Archer handheld display unit.

This annual deployment report illustrates, discusses and summarizes water quality related events from May 30 to October 19, 2021. During this time, four visits were made to each of the four RTWQ sites. Instruments were deployed for approximately month-long intervals referred to as deployment periods.

## Maintenance and Calibration

It is recommended that regular maintenance and calibration of the instruments take place on a monthly basis to ensure accurate data collection. This procedure is the responsibility of the Vale Environment staff and is performed approximately every 30 days.

Maintenance includes a thorough cleaning of the instrument and replacement of any small sensor parts that are damaged or unsuitable for reuse. Once the instrument is cleaned, Vale Environment staff members carefully calibrate each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity.

An extended deployment period (>30 days) can result in instrument sensor drift, which may result in skewed data. Instrument sensors will still work to capture any water quality event, although exact data values collected may be inaccurate. Installation and removal dates for each station in the 2021 deployment season are summarized in Table 1.

**Table 1: Installation and removal dates for 2021 deployment periods**

<b>Installation</b>	<b>Removal</b>	<b>Deployment</b>
May 30	July 10	42 days
July 11	August 14	35 days
August 16	September 11	27 days
September 13	October 19	37 days

## 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 Instrument is temporarily deployed adjacent to the Field Instrument. 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 Instrument and QA/QC Instrument at deployment and at removal, a qualitative statement is made on the data quality (Table 2).

**Table 2: Ranking classifications for deployment and removal**

Parameter	Rank				
	Excellent	Good	Fair	Marginal	Poor
Temperature (oC)	<=+/-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 instrument is the most important. All other parameters can be broken down into three groups: temperature dependent, temperature compensated and temperature independent. As the temperature sensor is not isolated from the rest of the instrument, the entire instrument 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 Voisey's Bay Network stations are summarized in Table 3. For additional information and explanations of rankings including "N/A" rankings, please refer to the monthly deployment reports.

**Table 3: Comparison Rankings for Voisey's Bay Network Stations for 2021 Deployment Season**

Station	Date	Action	Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Reid Brook at Outlet of Reid Pond	May 30, 2021	Deployment	Good	Good	Excellent	Excellent	Excellent
	July 10, 2021	Removal	Excellent	Fair	Excellent	Excellent	Excellent
	July 11, 2021	Deployment	Excellent	Excellent	Excellent	Good	Excellent
	August 14, 2021	Removal	Excellent	Fair	Excellent	Excellent	Excellent
	August 16, 2021	Deployment	Good	Fair	Excellent	Excellent	Excellent
	September 11, 2021	Removal	Excellent	Fair	Excellent	Excellent	Excellent
	September 13, 2021	Deployment	Excellent	Poor	Excellent	Good	Excellent
	October 19, 2021	Removal	Good	Fair	Excellent	Excellent	Excellent
Camp Pond Brook below Camp Pond	May 30, 2021	Deployment	Excellent	Good	Good	Excellent	Excellent
	July 10, 2021	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
	July 11, 2021	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	August 14, 2021	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
	August 16, 2021	Deployment	Excellent	Poor	Good	Excellent	Excellent
	September 11, 2021	Removal	Excellent	Fair	Good	Excellent	Excellent
	September 13, 2021	Deployment	Excellent	Marginal	Good	Excellent	Good
	October 19, 2021	Removal	Excellent	Good	Good	Excellent	Good
Reid Brook below Tributary	May 30, 2021	Deployment	Excellent	Good	Good	Poor	Excellent
	July 10, 2021	Removal	Excellent	Good	Excellent	Excellent	Excellent
	July 11, 2021	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	August 14, 2021	Removal	Excellent	Good	Excellent	Excellent	Excellent
	August 16, 2021	Deployment	Excellent	Poor	Poor	Excellent	Excellent
	September 11, 2021	Removal	Good	Marginal	Poor	Excellent	Excellent
	September 13, 2021	Deployment	Excellent	Fair	Poor	Excellent	Excellent
	October 19, 2021	Removal	Excellent	Fair	Good	Excellent	Excellent
Tributary to Reid Brook	May 30, 2021	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	July 10, 2021	Removal	Excellent	Good	Excellent	Good	Poor
	July 11, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	August 14, 2021	Removal	Excellent	Good	Excellent	Excellent	Excellent
	August 16, 2021	Deployment	Excellent	Excellent	Fair	Excellent	Excellent
	September 11, 2021	Removal	Excellent	Good	Good	Excellent	Good
	September 13, 2021	Deployment	Excellent	Marginal	Excellent	Good	Excellent
	October 19, 2021	Removal	Excellent	Fair	Excellent	Excellent	Excellent

## **Data Interpretation**

The following graphs and discussions illustrate significant water quality-related events from May 30 through October 19, 2021 in the Voisey's Bay RTWQ Network.

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. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

Initial deployment for 2021 was on-track compared to the previous 2020 season, which was delayed due to the COVID-19 pandemic which resulted in restrictions to travel and shipping delays. The success of this year was the result of improvements in the state and appropriate mitigation of the pandemic.

During the first deployment period, turbidity readings at Tributary to Reid Brook were at 3000 NTU for most of the duration of the deployment. Similarly to last year, this is the result of calibration error of the field sonde, meaning the data is inaccurate.

All instruments were sent to the St. John's WRMD laboratory at the end of the season for yearly PTE. Any necessary repairs and replacement sensors will be addressed before the 2022 season.

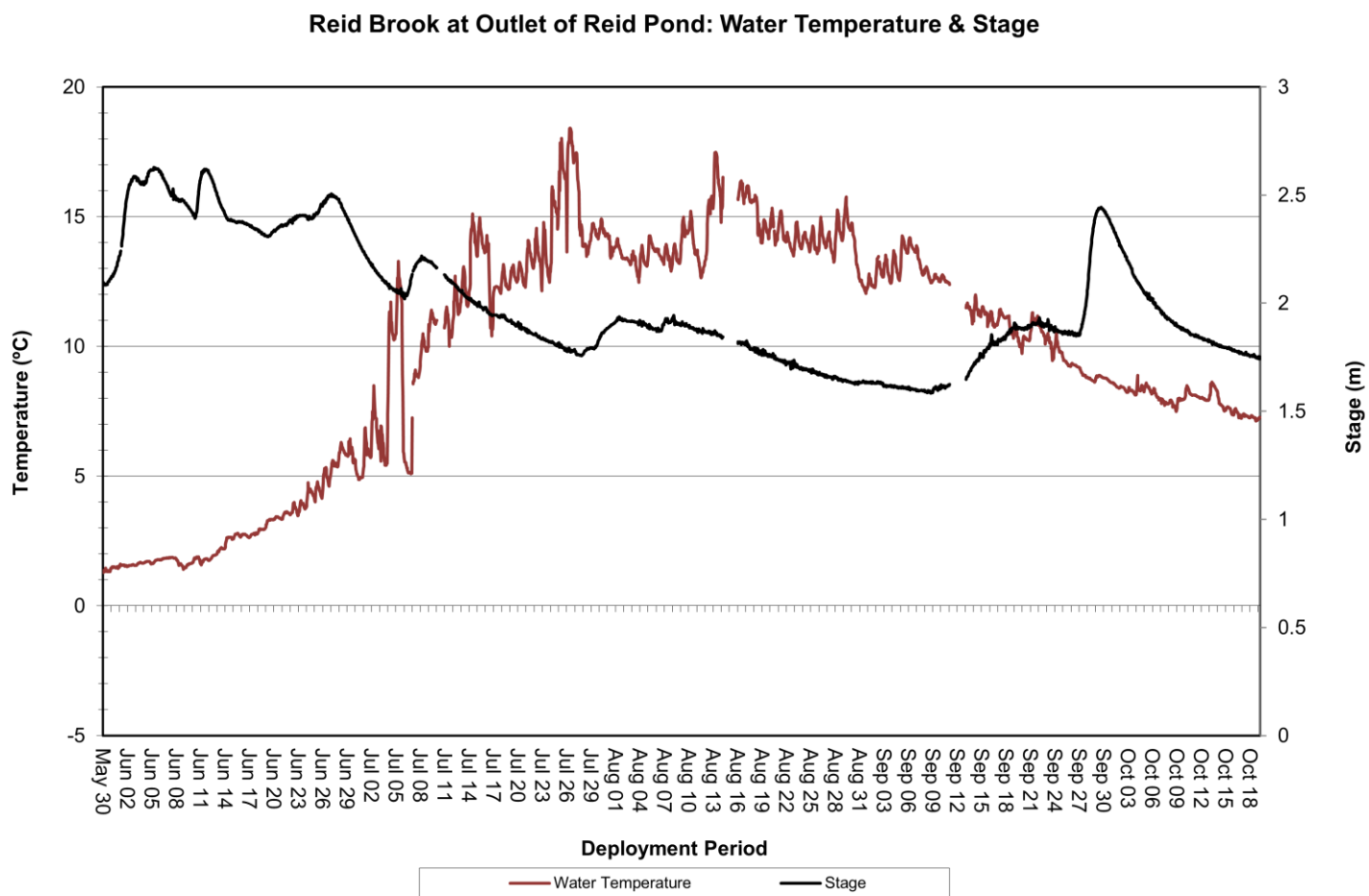


### Reid Brook at Outlet of Reid Pond

During the 2021 deployment season, water temperature ranged from 1.29°C to a maximum of 18.42°C (Figure 1), with a median value of 10.65°C. Water temperature values for 2021 were similar to data from the 2020 and 2019 deployment seasons (Table 4).

Temperatures steadily increased from the start of June at initial deployment through mid-August, after which they started to decrease again through September and October (Figure 1).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.



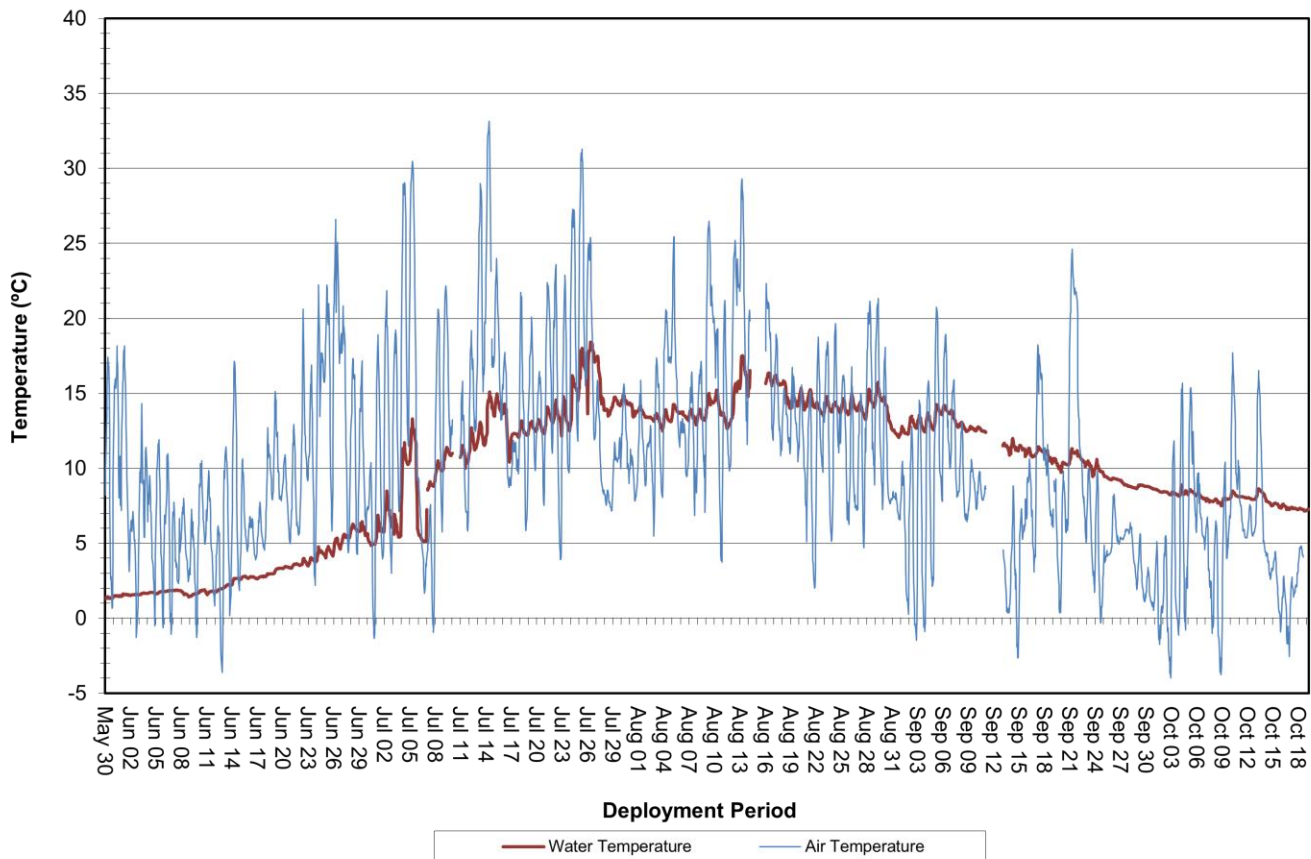
**Figure 1: Water Temperature & Stage at Reid Brook at Outlet of Reid Pond**

**Table 4: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Water Temperature	2021	2020	2019
Min	1.29	4.17	2.49
Max	18.42	20.62	13.99
Median	10.65	10.93	8.90

Water temperatures maintains a close relationship with air temperature (Figure 2). Increases and decreases in air temperatures throughout 2021 were associated with similar changes in water temperature. Air temperatures fluctuate to a greater extent each day when compared to water temperatures. This location is also less susceptible to extreme temperature fluctuations as Reid Pond is a larger body of water. Air temperature data was obtained from the Voisey's Bay Weather Station located at the airstrip.

**Reid Brook at Outlet of Reid Pond: Water & Air Temperature**



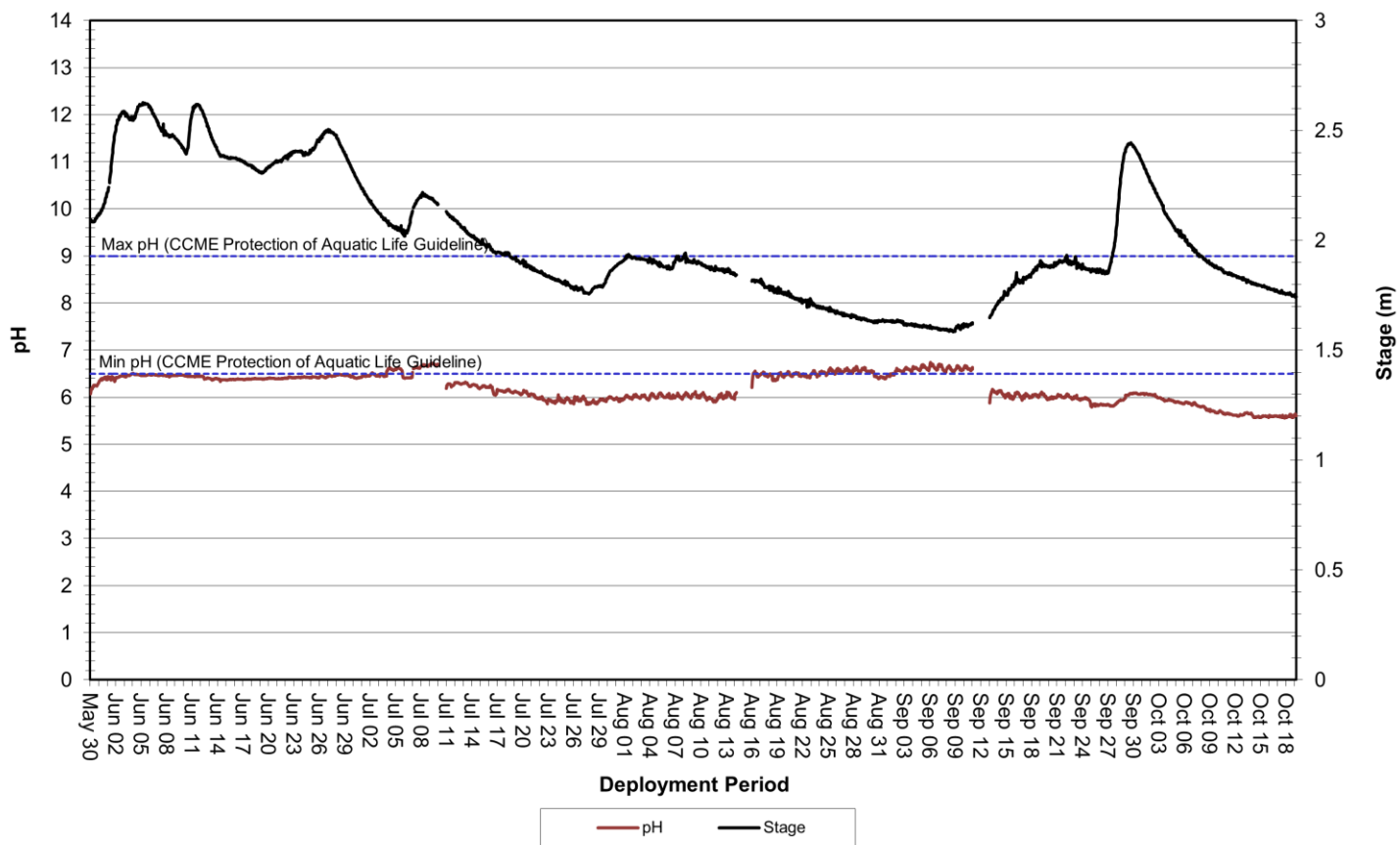
**Figure 2: Water Temperature & Air Temperature at Reid Brook at Outlet of Reid Pond**

During the 2021 deployment season, pH ranged from 5.56 pH units to a maximum of 6.74 pH units (Table 5), with a median value of 6.26 pH units. This station is at the outlet of a pond and so pH data has a wider range compared to that of a stream or brook. In a pond environment, water parameters take longer to change after an influence; ponds have a larger volume of water and in turn have a slower turnover rate compared to streams or brooks.

