

Real-Time Water Quality Annual Report

Flora Creek below TLH

June 7 to
October 19, 2023



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

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Acknowledgements

The Real-Time Water Quality Monitoring station (RTWQ) at Flora Creek is funded by Tacora Resources, Inc. The program is a joint partnership between Tacora Resources, Environment and Climate Change Canada (ECCC), and the Newfoundland & Labrador Department of Environment & Climate Change (ECC).

Various individuals from each sector have been diligently involved to ensure this program is a successful operation including, various WRMD staff (ECC), Sharlene Baird and Katherine Jacobs (Tacora Resources, Inc.), and various WSC staff (ECCC). In addition to these managers, there have been a team of individuals who work together to ensure the day-to-day operation of this station is providing quality data. Maria Murphy (ECC) was responsible for this water quality station during 2023; responsibilities included deployment and removal of the instrument, maintenance and calibration of the instrument and preparation of monthly deployment reports. Brenda Congram (ECC) is acknowledged for her assistance during deployment and removal procedures in 2023.

ECCC staff are essential in the operation of the data logging/communication aspect of the network. Staff of the Meteorological Service of Canada Division – Water Survey of Canada, visit the station regularly to ensure that the data logging and data transmitting equipment is working properly. ECCC is also the lead on dealing with water stage and flow issues.

Introduction

- The real-time water quality monitoring station on Flora Creek was established during the summer of 2014 as a partnership between the Newfoundland & Labrador Department of Environment and Climate Change and Cliffs Natural Resources. In 2017, the mine was sold and the partnership transferred to Tacora Resources and the Newfoundland & Labrador Department of Environment, Climate Change & Municipalities (currently ECC).
- The official name of the station is Flora Creek below TLH, also referred to as the Flora Creek station.
- This station measures water quality parameters water temperature, pH, specific conductivity, dissolved oxygen and turbidity, as well as water quantity parameters stage and flow. Parameters are recorded on an hourly basis during the deployment period.



Figure 1: Map of Western Labrador area showing the RTWQ Flora Creek station.

- The purpose of this network is to monitor, process, and distribute water quality/quantity data to Tacora Resources, ECC and ECCC, for assessment and management of water resources, as well as to provide an early warning for any potential or emerging water issues so that mitigative measures can be implemented in a timely manner.
- ECC provides Tacora Resources with monthly and annual deployment reports. Data is available in near real-time on the Department of Environment & Climate Change’s website.
- A RTWQ monitoring instrument has been deployed at this station each season since 2014, near a continuously evolving mine site. Unless otherwise stated, small gaps on graphs indicate the time frame where the instrument was removed from the water for calibration and maintenance.
- The initial deployment for the 2023 season was on June 7th. The instrument was removed for the winter season on October 19th. The following report depicts and discusses water quality events throughout this period.
- The station did not transmit water quality data in real time for the first day of the initial deployment, Issues were troubleshooted and the station began transmitting the following day.

Maintenance and Calibration

- To ensure accurate data collection, maintenance and calibration of the water quality instrumentation is performed normally approximately every 45 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, ECC staff carefully calibrate each sensor attachment for pH, specific conductivity, dissolved oxygen and turbidity to ensure accurate data collection.
- Installation and removal dates for the 2023 season are summarized in the table below.

Table 1: Water quality instrument deployment start and end dates for 2023

Installation	Removal	Deployment duration (days)
June 7	July 13	36
July 13	September 6	55
September 6	October 19	43

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 each deployment period. The procedure is based on the approach used by the United States Geological Survey.
- At deployment and removal, a QA/QC Sonde is temporarily deployed adjacent to the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the degree of difference between parameters recorded by the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 2).

Table 2: Ranking classifications for deployment and removal

Parameter	Rank				
	Excellent	Good	Fair	Marginal	Poor
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependent, temperature compensated and temperature independent. Since the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.
- Deployment and removal comparison rankings for the Flora Creek water quality station for the three deployment periods from June 7 to October 19, 2023, are summarized in Table 3.
- For additional information and explanations of rankings, please refer to the 2023 monthly deployment reports.

Table 3: QA/QC comparison rankings for Flora Creek June 7 to October 19, 2023

Date		Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity	
Flora Creek	7-Jun-23	Deployment	Excellent	Good	Good	Excellent	Good
	13-Jul-23	Removal	Excellent	Fair	Excellent	Excellent	Fair
	13-Jul-23	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	6-Sep-23	Removal	Excellent	Good	Excellent	Fair	Excellent
	6-Sep-22	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	19-Oct-22	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

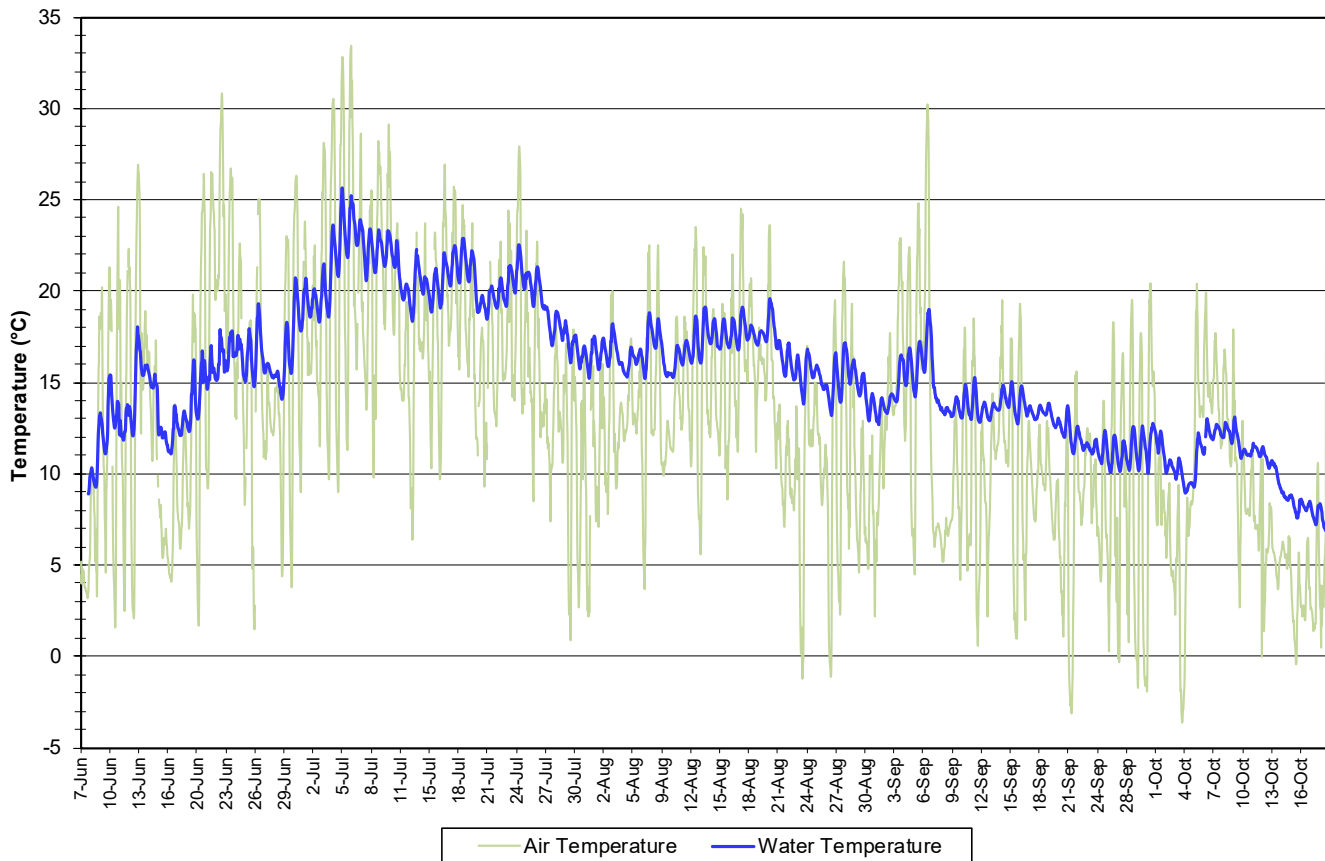
Data Interpretation

- The following graphs and discussion illustrate water quality-related events from June 7th, 2023 to October 19th, 2023 at Flora Creek.
- 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. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

Flora Creek below TLH

- Water temperature ranged from 7.17 to 25.66°C during the 2023 deployment season. The median value was 15.48 °C (Figure 2).
- Water temperature increases at the beginning of the season and decreases during the later portion of the season. This is expected, as ambient air temperature is warmer in the summer and cooler in the fall and water temperature followed the seasonal air temperature trends.