Figure 3 displays the relationship between pH and stage; generally when stage increases, pH decreases slightly. pH was below the CCME's Guidelines for the Protection of Aquatic Life for the majority of the deployment season, except for during the second deployment period from mid-August to early September.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Reid Brook at Outlet of Reid Pond: pH & Stage**



**Figure 3: pH & Stage at Reid Brook at Outlet of Reid Pond**

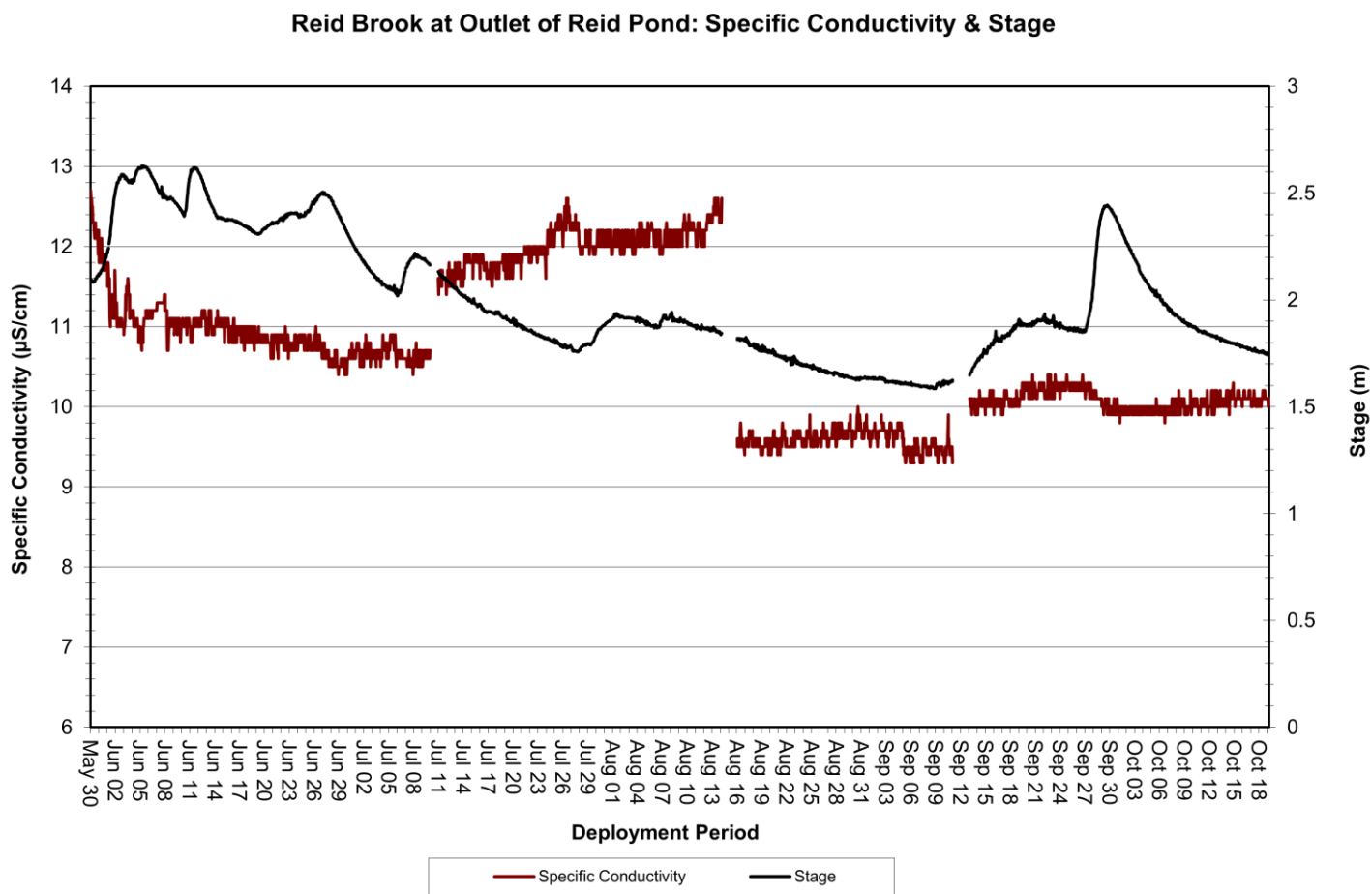
**Table 5: Comparisons of Minimum, Maximum and Median from the past three deployment years**

pH	2021	2020	2019
Min	5.56	4.59	5.21
Max	6.74	8.91	10.05
Median	6.26	6.06	6.86

During the 2021 deployment season, specific conductivity values ranged from 9.3µS/cm to a maximum of 12.70µS/cm. An overall conductivity median of 10.6µS/cm indicates that this station naturally has very low conductivity, and was similar to previous deployment seasons (Table 6).

Specific conductivity was low and stable throughout the majority of the deployment season with only minimal fluctuations (Figure 4). This trend is to be expected at this station, since it is located at the outflow of the stable environment of Reid Pond.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.



**Figure 4: Specific Conductivity & Stage at Reid Brook at Outlet of Reid Pond**

**Table 6: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Specific Conductivity	2021	2020	2019
Min	9.3	9.1	8.5
Max	12.7	29.7	13.8
Median	10.6	12.1	11.6

During the 2021 deployment season, dissolved oxygen concentrations ranged from 9.66mg/L to a maximum of 14.48mg/L, with a median value of 11.18mg/L. Saturation of dissolved oxygen ranged from 89.8% to 112.3%, with a median value of 98.8% (Table 7).

Dissolved oxygen concentrations displayed typical seasonal fluctuations throughout the deployment season, and exhibited an inverse relationship with water temperature (Figure 5). Dissolved oxygen values were high at the beginning of deployment when water temperatures were low. Dissolved oxygen values decreased steadily until August, after which they were consistent throughout that month and then began to increase again through the remainder of deployment as water temperatures decreased into the fall season.

Dissolved oxygen values remained above the CCME's Minimum Guideline for the Protection of Other Life Stages (6.5mg/L) and Early Life Stages (9.5mg/L) for the duration of the deployment season.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

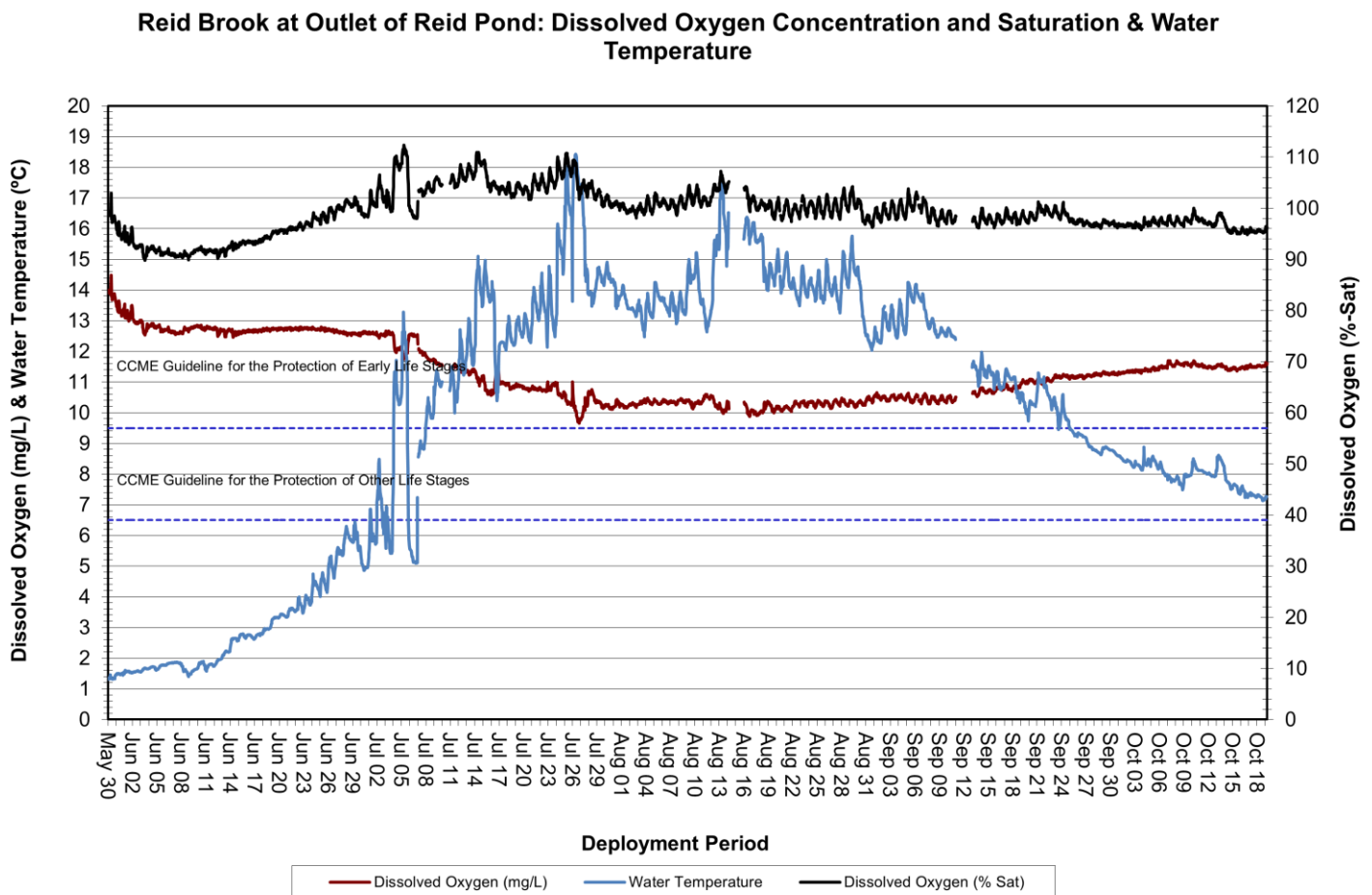


Figure 5: Dissolved Oxygen Concentration and Saturation & Water Temperature at Reid Brook at Outlet of Reid Pond

Table 7: Comparisons of Minimum, Maximum and Median from the past three deployment years

Dissolved Oxygen (mg/L)	2021	2020	2019
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<b>Min</b>	9.66	9.36	10.37
<b>Max</b>	14.48	12.81	12.52
<b>Median</b>	11.18	11.04	11.00

<b>Percent Saturation (%)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	89.8	83.6	90.3
<b>Max</b>	112.3	110.6	106.7
<b>Median</b>	98.8	98.6	97.0

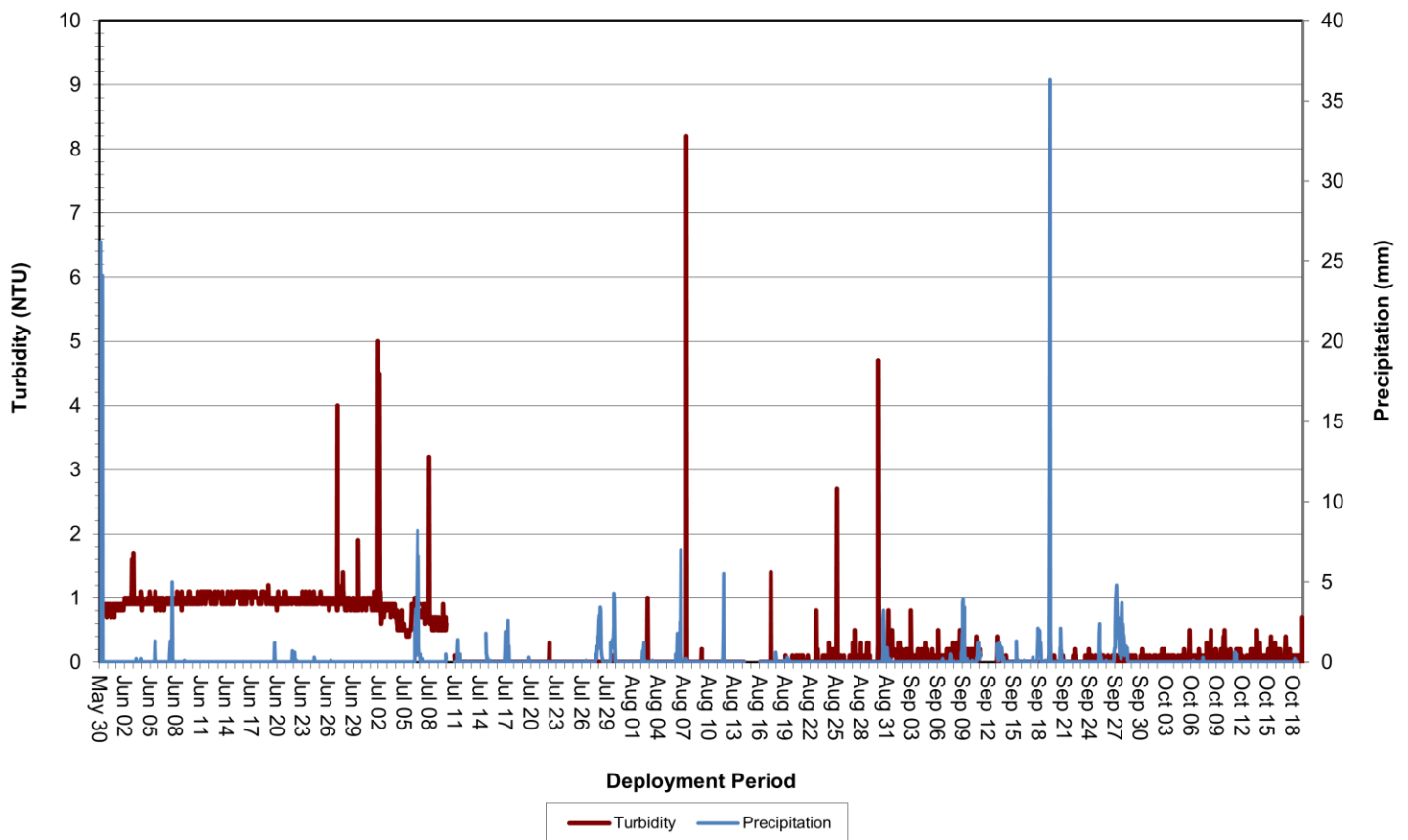
During the 2021 deployment season, turbidity values ranged from 0.0NTU to a maximum of 8.2NTU. A median value of 0.0NTU indicates that there is very little background turbidity at this station (Table 8).

There were only a few turbidity events at this station over the course of deployment (Figure 6). This is to be expected, as this site is pristine in nature and far removed from the Voisey's Bay mine site.

Turbidity levels can be influenced by precipitation and subsequent runoff. It is common to see levels increase during these events and it is important that the turbidity levels return to natural levels after such events.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Reid Brook at Outlet of Reid Pond: Turbidity & Precipitation**



**Figure 6: Turbidity & Stage at Reid Brook at Outlet of Reid Pond**

**Table 8: Comparisons of Minimum, Maximum and Median from the past three deployment years**

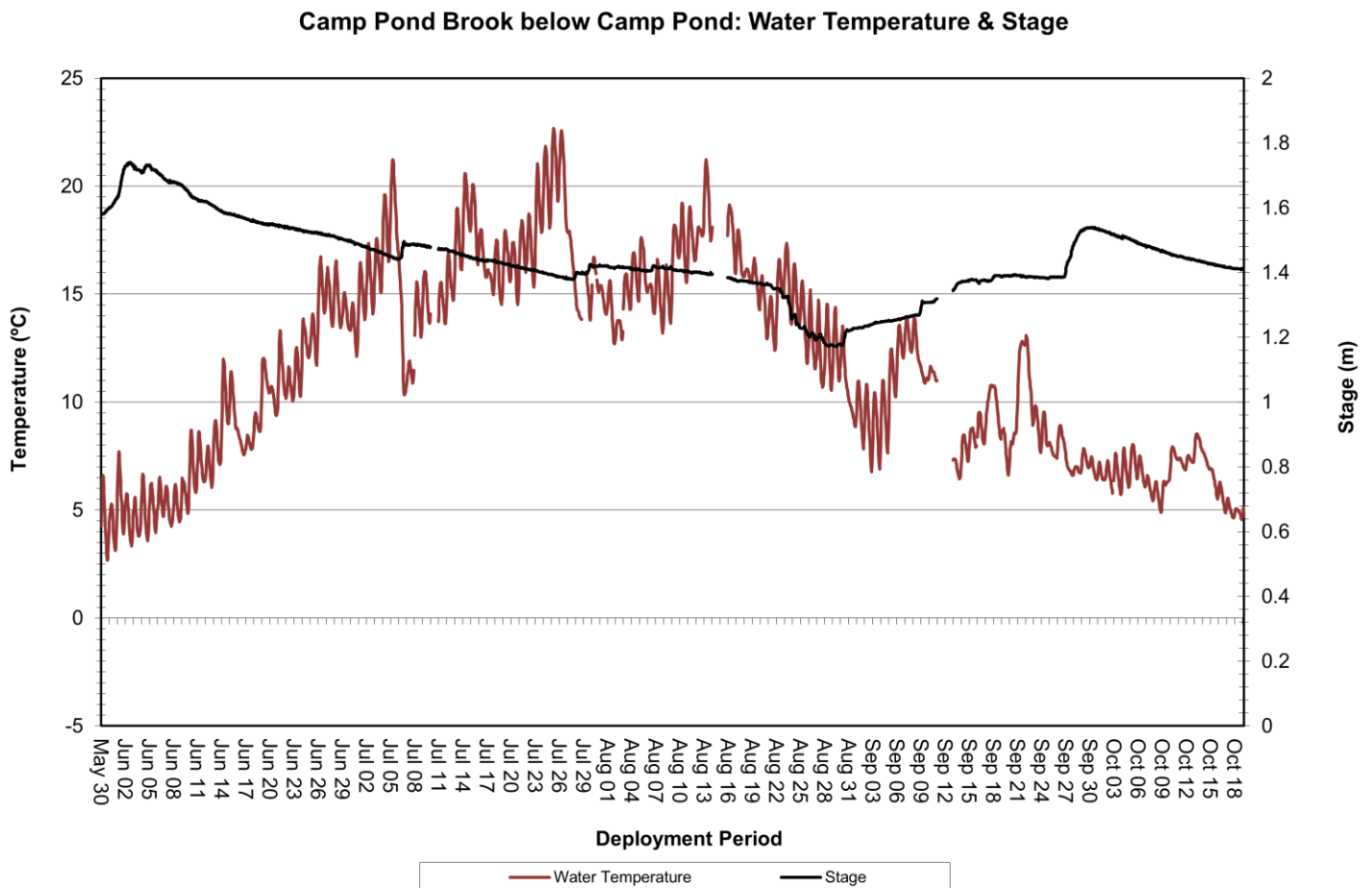
Turbidity	2021	2020	2019
Min	0.0	0.0	0.0
Max	8.2	774.0	484.0
Median	0.0	0.0	0.0

## Camp Pond Brook below Camp Pond

During the 2021 deployment season, water temperature ranged from 2.66°C to a maximum of 22.68°C. The median temperature of 11.59°C was slightly lower than the median from 2020, and more similar to that of the 2019 deployment seasons (Table 9).

Water temperature was highest during late July (Figure 7). Water temperatures started to noticeably decrease from mid-August onwards as ambient air temperatures also decreased (Figure 8).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.



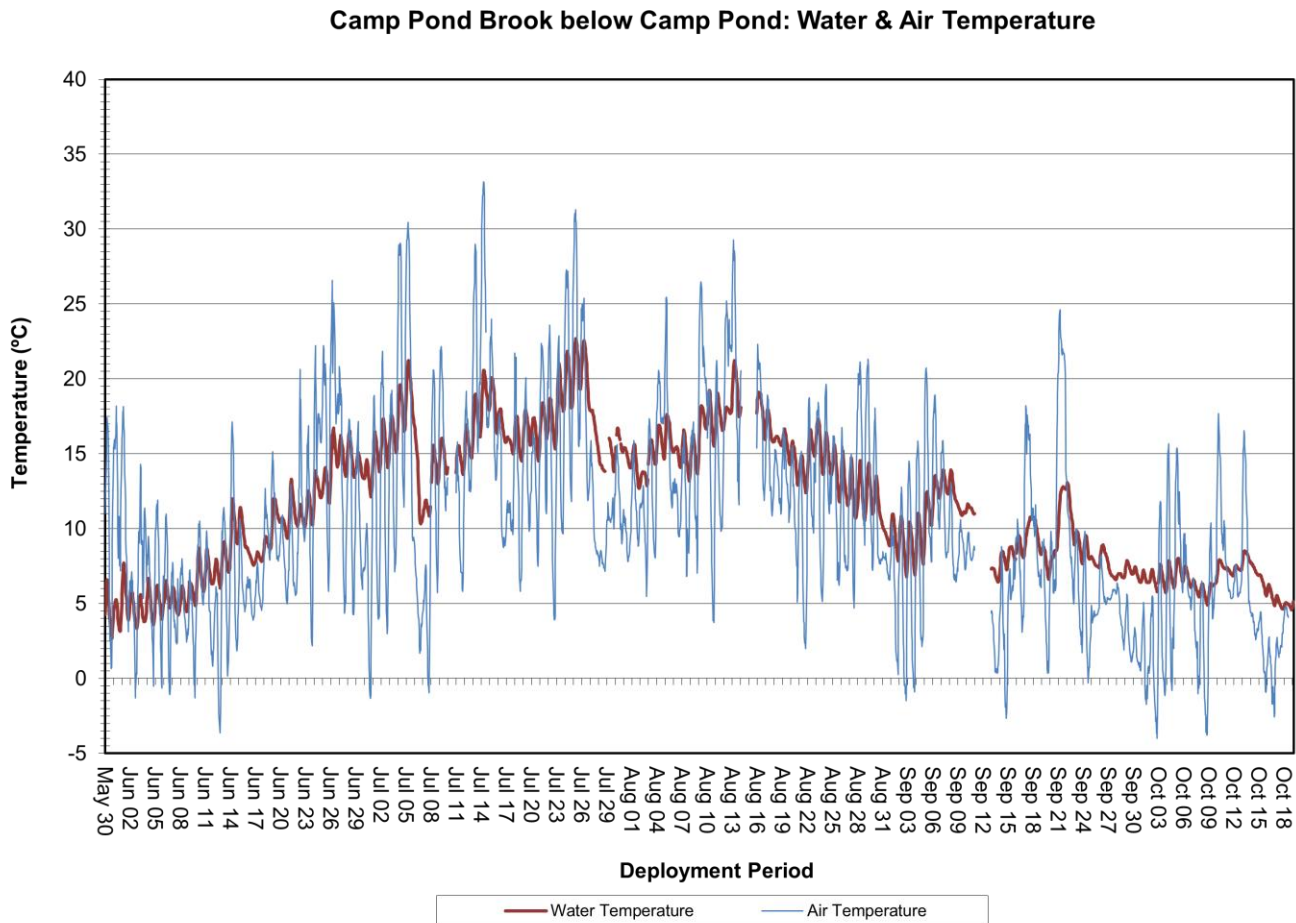
**Figure 7: Water Temperature & Stage at Camp Pond Brook below Camp Pond**

**Table 9: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Water Temperature	2021	2020	2019
Min	2.66	0.16	2.99
Max	22.68	23.45	18.76
Median	11.59	13.00	11.22



Water temperature values showed a close relationship with ambient air temperatures (Figure 8); increases and decreases in air temperatures were reflected in similar changes in water temperatures. Air temperatures fluctuate to a greater extent than water temperatures. Air temperature data was obtained from the Voisey's Bay Weather Station located at the airstrip.



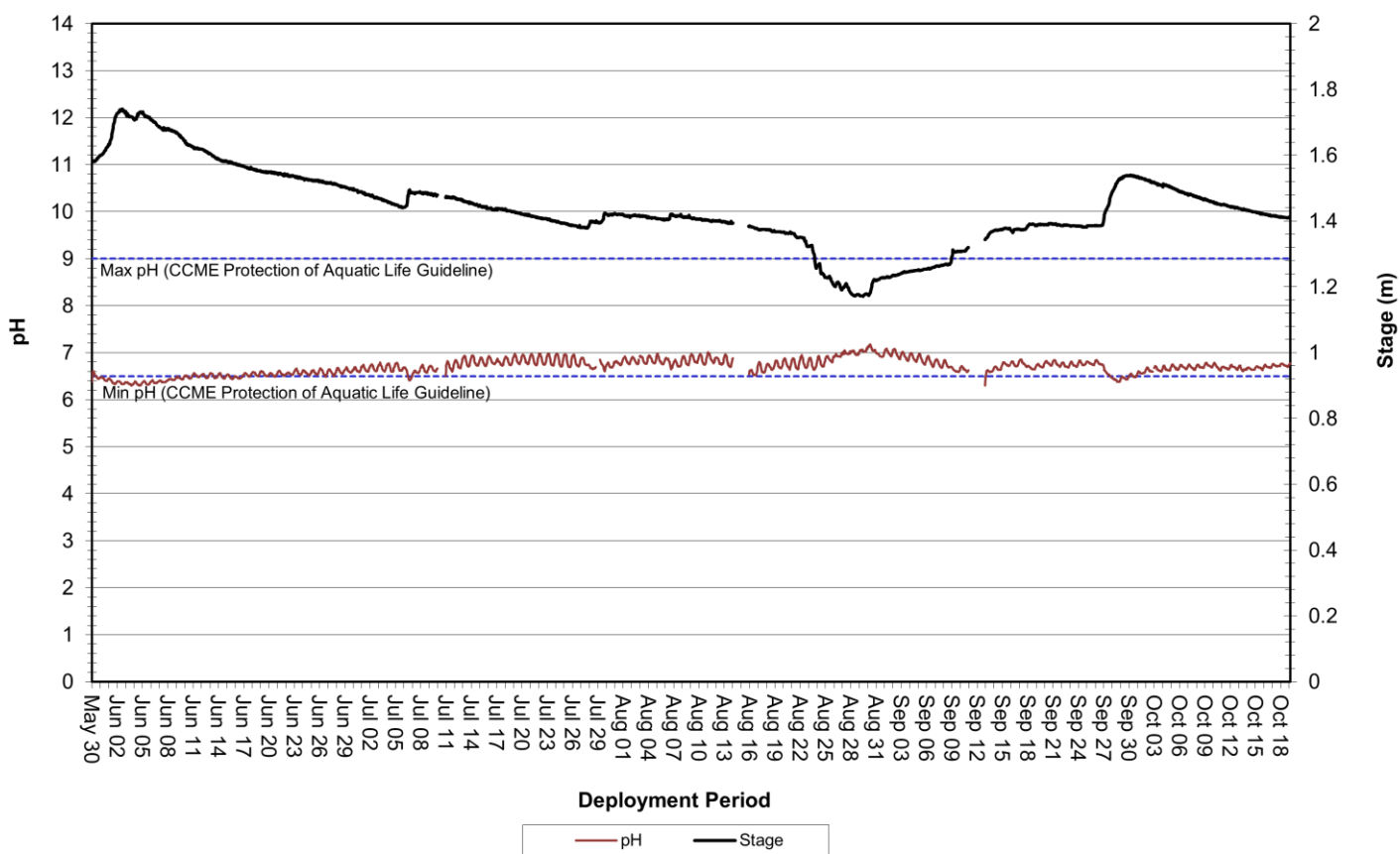
**Figure 8: Water Temperature & Air Temperature at Camp Pond Brook below Camp Pond**

During the 2021 deployment season, pH ranged from 6.30 pH units to a maximum of 7.18 pH units. The median value of 6.70 was similar to those from both 2020 (6.62) and 2019 (6.58) (Table 10).

Stage is included in the graph below to show the relationship between water level and pH values. Across the deployment season, pH data was reasonably stable. pH values were within the CCME's Guidelines for the Protection of Aquatic Life for the majority of the deployment season. Instances where pH values fell below the CCME's Minimum Guideline were often associated with increases in stage (Figure 9).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Camp Pond Brook below Camp Pond: pH & Stage**



**Figure 9: pH & Stage at Camp Pond Brook below Camp Pond**

**Table 10: Comparisons of Minimum, Maximum and Median from the past three deployment years**

pH	2021	2020	2019
Min	6.30	6.35	5.70
Max	7.18	7.11	7.07
Median	6.70	6.62	6.58

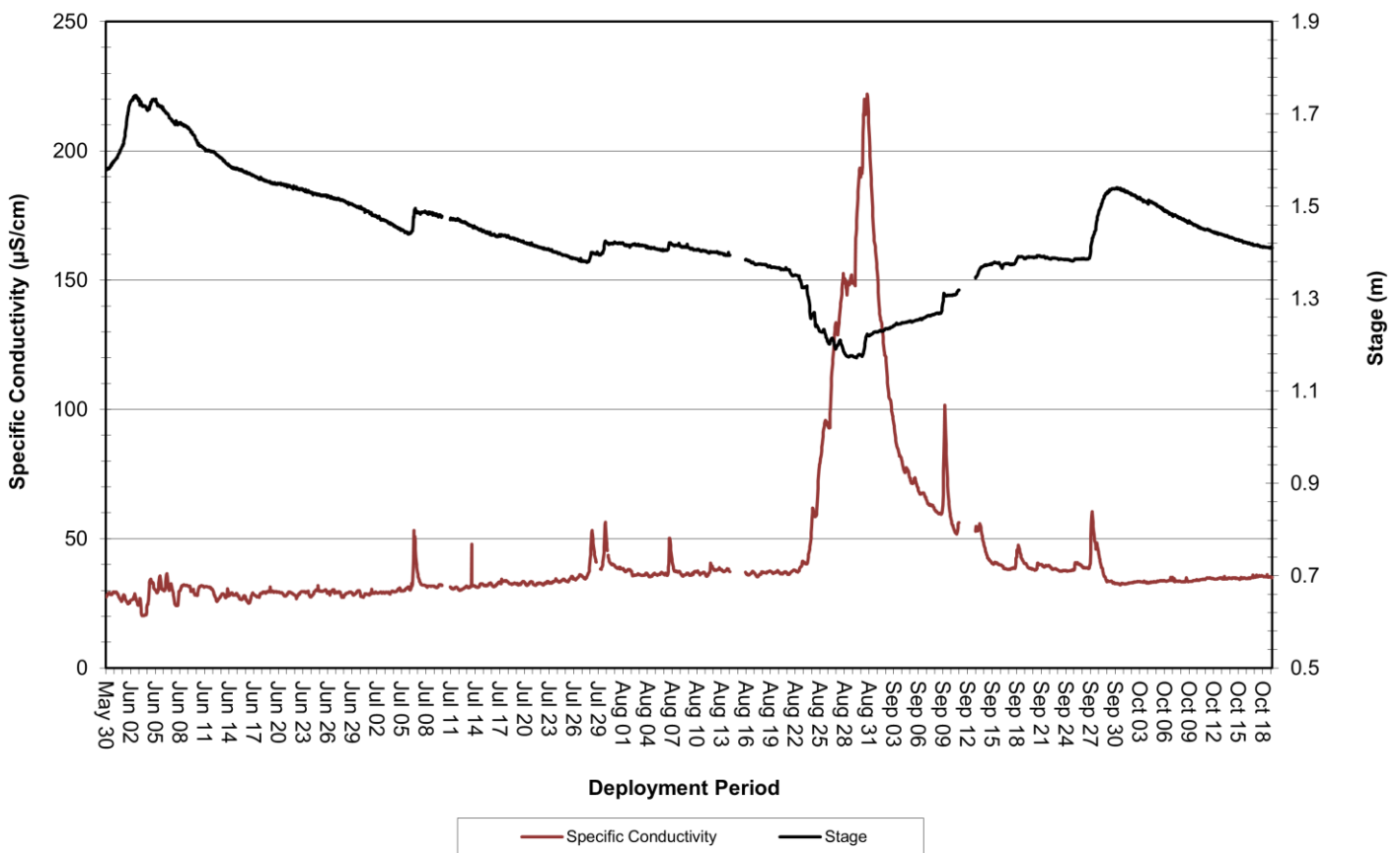
During the 2021 deployment season, specific conductivity ranged from 20.2µS/cm to a maximum of 222.0µS/cm (Figure 10). The median value of 34.5µS/cm was very similar to those from 2020 (36.6µS/cm) and 2019 (34.8µS/cm) (Table 11).

Stage is included in the graph below to illustrate the relationship between conductivity and water level (Figure 10). In general, stage and conductivity exhibit an inverse relationship: when one parameter increases, the other decreases. In some instances, however, sharp increases in stage correlate with similar increases in conductivity, which is likely due to increased rainfall and runoff. This site is in close proximity to the mine site and so is heavily influenced by runoff factors that the other Voisey's Bay real-time stations do not experience.

Over the deployment season, conductivity levels in Camp Pond Brook increased steadily and then stabilized, while stage generally decreased. This relationship is to be expected as rainfall events, and subsequent bank runoff, generally decrease as the winter season approaches.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Camp Pond Brook below Camp Pond: Specific Conductivity & Stage**



**Figure 10: Specific Conductivity & Stage at Camp Pond Brook below Camp Pond**

**Table 11: Comparisons of Minimum, Maximum and Median from the past three deployment years**

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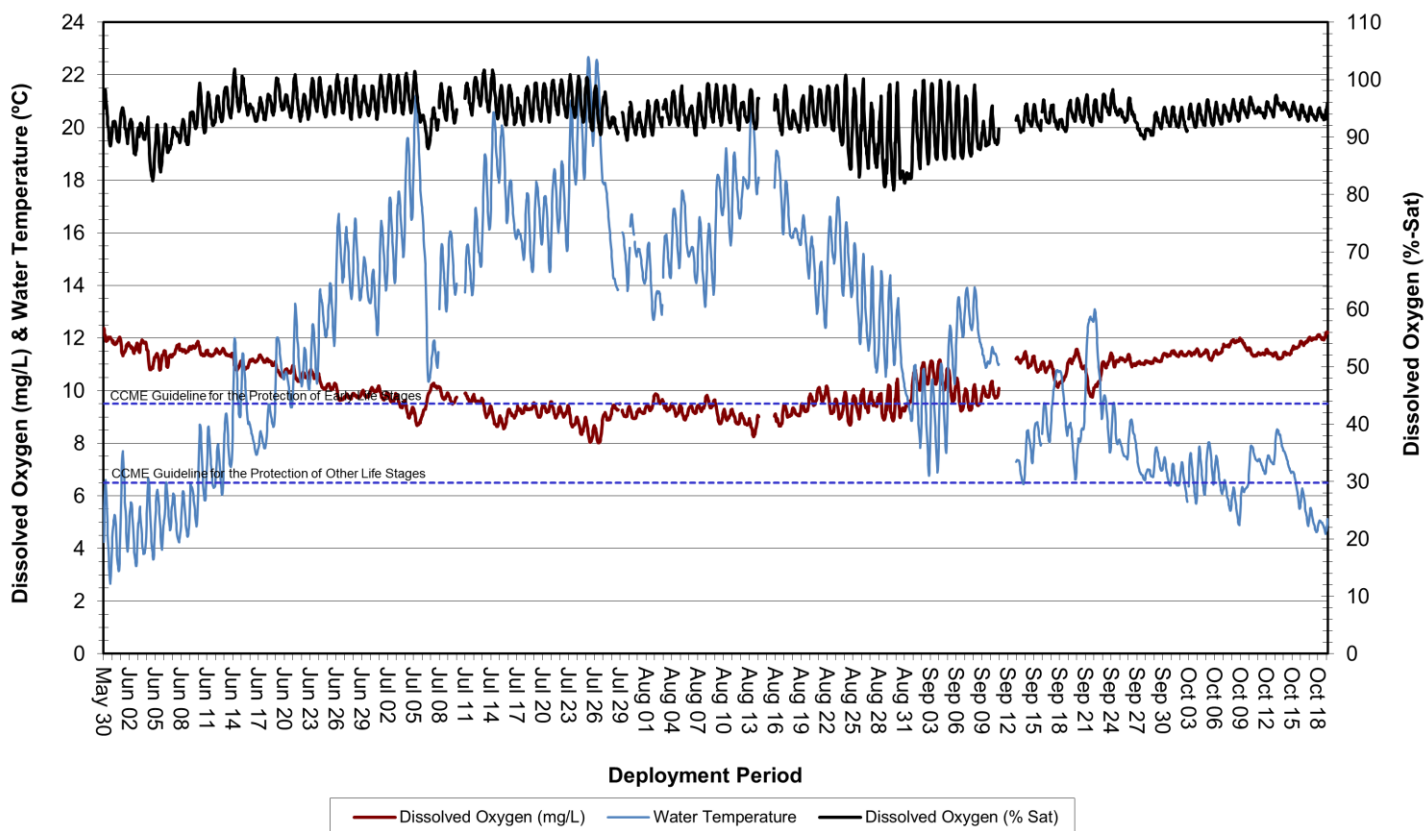
<b>Specific Conductivity</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	20.2	26.4	25.6
<b>Max</b>	222.0	76.5	49.7
<b>Median</b>	34.5	36.6	34.8

During the 2021 deployment season, dissolved oxygen concentrations ranged from 8.01mg/L to a maximum of 12.37mg/L, with a median value of 10.11mg/L that was close to the 2020 median of 10.04mg/L. Saturation of dissolved oxygen ranged from 80.8% to 101.8%, with a median value of 94.1% (Table 12).

Dissolved oxygen concentrations exhibited typical seasonal trends, and were inversely related to water temperature. Dissolved oxygen concentrations were lowest throughout July and mid-August when water temperatures were warmest. As water temperatures decreased into late summer and fall, dissolved oxygen concentrations began to increase. Frequent fluctuations in dissolved oxygen levels are consistent with smaller daily changes in water temperature (Figure 11).

Dissolved oxygen concentrations dipped below the CCME's Guideline for the Protection of Early Life Stages (9.5mg/L) through late June until mid-August. These dips are to be expected as they correspond closely with increased water temperatures during the same time frames. Dissolved oxygen concentrations remained above the CCME's Guideline for the Protection of Other Life Stages (6.5mg/L) for the duration of the deployment season.

**Camp Pond Brook below Camp Pond: Dissolved Oxygen (Concentration & Saturation) & Water Temperature**



**Figure 11: Dissolved Oxygen Concentration and Saturation & Water Temperature at Camp Pond Brook below Camp Pond**

**Table 12: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Voisey's Bay Network, Newfoundland and Labrador

<b>Dissolved Oxygen (mg/L)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	8.01	7.90	9.00
<b>Max</b>	12.37	13.58	12.42
<b>Median</b>	10.11	10.04	10.46

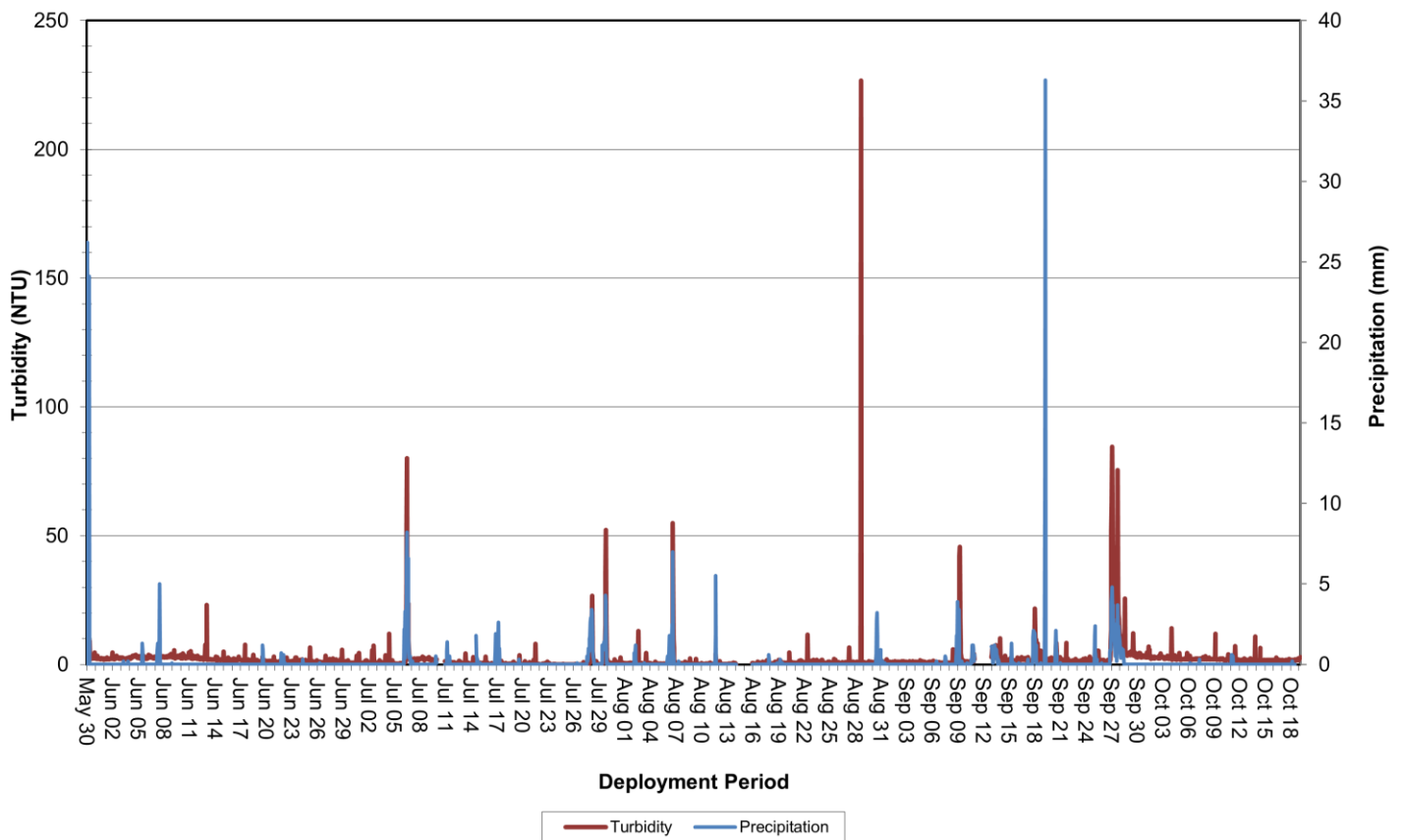
<b>Percent Saturation (%)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	80.8	87.5	90.3
<b>Max</b>	101.8	103.1	104.4
<b>Median</b>	94.1	94.8	96.2

During the 2021 deployment season, turbidity values ranged from 0.0NTU to a maximum of 226.6NTU, with a median value of 1.2NTU (Figure 12). A median value of 1.2NTU indicates that there is a small amount of natural background turbidity at this station. The median turbidity value for 2021 was between those from the 2020 (0.8 NTU) and 2019 (4.7 NTU) deployment seasons (Table 13).