**Water and Air Temperature: Flora Creek below TLH
June 7 to October 19, 2023**



**Figure 2: Water and Air Temperature – Flora Creek below TLH
(Weather data collected from climate station near Moosehead Lake)**

- pH ranges from 7.67 to 8.48 pH units at Flora Creek, throughout the 2023 deployment season (Figure 3). The median pH is 7.89.
- pH increased slightly during the first deployment and then decreased slightly during the remainder of the deployment season. pH fluctuates daily. Peaks are observed during late afternoon and early evening.
- All values during the deployment are within the CCME Water Quality Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units).

**Water pH: Flora Creek below TLH
June 7 to October 19, 2023**

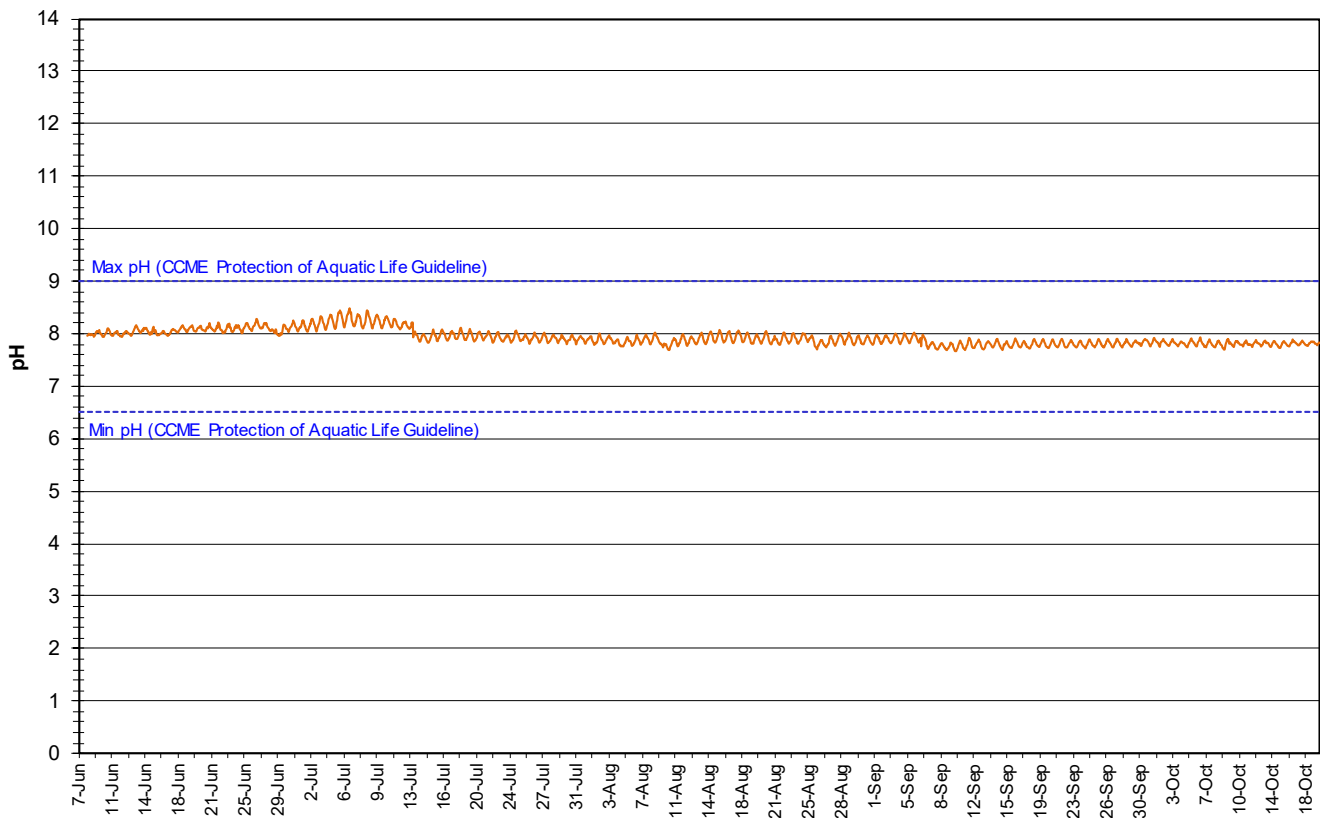


Figure 3: pH – Flora Creek below TLH

- Throughout the 2023 deployment season, specific conductivity ranged from 65.2 to 74.9 $\mu\text{S}/\text{cm}$, with a median value of 71.6 $\mu\text{S}/\text{cm}$ at Flora Creek (Figure 4).
- Conductivity increased over the course of this deployment season, occasionally fluctuating in response to increases/decreases in stage.
- 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. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

**Specific Conductivity and Stage: Flora Creek below TLH
June 7 to October 19, 2023**

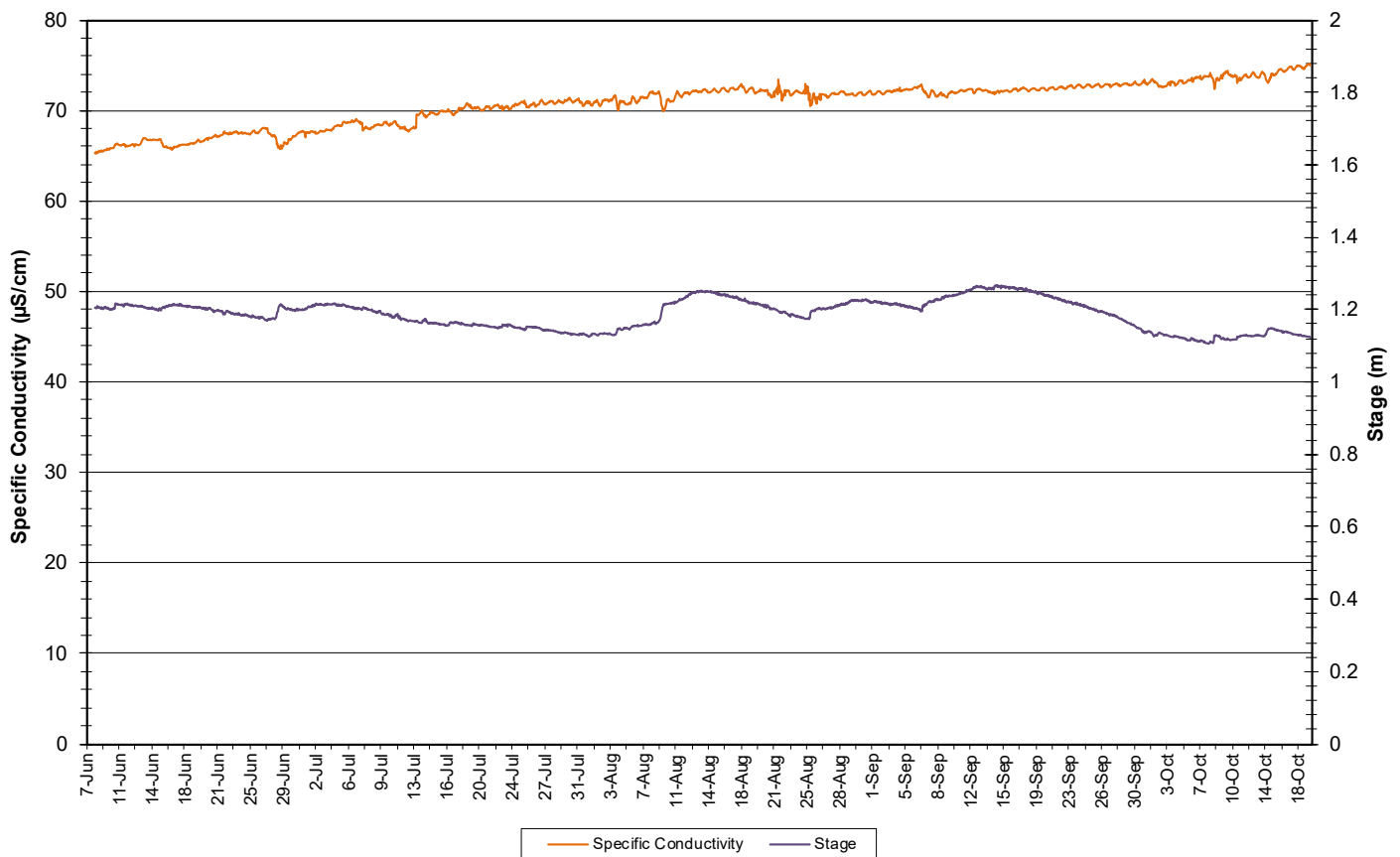


Figure 4: Specific Conductivity and Stage – Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 87.7 to 106.7%, while the dissolved oxygen content ranged from 7.95 to 11.17 mg/l, with a median value of 9.70 mg/l (Figure 5).
- Dissolved oxygen fluctuated daily with decreases observed at night.
- Dissolved oxygen decreases slightly during the first deployment period, due to warming water temperatures into summer. It then increases as water temperatures cool into the fall.
- All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages of 6.5 mg/l. The majority of values recorded were above the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. The guidelines are indicated in blue on Figure 5.