There were a number of turbidity spikes throughout the deployment season, the majority of which corresponded with precipitation events and subsequent increases in stage.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Camp Pond Brook below Camp Pond: Turbidity & Precipitation**



**Figure 12: Turbidity & Stage at Camp Pond Brook below Camp Pond**

**Table 13: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Turbidity	2021	2020	2019
Min	0.0	0.0	0.0
Max	226.6	314.7	46.5
Median	1.2	0.8	4.7

## Reid Brook below Tributary

During the 2021 deployment season, water temperature ranged from 1.44°C to a maximum of 19.01°C, with a median value of 9.67°C (Table 14). Water temperatures were highest through late July to mid-August as air temperatures increased with the summer season. From late August onwards, water temperatures steadily declined as ambient air temperatures also declined (Figure 13 & 14).

Water temperatures have been very consistent at this station over recent years (Table 14).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

Reid Brook below Tributary: Water Temperature & Stage

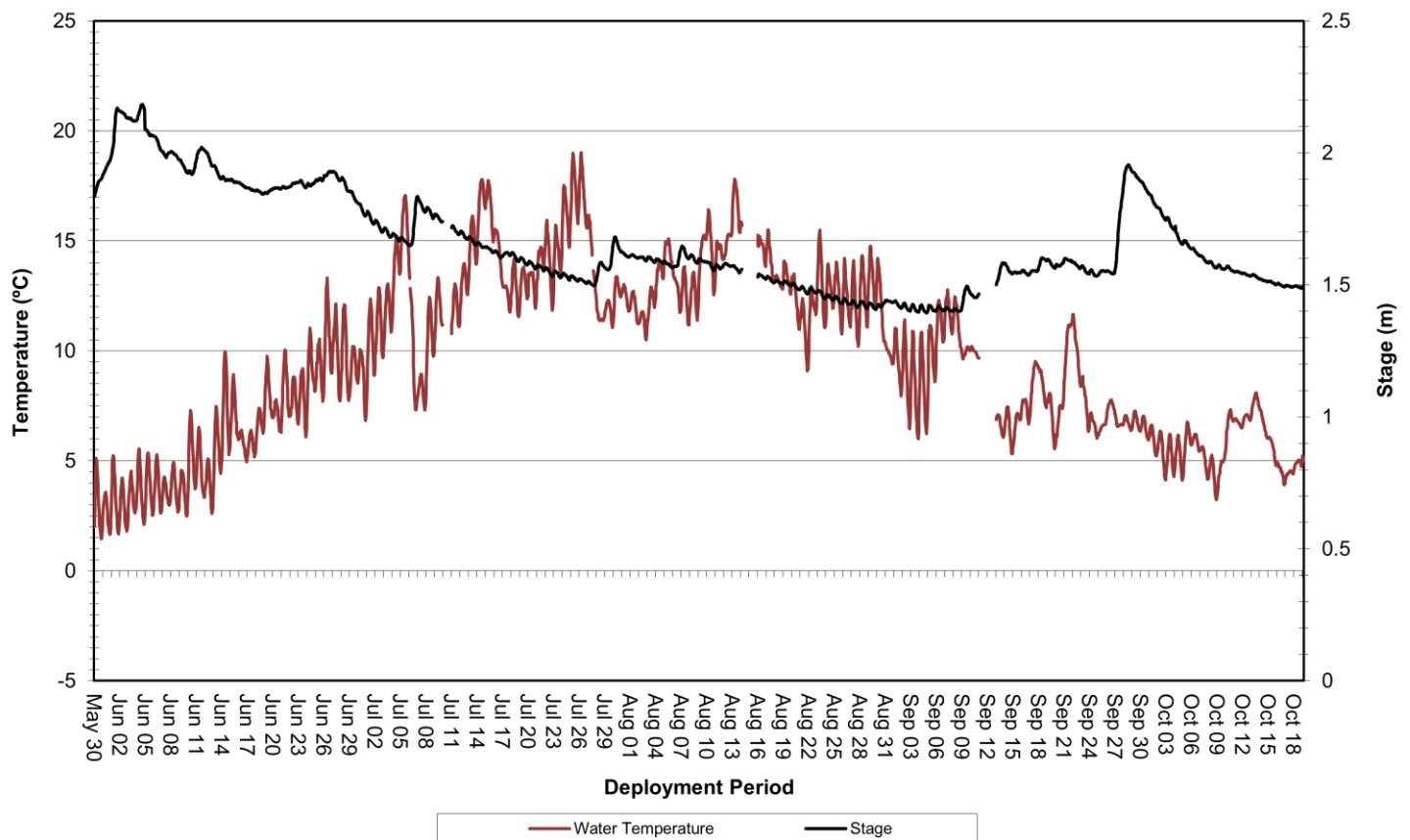


Figure 13: Water Temperature & Stage at Reid Brook below Tributary

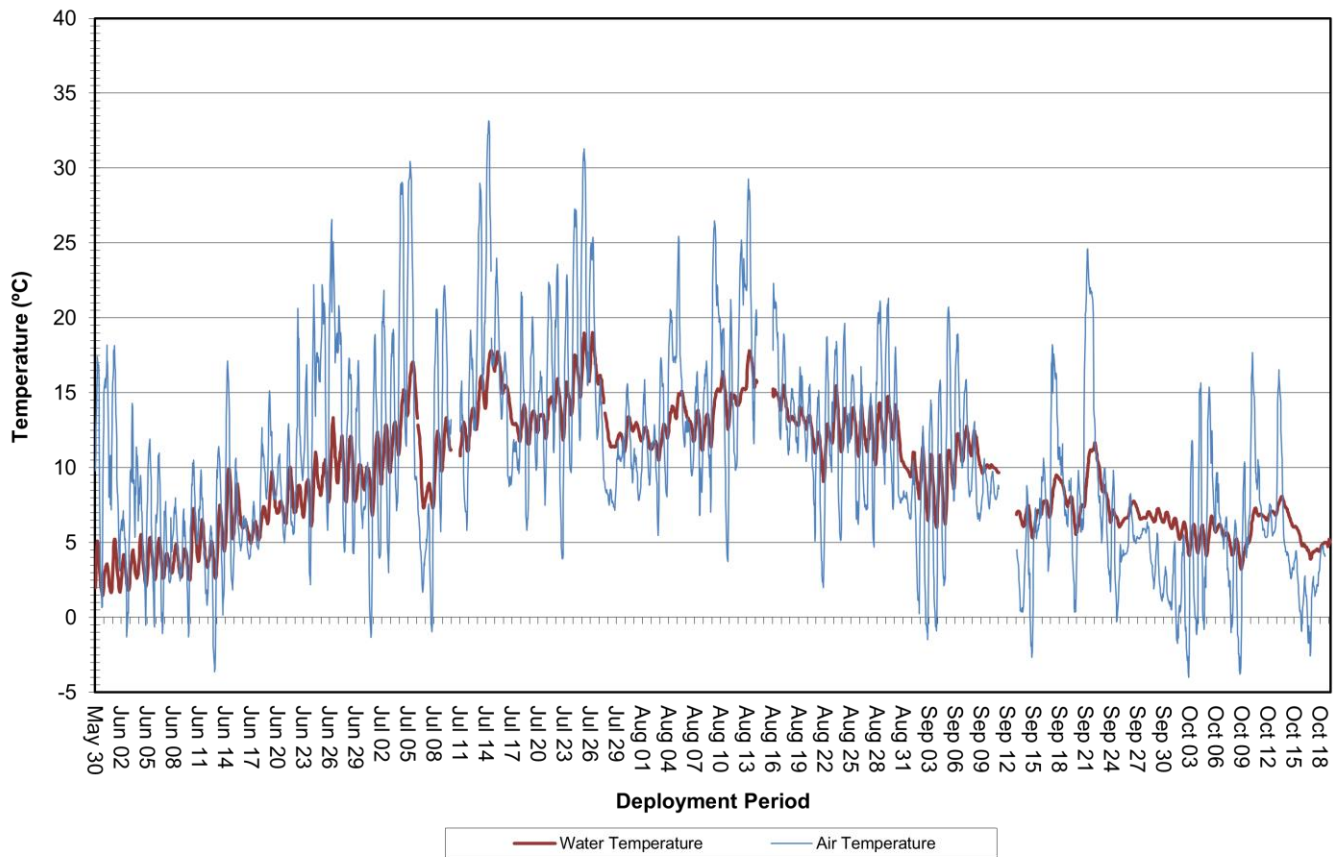
Table 14: Comparisons of Minimum, Maximum and Median from the past three deployment years

Water Temperature	2021	2020	2019
Min	1.44	0.2	3.4
Max	19.01	20.1	15.2
Median	9.67	10.7	9.2



Water temperatures closely correlates with ambient air temperatures, with increases and decreases in ambient air temperatures being reflected in water temperatures (Figure 14). Air temperatures fluctuate to a greater extent each day as compared to water temperatures. Air temperature data was obtained from the Voisey's Bay Weather Station located at the Air Strip.

**Reid Brook below Tributary: Water & Air Temperature**



**Figure 14: Water Temperature & Air Temperature at Reid Brook below Tributary**

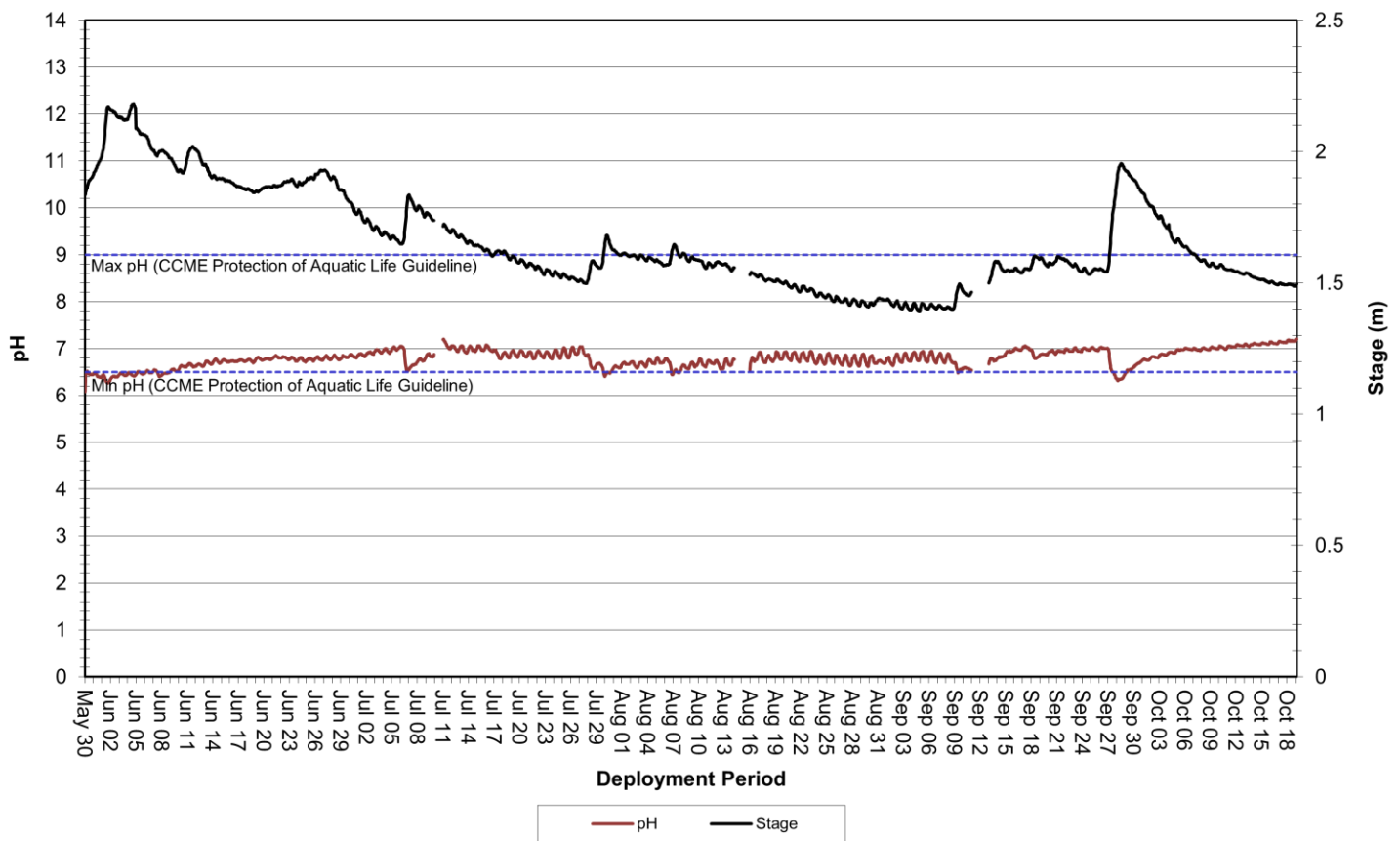
During the 2021 deployment season, pH ranged from 6.08 pH units to a maximum of 7.2 pH units, with a median value of 6.8 (Figure 15). pH data at this station has been consistent over recent years with median values of 6.86 in 2020 and 6.72 in 2019 (Table 15).

Stage data is included in Figure 15 to show how stage influences pH over time. In general, as stage decreases, pH increases and vice versa. This is a natural relationship and is expected in brooks.

pH values at this site were within the CCME's Guidelines for the Protection of Aquatic Life for the majority of the deployment season. Instances where pH values fell below the CCME's Minimum Guideline often correlated closely with increases in stage.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Reid Brook below Tributary: pH & Stage**



**Figure 15: pH & Stage at Reid Brook below Tributary**

**Table 15: Comparisons of Minimum, Maximum and Median from the past three deployment years**

pH	2021	2020	2019
Min	6.08	5.97	5.97
Max	7.20	7.52	7.71
Median	6.80	6.86	6.72

During the 2021 deployment season, specific conductivity levels ranged from 12.8µS/cm to a maximum of 40.2µS/cm, with a median value of 27.9µS/cm (Table 16). This median value is considerably lower than the 2020 reading of 34.1µS/cm and similar to the 2019 reading of 30.7µS/cm. A calibration error was suspected to be the reason for the high median of 2020.

Specific conductivity changes with water level fluctuations: as stage increases, specific conductivity decreases. This is due to dilution of dissolved solids in the water column; as stage decreases, the concentration of dissolved solids increases, in turn increasing specific conductivity. This relationship is evident in the graph below.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Reid Brook below Tributary: Specific Conductivity & Stage**



**Figure 16: Specific Conductivity & Stage at Reid Brook below Tributary**

**Table 16: Comparisons of Minimum, Maximum and Median from the past three deployment years**

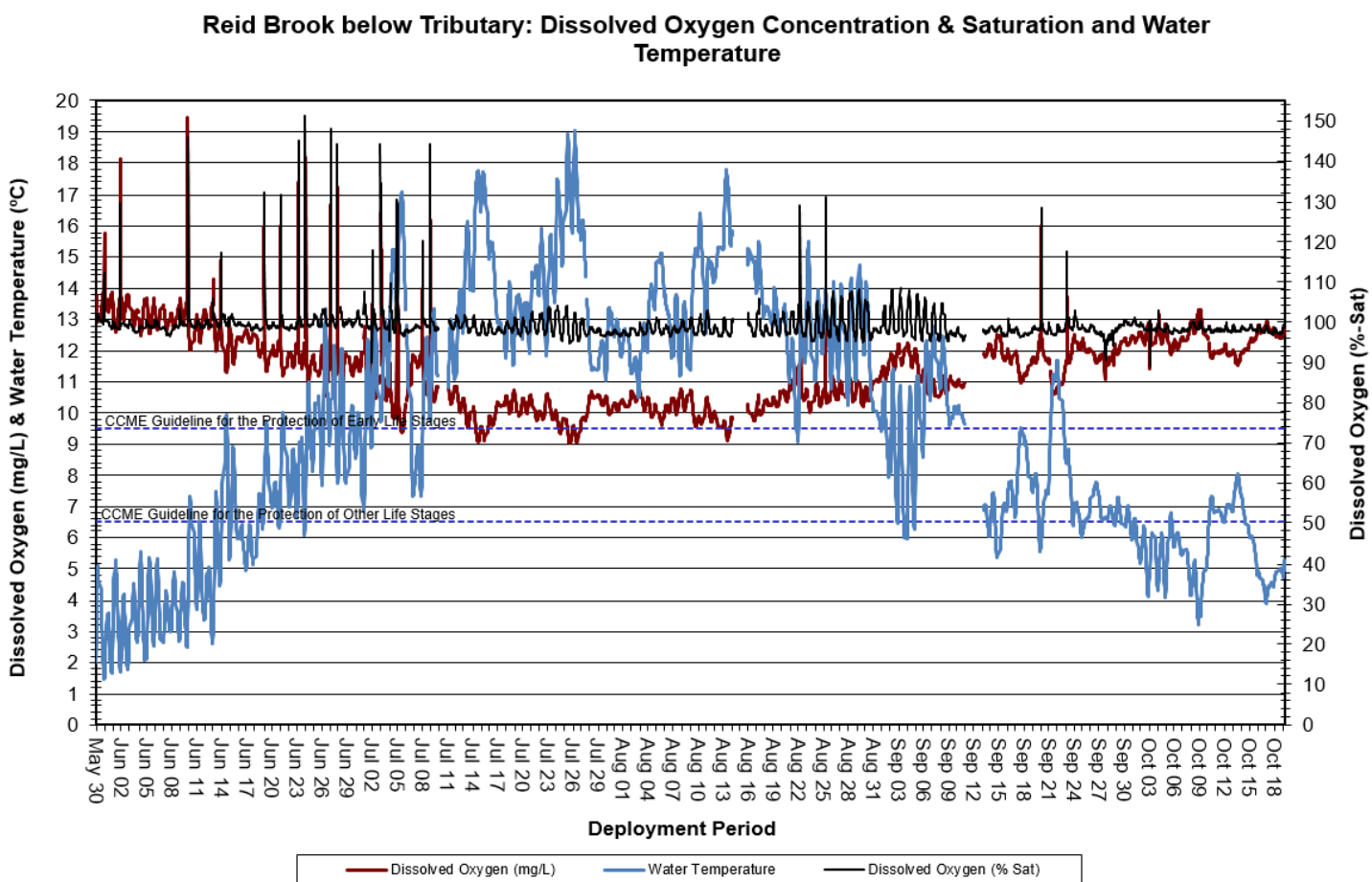
Specific Conductivity	2021	2020	2019
Min	12.8	16.3	20.0
Max	40.2	247	42.3
Median	27.9	34.1*	30.7

\*median higher than expected due to suspected calibration error

During the 2021 deployment season, dissolved oxygen concentrations ranged from 9.05mg/L to a maximum of 19.48mg/L, with a median value of 11.36mg/L. The saturation of dissolved oxygen ranged from 89.2% to 151.2%, with a median value of 98.7% (Figure 17). Dissolved oxygen values have been quite consistent at this site over recent years (Table 17).