**Dissolved Oxygen Concentration & Saturation and Water Temperature:
Flora Creek below TLH
June 7 to October 19, 2023**

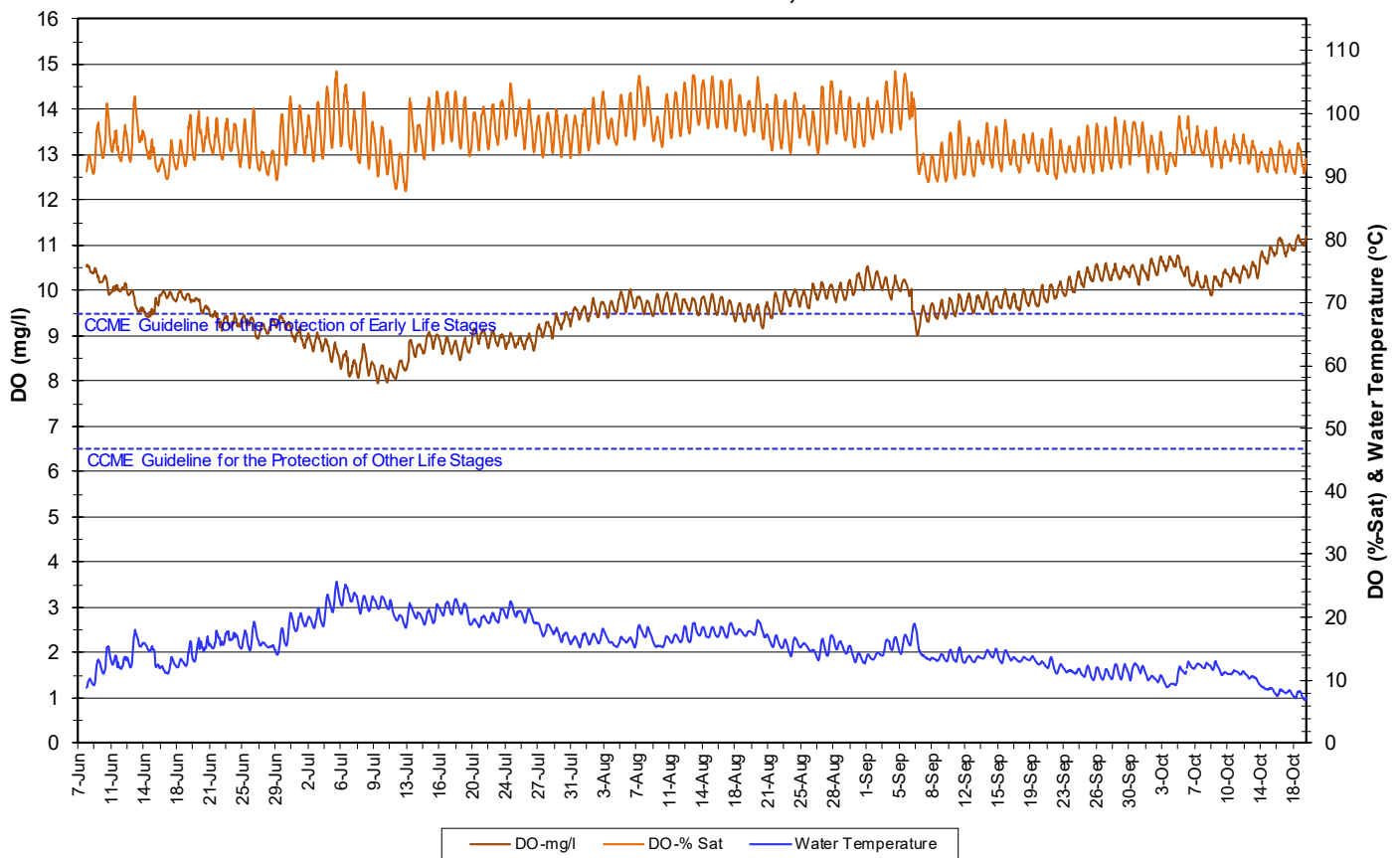


Figure 5: Dissolved Oxygen Concentration and Saturation and Water Temperature – Flora Creek below TLH

- At the Flora Creek station, turbidity values range from 0.0 to 60.4 NTU with a median value of 2.9 NTU (Figure 6).
- Turbidity was high at the beginning of the season due to late winter melt/freshet. Other spikes are noted during and after significant precipitation events. This station is known for high turbidity values.