Dissolved oxygen concentrations were lowest through mid-July when water temperatures were highest. Increases in water temperature result in less dissolved oxygen being present in a water body. As water temperatures started to decrease from late August onwards, dissolved oxygen concentrations started to increase.

Dissolved oxygen concentrations remained above the CCME's Guidelines for the Protection of Early Life Stages (9.5mg/L) and Other Life Stages (6.5mg/L) for the majority of the deployment season. Instances where dissolved oxygen levels fell below the CCME's Guideline for the Protection of Early Life Stages correlated closely with periods of warmer water temperatures.



**Figure 17: Dissolved Oxygen Concentration and Saturation & Water Temperature at Reid Brook below Tributary**

**Table 17: Comparisons of Minimum, Maximum and Median from the past three deployment years**

<b>Dissolved Oxygen (mg/L)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	9.05	8.79	9.58
<b>Max</b>	19.48	14.67	12.68
<b>Median</b>	11.36	10.71	11.05

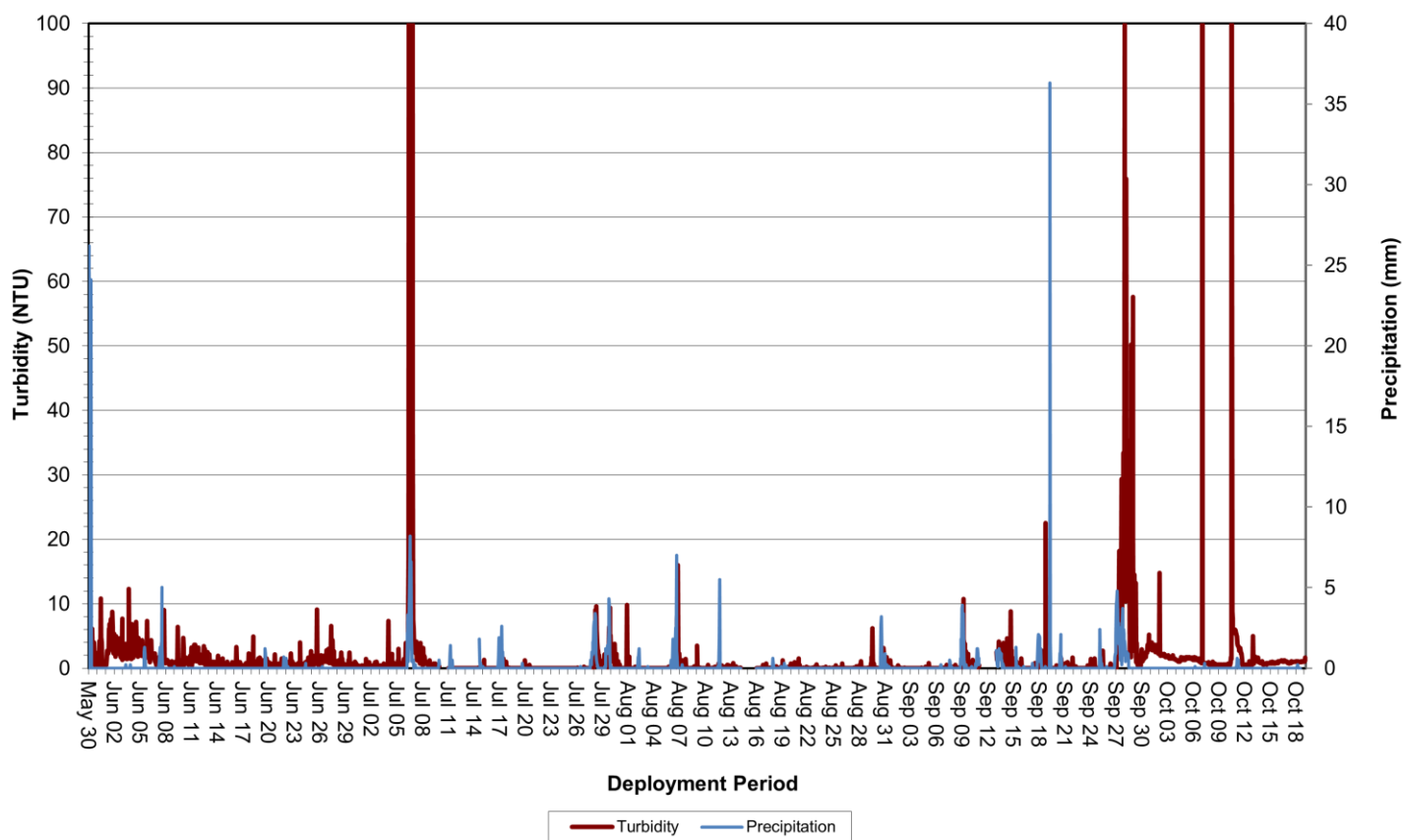
<b>Percent Saturation (%)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	89.2	91.9	91.7
<b>Max</b>	151.2	144.2	102.3
<b>Median</b>	98.7	96.1	97.0

During the 2021 deployment season, turbidity ranged from 0.0NTU to a maximum of 2272NTU, with a median value of 0.2NTU (Figure 18). A median value of 0.0NTU indicates that there is a very low level of natural background turbidity at this station, and is consistent with past deployment seasons (Table 18).

Many of the turbidity increases at this site corresponded with rainfall events and subsequent runoff. Observed turbidity events were generally low in magnitude and short in duration. It is not uncommon to see turbidity fluctuate in a brook relating to environmental factors, such as changes in stage level and precipitation.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Reid Brook below Tributary: Turbidity & Precipitation**



**Figure 18: Turbidity, Precipitation & Stage at Reid Brook below Tributary**

**Table 18: Comparisons of Minimum, Maximum and Median from the past three deployment years**

<b>Turbidity</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	0.0	0.0	0.0
<b>Max</b>	2272	41.7	1053
<b>Median</b>	0.2	0.0	0.0

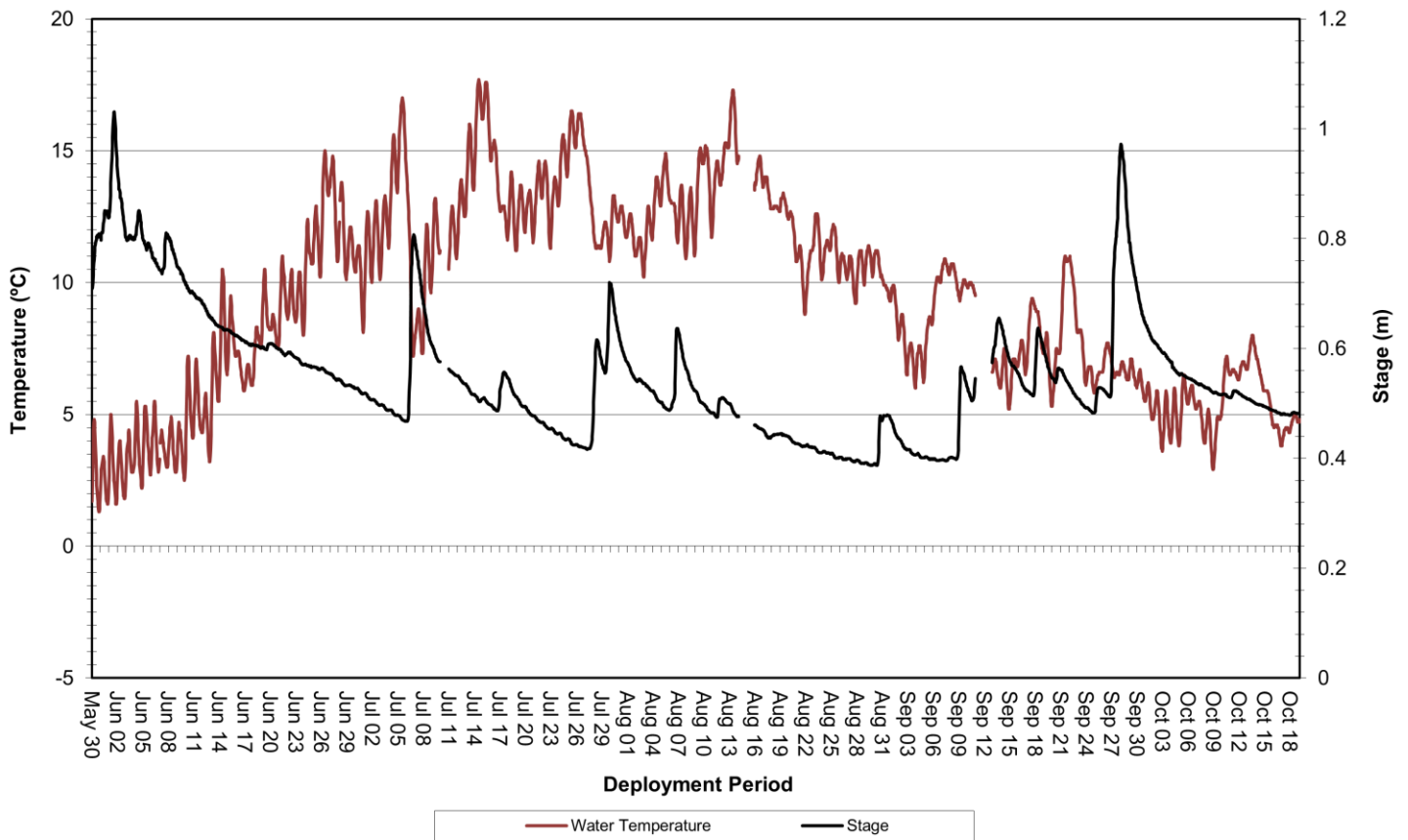
## Tributary to Reid Brook

During the 2021 deployment season, water temperature ranged from 1.3°C to a maximum of 17.7°C, with a median value of 9.9°C (Figure 19). Water temperature at this site has been quite consistent over recent years, with median values of 10.6°C in 2020 and 9.20°C in 2019 (Table 19).

Water temperatures were highest through mid-July and mid-August as air temperatures increased with the summer season (Figure 19 & 20). From the end of August onwards, water temperatures steadily declined as ambient air temperatures also declined (Figure 20).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Tributary to Reid Brook: Water Temperature & Stage**

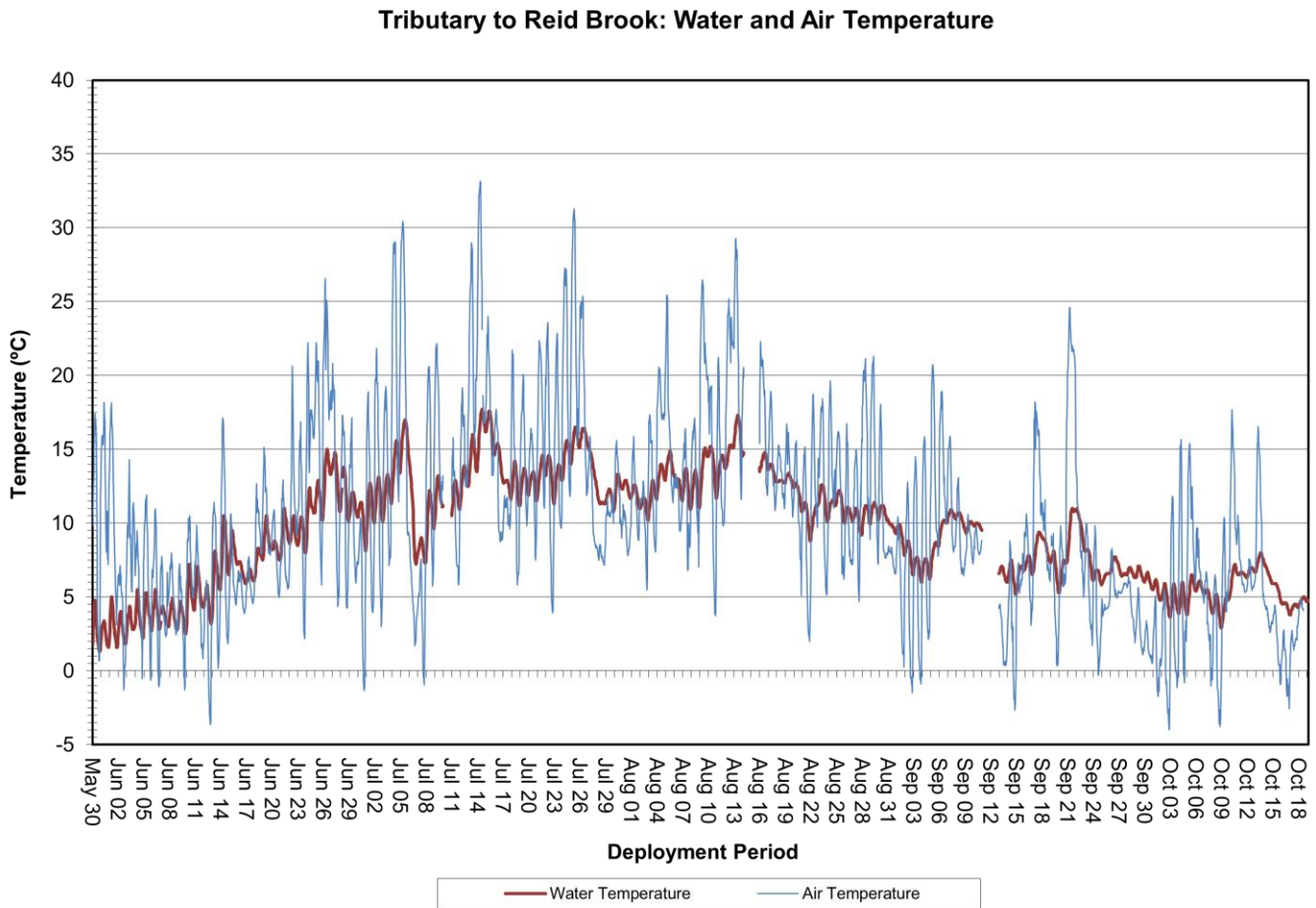


**Figure 19: Water Temperature & Stage at Tributary to Reid Brook**

**Table 19: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Water Temperature	2021	2020	2019
Min	1.3	0.2	3.30
Max	17.7	17.4	15.10
Median	9.9	10.6	9.20

Water temperatures showed a close relationship with air temperatures (Figure 20). Fluctuations in air temperatures were reflected in water temperatures. Air temperatures fluctuate to a greater extent each day when compared with water temperatures.



**Figure 20: Water Temperature & Air Temperature at Tributary to Reid Brook**



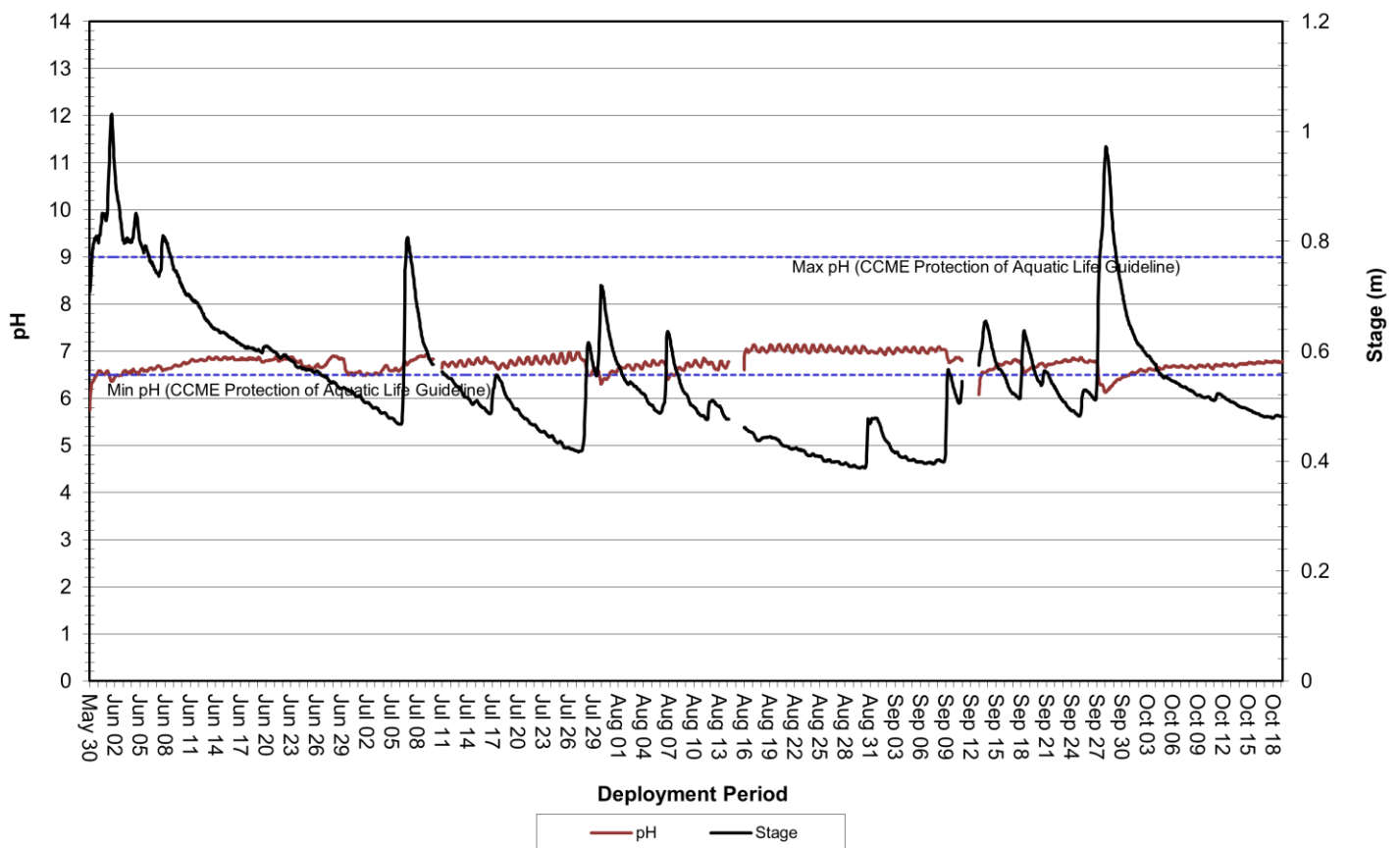
During the 2021 deployment season, pH data ranged from 5.75 to a maximum of 7.15 pH units, with a median value of 6.75 pH units (Table 20).

Stage data is included in Figure 21 to show how stage influences pH over time. In general, as stage decreases pH increases, and vice versa. Sharp increases in stage correlate closely with sharp decreases in pH.

pH values remained within the CCME's Guidelines for the Protection of Aquatic Life for the majority of the deployment season. Instances where pH values temporarily fell below the CCME's Minimum Guideline correlate closely with sharp increases in stage (Figure 21).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Tributary to Reid Brook: pH & Stage**



**Figure 21: pH & Stage at Tributary to Reid Brook**

**Table 20: Comparisons of Minimum, Maximum and Median from the past three deployment years**

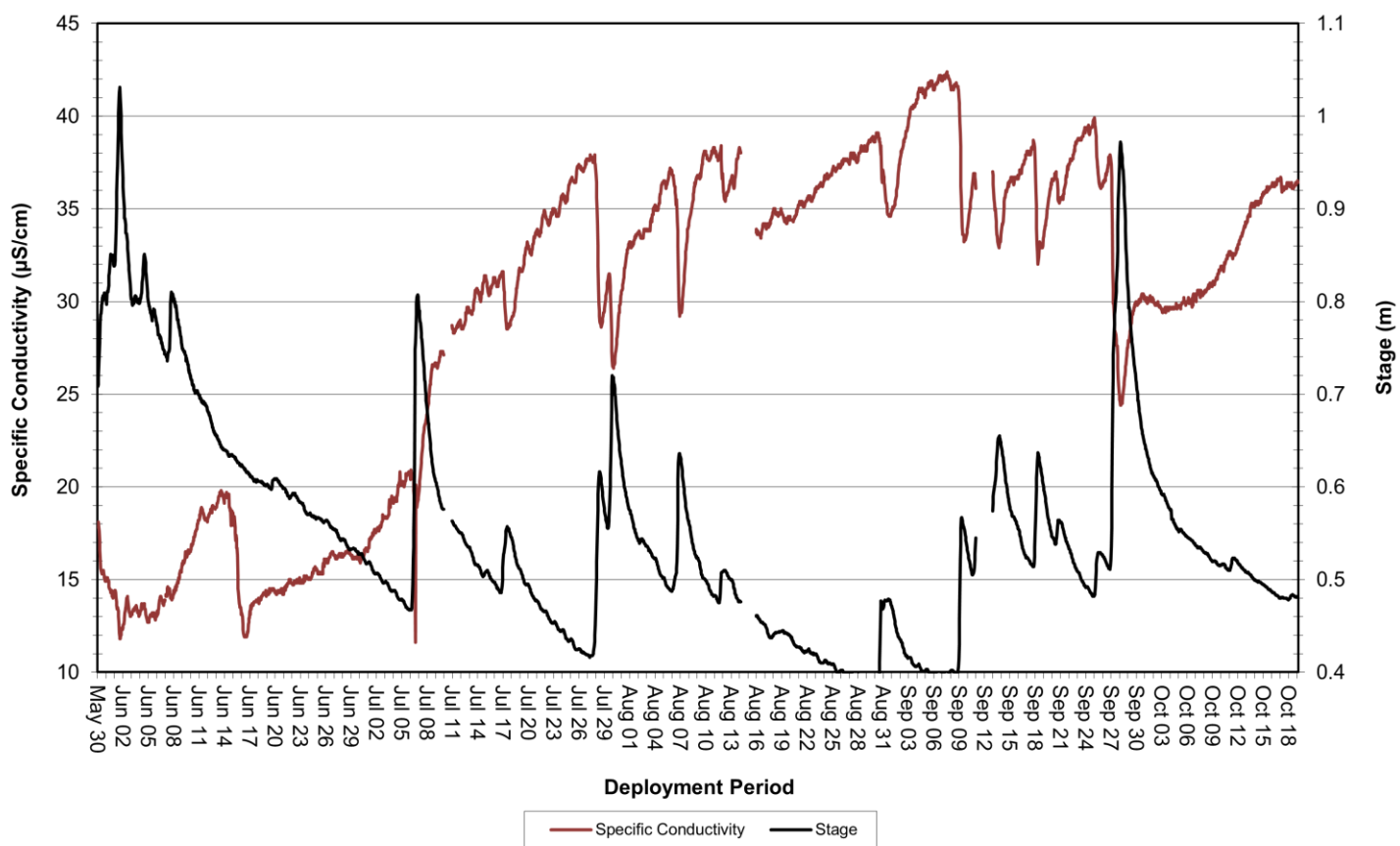
pH	2021	2020	2019
Min	5.75	5.95	6.05
Max	7.15	7.19	7.11
Median	6.75	6.80	6.74

During the 2021 deployment season, specific conductivity ranged from 11.6µS/cm to a maximum of 42.4µS/cm, with a median value of 32.6µS/cm (Table 21).

Specific conductivity demonstrated a continuously increasing trend over the course of deployment, exhibiting a strong inverse relationship with stage. Increases in stage level dilute dissolved solids in the water column, in turn reducing specific conductivity. Inversely, as stage decreases specific conductivity increases as dissolved solids become more concentrated in the water column (Figure 22).

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.

**Tributary to Reid Brook: Specific Conductivity & Stage**



**Figure 22: Specific Conductivity & Stage at Tributary to Reid Brook**

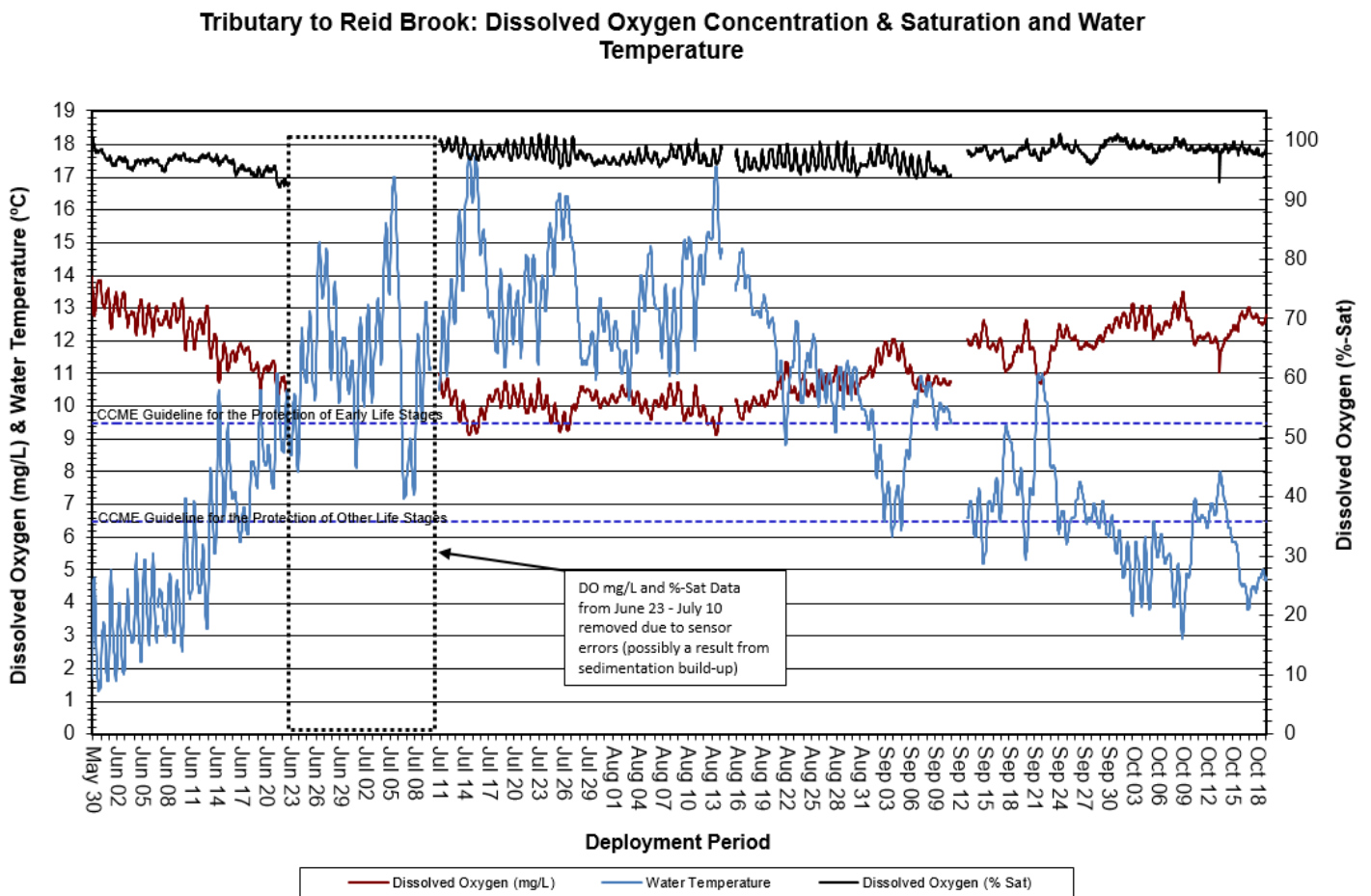
**Table 21: Comparisons of Minimum, Maximum and Median from the past three deployment years**

Specific Conductivity	2021	2020	2019
Min	11.6	21.2	8.8
Max	42.4	47.4	41.1
Median	32.6	33.9	27.5

During the 2021 deployment season, dissolved oxygen concentration ranged from 9.12mg/L to a maximum of 13.96mg/L, with a median value of 11.13mg/L. Saturation of dissolved oxygen ranged from 92.1% to 101.2%, with a median value of 97.4% (Figure 23). Median values for both dissolved oxygen concentration and percent saturation were consistent with values from previous deployment seasons (Table 22).

Observed dissolved oxygen concentrations exhibited typical seasonal trends and were inversely related to water temperature. Dissolved oxygen concentrations were lowest through July and mid-August when water temperatures were warmest. Dissolved oxygen concentrations began to increase from late August onwards as water temperatures decreased (Figure 23). Data from June 23 – July 10 was removed due to a sensor error, possibly resulted from sedimentation build-up as noted by the technicians at removal of the instrument on July 10.

Dissolved oxygen concentrations remained above the CCME's Guidelines for the Protection of Early Life Stages (9.5mg/L) for the majority of deployment; instances where dissolved oxygen levels fell below the guideline correlated closely with warmer water temperatures and the discrepancy caused by the suspected sediment build-up. Dissolved oxygen concentrations remained above the CCME's Guidelines for the Protection of Other Life Stages (6.5mg/L) for the full deployment season.



**Figure 23: Dissolved Oxygen Concentration and Saturation & Water Temperature at Tributary to Reid Brook**

**Table 22: Comparisons of Minimum, Maximum and Median from the past three deployment years**

<b>Dissolved Oxygen (mg/L)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	9.12	9.10	9.50
<b>Max</b>	13.96	13.77	12.73
<b>Median</b>	11.13	10.73	10.99

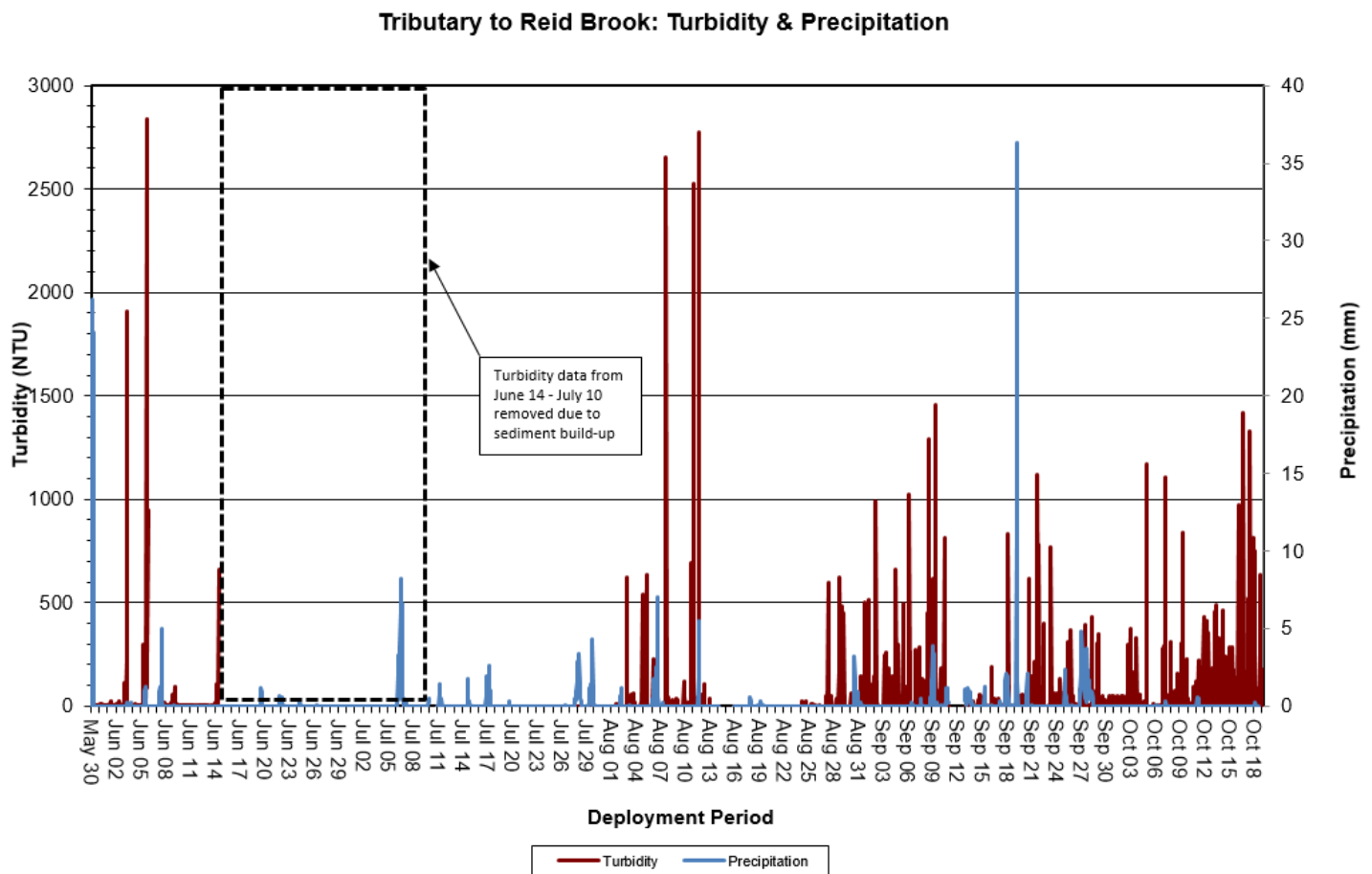
<b>Percent Saturation (%)</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	92.1	90.1	92.2
<b>Max</b>	101.2	101.1	100.7
<b>Median</b>	97.4	95.9	96.5

During the 2021 deployment season, turbidity ranged from 0.0NTU to a maximum of 2840NTU, with a median value of 0.0NTU (Table 23).

Over the course of the deployment season, increases in turbidity generally corresponded with increases in stage and precipitation events. This is to be expected as increased precipitation and run-off may introduce natural organic matter into the water column. Turbidity levels quickly returned to background levels following stage increases and precipitation events (Figure 24).

With a sandy-clay bottom, this site is subject to a lot of variability in turbidity and is more sensitive to being disturbed by external factors, like precipitation events. A lengthy period of high turbidity at 3000NTU that occurred from mid-June to mid-July was likely due to the build-up of sediment around the sensor and was not an accurate reflection of the overall water quality during that period. This data has been removed from the dataset.

Please note that the stage data on the graph below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.



**Figure 24: Turbidity, Precipitation & Stage at Tributary to Reid Brook**

**Table 23: Comparisons of Minimum, Maximum and Median from the past three deployment years**

<b>Turbidity</b>	<b>2021</b>	<b>2020</b>	<b>2019</b>
<b>Min</b>	0.0	2.1	0.0
<b>Max</b>	2840	100	1131.1
<b>Median</b>	0.0	4.5*	1.2

\*median higher than expected due to suspected calibration error

## **Multi-Station Comparison**

The following section of this report focuses on comparisons between the four stations in the Voisey's Bay real-time network.

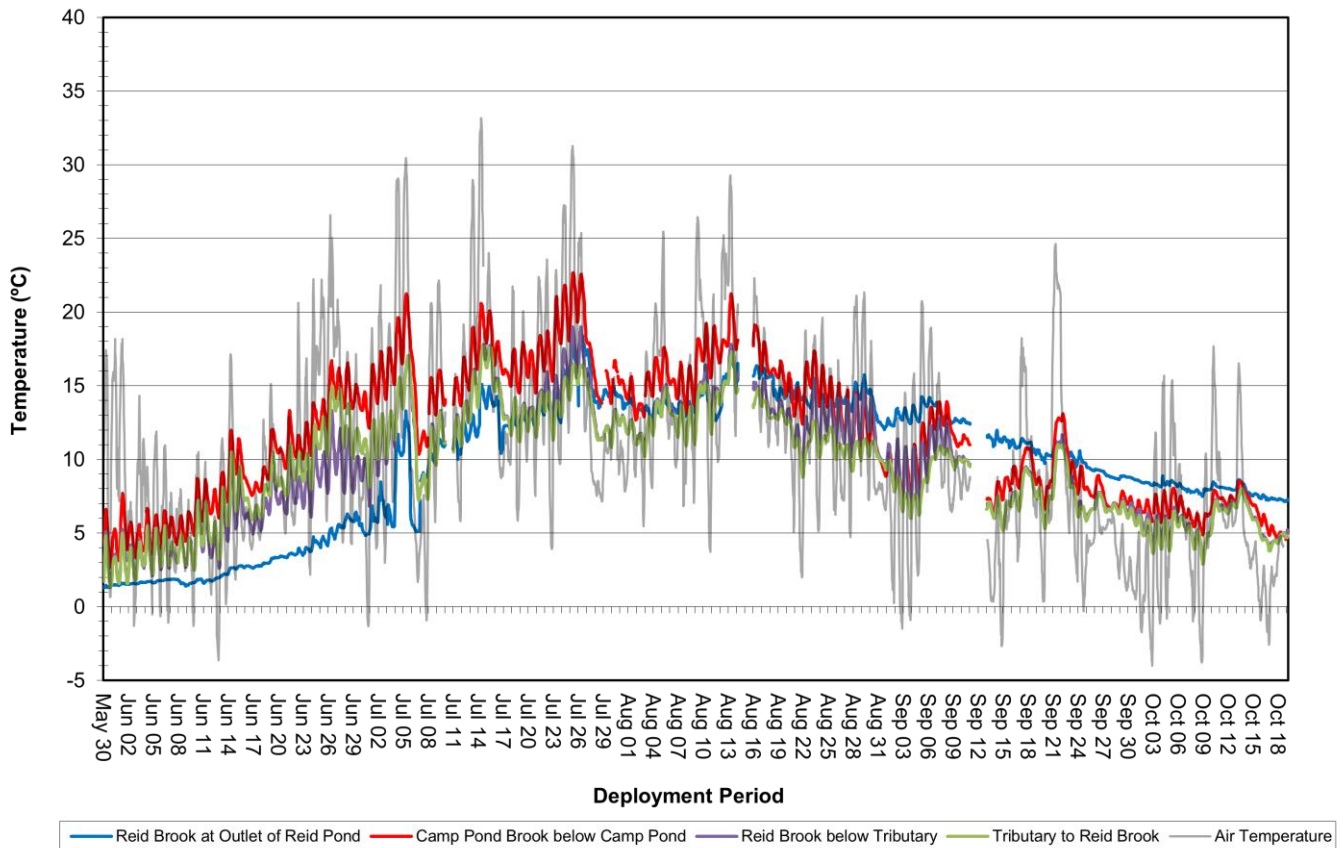
### **Temperature**

During the 2021 deployment season, water temperatures at all four real-time stations ranged from 1.29°C to a maximum of 22.68°C, the lower of which was recorded at Reid Brook at Outlet of Reid Pond, and the higher at Camp Pond Brook below Camp Pond.

Water temperature trends were similar at each of the four RTWQ stations, and closely resembled ambient air temperatures (Figure 25). Water temperatures at Camp Pond Brook below Camp Pond, Reid Brook below Tributary and Tributary to Reid Brook all followed a similar trend, peaking in late July. Reid Brook at Outlet of Reid Pond is generally slower to respond to changes in air temperatures since it is a larger volume of water and takes longer to adjust. Readings from Reid Brook at Outlet of Reid Pond were stable up until late June while Reid Pond was still covered in ice.

Tributary to Reid Brook and Reid Brook below Tributary had very similar water temperature data. This is to be expected as Tributary to Reid Brook flows directly into Reid Brook below Tributary. Both are fast flowing sites with similar environmental influences. Camp Pond Brook below Camp Pond exhibits more pronounced changes in water temperature compared to the other stations, recording the highest single temperature in the network, as well as the highest median temperature of 11.59°C (Table 24).

**Water Temperature & Air Temperature at Real-Time Water Quality Monitoring Stations**



**Figure 25: Water Temperature & Air Temperature at all RTWQ Stations**

**Table 24: Comparisons of Minimum, Maximum and Median from all RTWQ stations**

Temperature (°C)	Reid Brook at Outlet of Reid Pond	Camp Pond Brook below Camp Pond	Reid Brook below Tributary	Tributary to Reid Brook
Min	1.29	2.66	1.44	1.3
Max	18.42	22.68	19.01	17.7
Median	10.65	11.59	9.76	9.9



## pH

During the 2021 deployment season, median pH values at all four real-time stations ranged from 6.26 pH units at Reid Brook at Outlet of Reid Pond to 6.8 pH units at Reid Brook below Tributary (Table 25).

pH data for all stations followed a similar trend. The Reid Brook at Outlet of Reid Pond station is at the outlet of a pond and has different factors influencing pH as compared to the other sites, and tends to exhibit a wider range of pH values. Camp Pond Brook below Camp Pond, Reid Brook below Tributary, and Tributary to Reid Brook all showed similar pH movements across the deployment season (Figure 26).

There were several events where pH fell below the CCME's Minimum Guideline for the Protection of Aquatic Life. When compared to precipitation data (Figure 26), there is an evident change in pH levels during higher and longer precipitation events, specifically at Camp Pond Brook below Camp Pond, Reid Brook below Tributary, and Tributary to Reid Brook. Many of the fluctuations in the pH data across the real-time stations corresponded closely with precipitation events. This relationship is much less evident at Reid Brook at Outlet of Reid Pond.

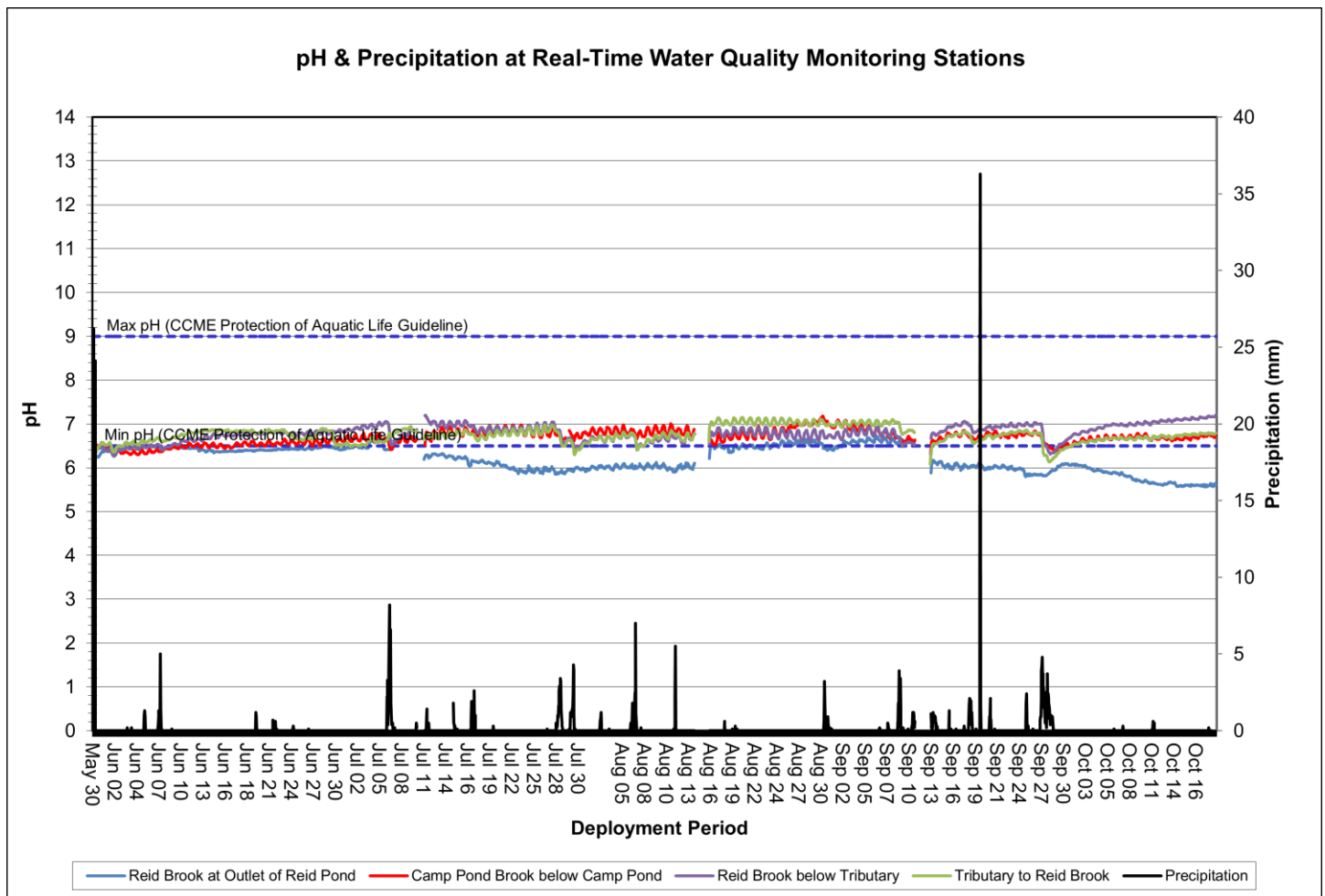


Figure 26: pH & Precipitation at all RTWQ Stations

**Table 25: Comparisons of Minimum, Maximum and Median from the four real-time stations**

<b>pH (units)</b>	<b>Reid Brook at Outlet of Reid Pond</b>	<b>Camp Pond Brook below Camp Pond</b>	<b>Reid Brook below Tributary</b>	<b>Tributary to Reid Brook</b>
<b>Min</b>	5.56	6.3	6.08	5.75
<b>Max</b>	6.74	7.18	7.2	7.15
<b>Median</b>	6.26	6.7	6.8	6.75

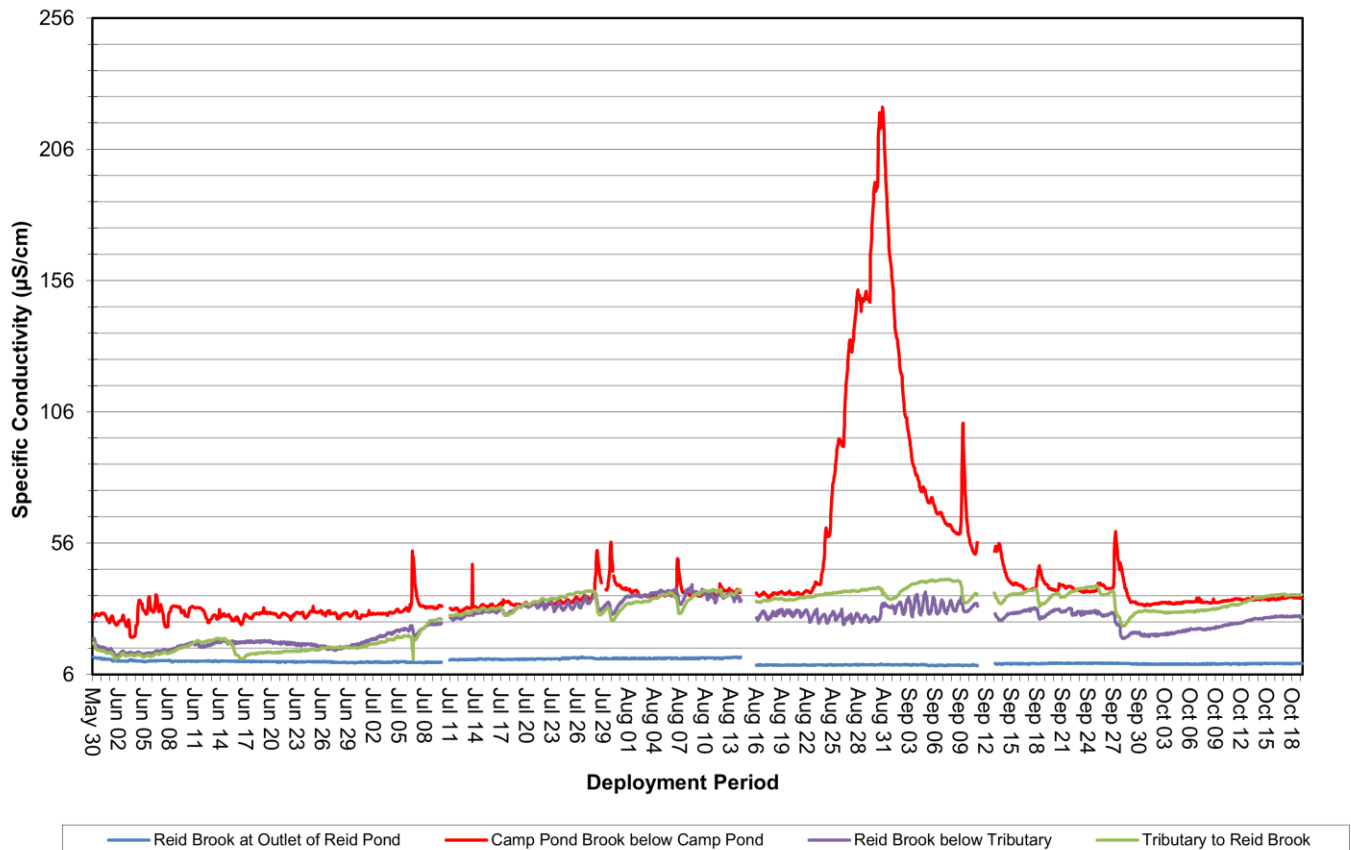
### Specific Conductivity

During the 2021 deployment season, specific conductivity medians ranged from 10.6µS/cm at Reid Brook at Outlet of Reid Pond to a maximum of 34.5µS/cm at Camp Pond Brook below Camp Pond (Table 26).

Reid Brook at Outlet of Reid Pond maintained a stable specific conductivity level across most of the deployment season. Stable conductivity levels are to be expected at this station since it is located in an established pond environment. Reid Brook below Tributary and Tributary to Reid Brook had similar conductivity levels and followed a similar trend. Camp Pond Brook below Camp Pond displayed greater and more fluctuating specific conductivity levels. This trend is typical of this station, as it is located closer to the Voisey's Bay mine site than the other stations and is therefore more susceptible to anthropogenic influences (Figure 27). There was a notable, prolonged increase of conductivity from August 24 to September 11 at Camp Pond Brook that did not impact the other stations.

Reid Brook below Tributary, Tributary to Reid Brook and Camp Pond Brook below Camp Pond all generally displayed increasing conductivity levels across the deployment season. This is to be expected as stage levels decrease and suspended solids become more concentrated in the water column. As Reid Brook at Outlet of Reid Pond is a more stable water quality environment, conductivity data remained quite consistent.

**Specific Conductivity at Real-Time Water Quality Monitoring Stations**



**Figure 27: Specific Conductivity at all RTWQ Stations**

**Table 26: Comparisons of Minimum, Maximum and Median from the four real-time stations**

<b>Specific Conductivity</b>	<b>Reid Brook at Outlet of Reid Pond</b>	<b>Camp Pond Brook below Camp Pond</b>	<b>Reid Brook below Tributary</b>	<b>Tributary to Reid Brook</b>
<b>Min</b>	9.3	20.2	12.8	11.6
<b>Max</b>	12.7	222	40.2	42.4
<b>Median</b>	10.6	34.5	27.9	32.6

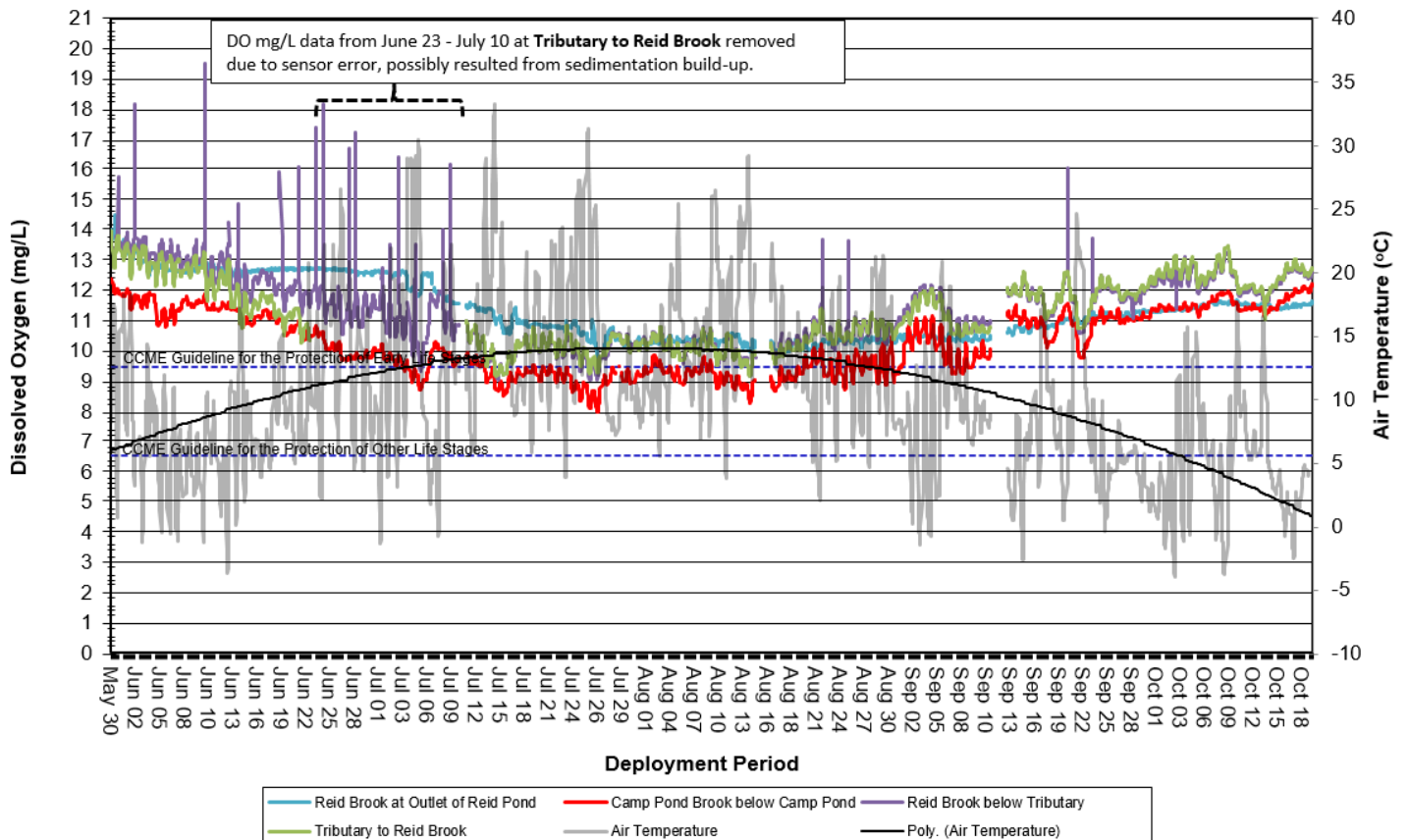
### Dissolved Oxygen Concentration and Saturation of Dissolved Oxygen

During the 2021 deployment season, dissolved oxygen concentration medians ranged from 10.11mg/L at Camp Pond Brook below Camp Pond to a maximum of 11.36mg/L at Reid Brook below Tributary (Table 27). Dissolved oxygen concentrations displayed a typical inverse relationship with both water and ambient air temperatures at all stations (Figure 28a). Dissolved oxygen levels were most stable at Reid Brook at Outlet of Reid Pond, whereas there was greater fluctuation at the other three stations.

During the warmer periods through July and August, dissolved oxygen levels at all stations fell, at least occasionally, below the CCME's Guideline for the Protection of Early Life Stages (9.5mg/L). Dissolved oxygen concentrations rose above the CCME's Guidelines for the Protection of Early Life Stages at all stations from late August onwards as water temperatures decreased. Dissolved oxygen concentrations remained above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment at all stations (Figure 28a). DO readings at Tributary to Reid Brook between June 23 – July 10 were possibly impacted by sediment build-up and have been removed as they were not an accurate representation of that site's water quality data.

The observed changes in dissolved oxygen levels are not unusual and are to be expected during warmer temperatures. As air temperatures decreased into the cooler fall season, dissolved oxygen levels began to steadily increase.

**Dissolved Oxygen Concentration & Air Temperature at Real-Time Water Quality Monitoring Stations**



**Figure 28a: Dissolved Oxygen Concentration & Air Temperature at all RTWQ Stations**

### Saturation of Dissolved Oxygen at Real-Time Water Quality Monitoring Stations

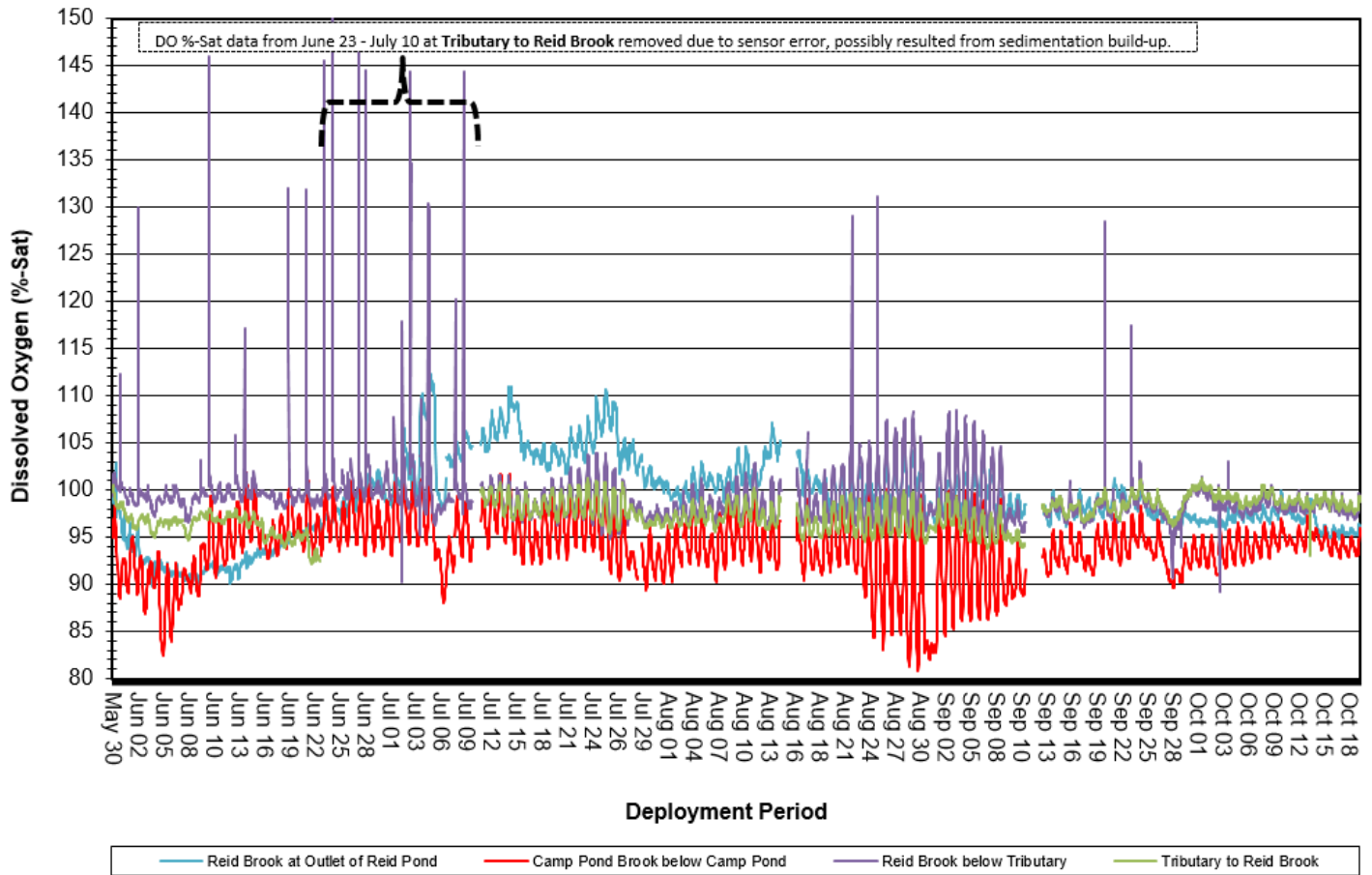


Figure 28b: Saturation of Dissolved Oxygen at all RTWQ Stations

Table 27: Comparisons of Minimum, Maximum and Median from the four real-time stations

	Dissolved Oxygen (mg/L)				Dissolved Oxygen (% Saturation)			
	Reid Brook at Outlet of Reid Pond	Camp Pond Brook below Camp Pond	Reid Brook below Tributary	Tributary to Reid Brook	Reid Brook at Outlet of Reid Pond	Camp Pond Brook below Camp Pond	Reid Brook below Tributary	Tributary to Reid Brook
<b>Min</b>	9.66	8.01	9.05	9.12	89.8	80.8	89.2	92.1
<b>Max</b>	14.48	12.37	19.48	13.96	112.3	101.8	151.2	101.2
<b>Median</b>	11.18	10.11	11.36	11.13	98.8	94.1	98.7	97.4

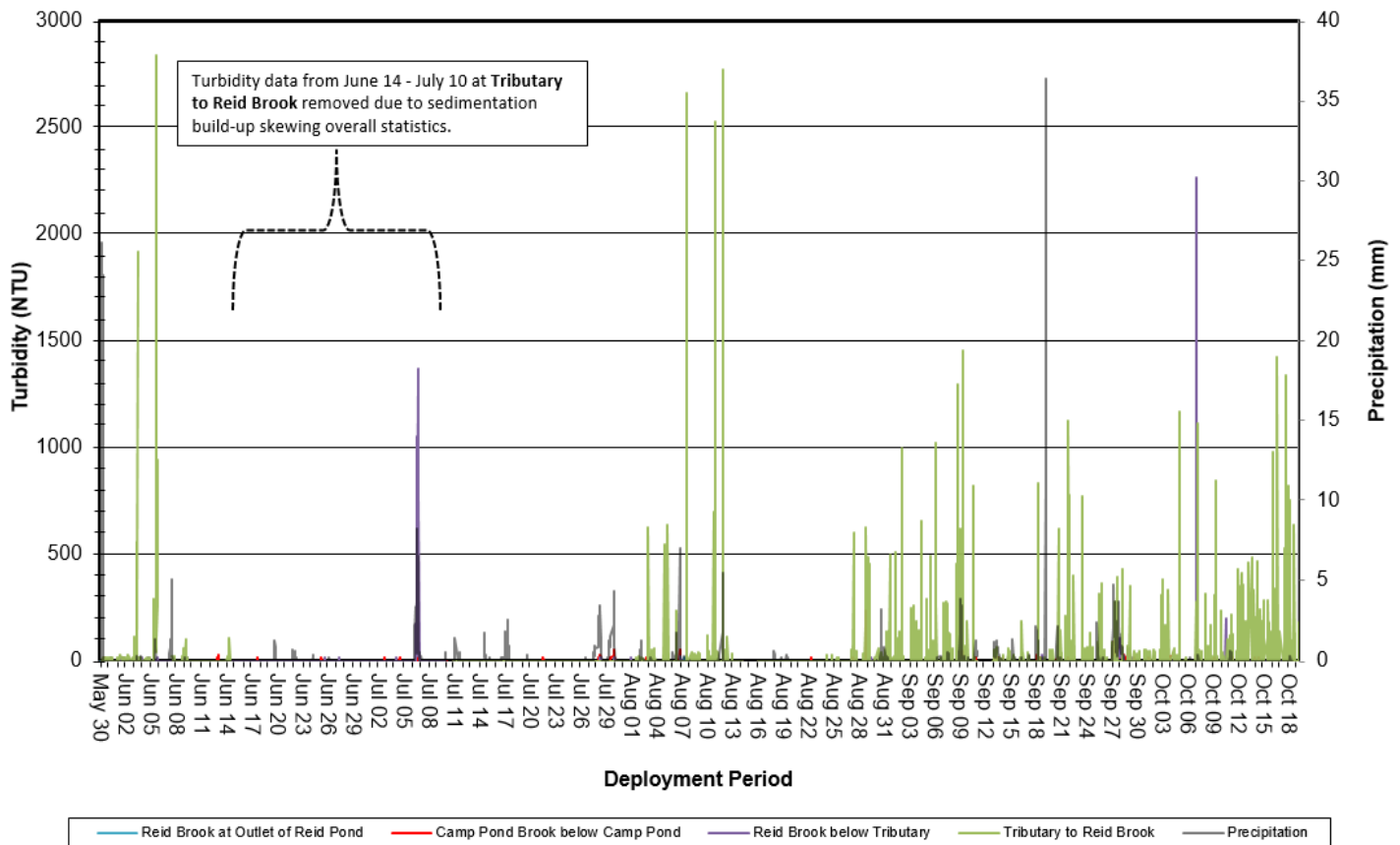
## Turbidity

During the 2021 deployment season, turbidity ranged from 0.0NTU at all stations to a maximum of 2840NTU at Tributary to Reid Brook (Table 28). It is not unusual to see significant variability in turbidity data, as this parameter is influenced by many factors (e.g. precipitation, runoff from surrounding environments, high water flow (bubbles) and debris, such as leaf litter). Median turbidity values at all stations indicate that there is very little background turbidity at these stations, which is to be expected (Figure 29b).

There was a lengthy period of high turbidity at Tributary to Reid Brook recording 3000NTU from June 14 – July 10 that was likely due to the build-up of sediment around the sensor and was not an accurate reflection of the overall water quality during that period. This data has been removed from the dataset.

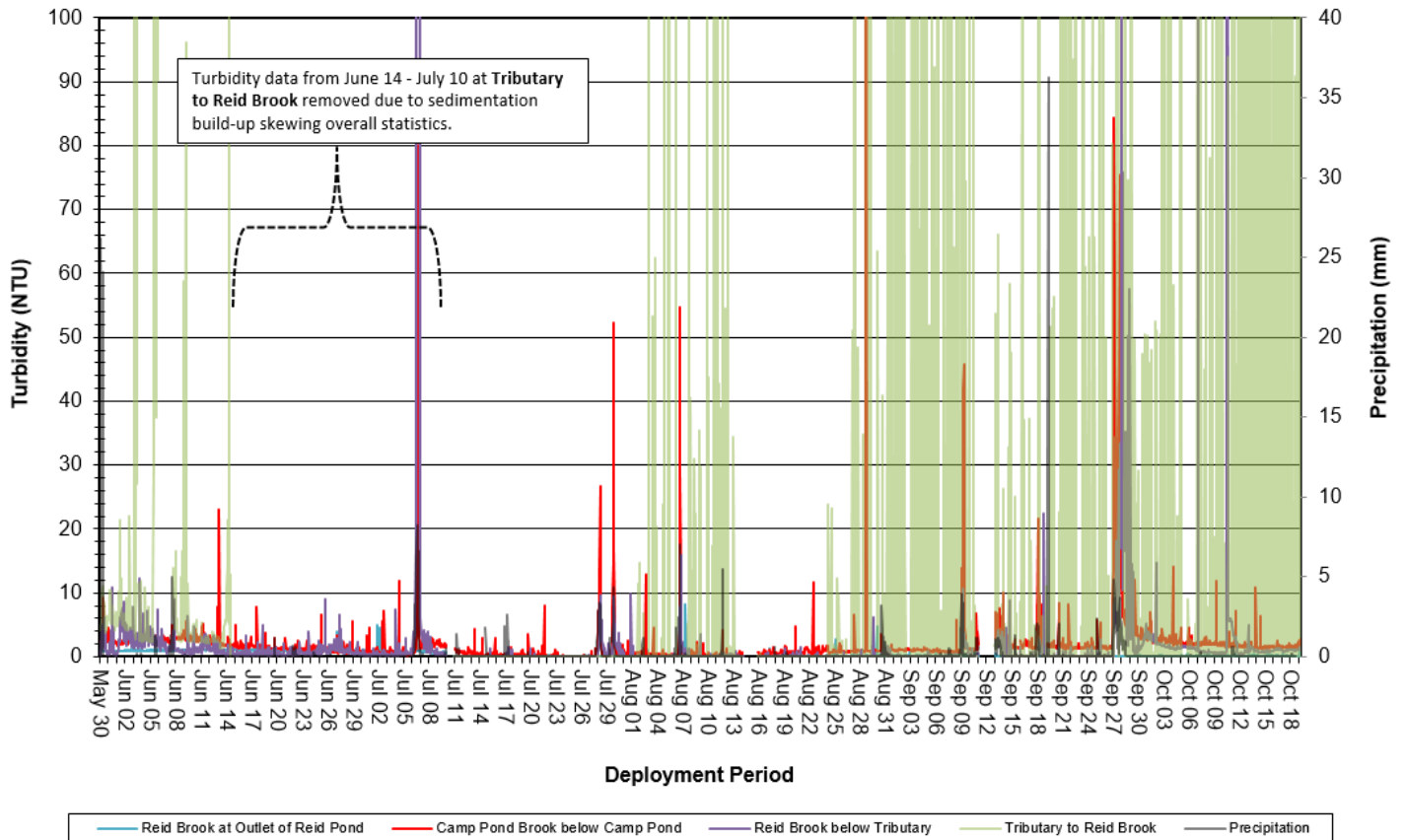
Figure 29a displays all turbidity data for the four real-time stations, as well as precipitation data. In contrast, Figure 29b displays turbidity data on a scale of 100NTU. The use of a smaller scale allows for more accurate comparison of turbidity events between the different stations, and clearly shows the relationship between precipitation events and increased turbidity levels.

**Turbidity & Precipitation at Real-Time Water Quality Monitoring Stations**



**Figure 29a: Turbidity & Precipitation at all RTWQ Stations**

**Turbidity (100 NTU) & Precipitation at Real-Time Water Quality Monitoring Stations**



**Figure 29b: Turbidity & Precipitation at all RTWQ Stations (graphed to 100 NTU)**

**Table 28: Comparisons of Minimum, Maximum and Median from the four real-time stations**

Turbidity (NTU)	Reid Brook at Outlet of Reid Pond	Camp Pond Brook below Camp Pond	Reid Brook below Tributary	Tributary to Reid Brook
Min	0.0	0.0	0.0	0.0
Max	8.2	226.6	2272	2840
Median	0.0	1.2	0.2	0.0



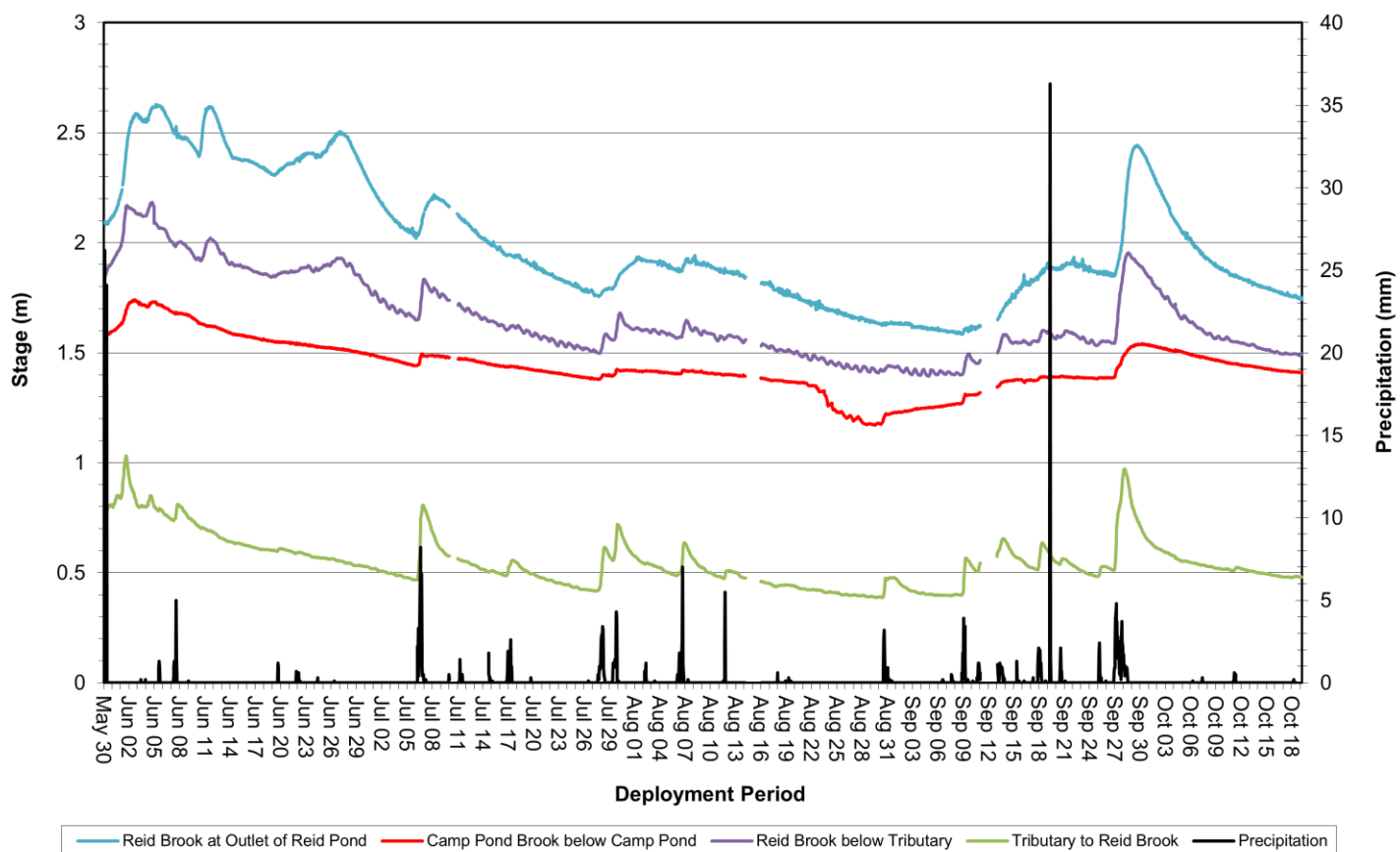
### Stage

During the 2021 deployment season, stage levels were initially high but generally decreased over the course of deployment at all stations, with variable fluctuation from time to time. Camp Pond Brook below Camp Pond exhibited the least variation in stage level, but did react to high precipitation events (Figure 30).

There is an obvious relationship between precipitation and stage. Tributary to Reid Brook, Reid Brook below Tributary, and Reid Brook at Outlet of Reid Pond had very obvious responses to precipitation events. Precipitation events had slightly less influence at Camp Pond Brook below Camp Pond as this station is in close proximity to the lake, but the relationship is still evident (Figure 30).

Please be advised that WSC is responsible for the QA/QC of water quantity data. Corrected data can be obtained upon request. Stage data is included in this report to highlight the relationship with water quality parameters.

**Stage & Precipitation at Real-Time Water Quality Monitoring Stations**



**Figure 30: Stage & Precipitation at all RTWQ Stations**

**Table 29: Comparisons of Minimum, Maximum and Median from the four real-time stations**

<b>Stage (m)</b>	<b>Reid Brook at Outlet of Reid Pond</b>	<b>Camp Pond Brook below Camp Pond</b>	<b>Reid Brook below Tributary</b>	<b>Tributary to Reid Brook</b>
<b>Min</b>	1.584	1.171	1.393	0.387
<b>Max</b>	2.628	1.740	2.183	1.031
<b>Median</b>	1.902	1.422	1.592	0.526
<b>Difference (Max-Min)</b>	1.044	0.569	0.790	0.644

## **Conclusions**

The 2021 deployment season ran from May 30<sup>th</sup> until October 19<sup>th</sup>, and consisted of four deployment periods.

The majority of water quality events at the four RTWQ stations can be explained by precipitation events, spring thaw influences, and/or changes in air temperature as the seasons moved from spring to summer to fall.

Water temperature and dissolved oxygen were directly influenced by typical seasonal trends, increasing or decreasing with warming or cooling air temperatures. pH levels were generally maintained throughout deployment, except during high stage events or precipitation events when pH values decreased for a short period of time.

Three RTWQ stations had specific conductivity levels that increased across the deployment season; Reid Brook at Outlet of Reid Pond was the exception with relatively stable conductivity levels, which are attributed to the stable pond environment nearby. There was a notable, prolonged increase of conductivity from August 24 to September 11 at Camp Pond Brook that did not impact the other stations.

Turbidity data showed significant variation across the network; however, the majority of turbidity increases were associated with precipitation events occurring at the same time. Observed turbidity events were short in duration and turbidity readings typically returned to background levels.

## Path Forward

The success of the real-time water monitoring network is largely due to environmental staff maintaining and monitoring the Voisey's Bay RTWQ network. This network has been improving since 2003 and continues to advance annually in background knowledge and awareness of the area's characteristics. Data collected within this network is essential for identifying the difference between natural and anthropogenic events. As this agreement progresses into the 2022 deployment period for the Voisey's Bay stations, the following is a list of planned activities to be carried out. This list also includes some multi-year activities planned in the previous year that are still in progress.

- Staff from Vale will be responsible for monthly maintenance and calibration (as was the case in the past). WRMD staff will perform regular site visits to audit and assist in the maintenance and calibration procedures from time to time. WSC staff will perform regular site visits to ensure water quantity instrumentation is functioning correctly, calibrated and providing accurate measurements.
- WRMD staff will update Voisey's Bay staff on any changes to processes and procedures with handling, maintaining and calibrating the RTWQ instruments.
- If necessary, changes or improvements to deployment techniques will be adapted to each specific site, ensuring secure and suitable conditions for RTWQ.
- WRMD will work with Vale Environment staff to reassess the network design (station location) and plan for any necessary or desired changes in 2022 or in future seasons.
- Open communication lines will continue to be maintained between WRMD, ECCC and Vale employees involved with the agreement in order to respond to emerging issues on a proactive basis.
- Vale will receive deployment reports outlining the events that occurred in the previous deployment period and a 2022 annual report summarizing the events of the entire deployment season.
- WRMD will continue to work on Automatic Data Retrieval System to incorporate new capabilities when applicable.
- WRMD will continue to work on the creation of value added products using the RTWQ data, remote sensing and water quality indices.
- WRMD will begin development of models using RTWQ data and grab sample data to estimate a variety of additional water quality parameters (*i.e.* TSS, major ions *etc.*).
- 2022 deployments will recommence in the Spring.