**Water Turbidity and Precipitation: Flora Creek below TLH
June 7 to October 19, 2023**

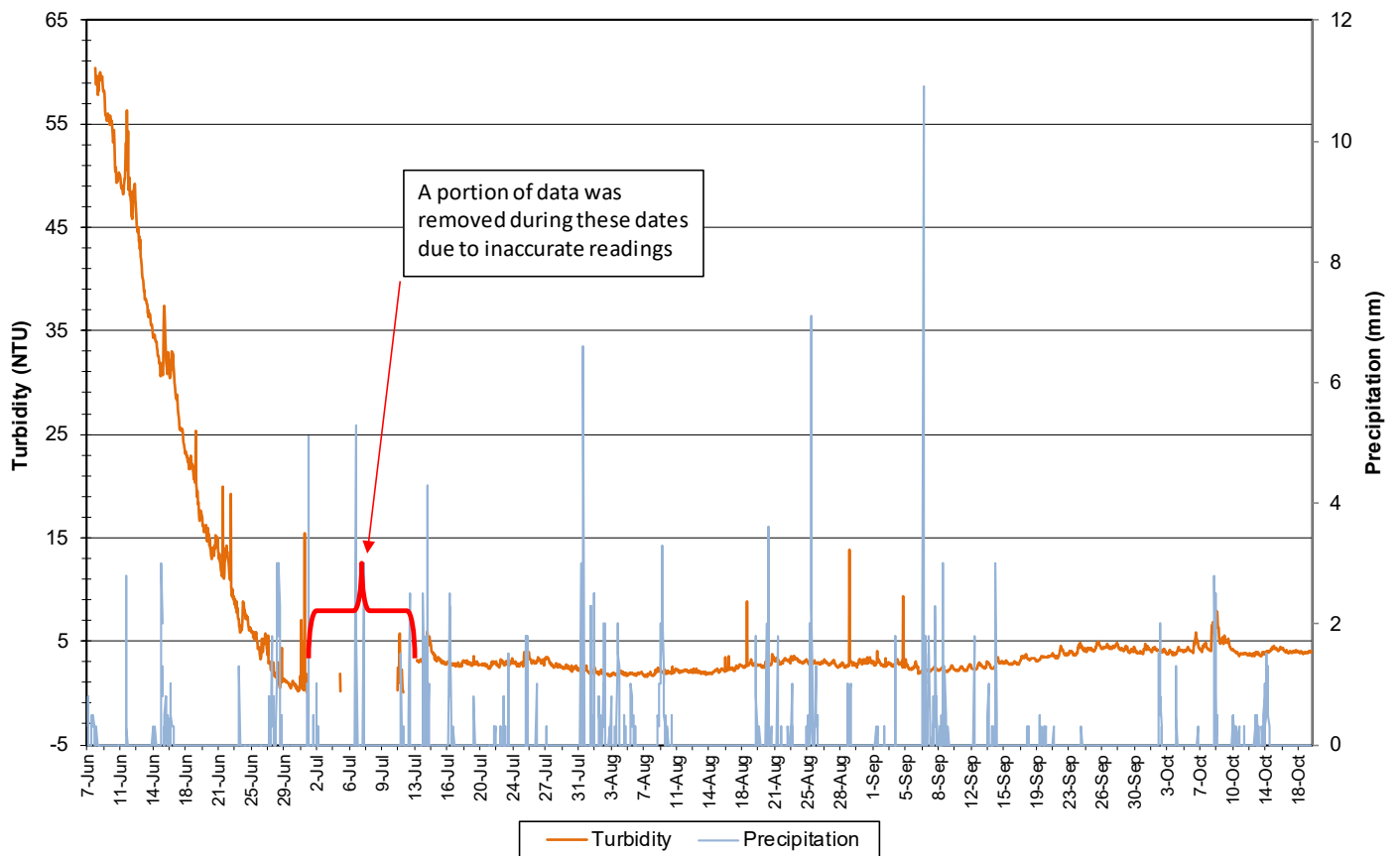
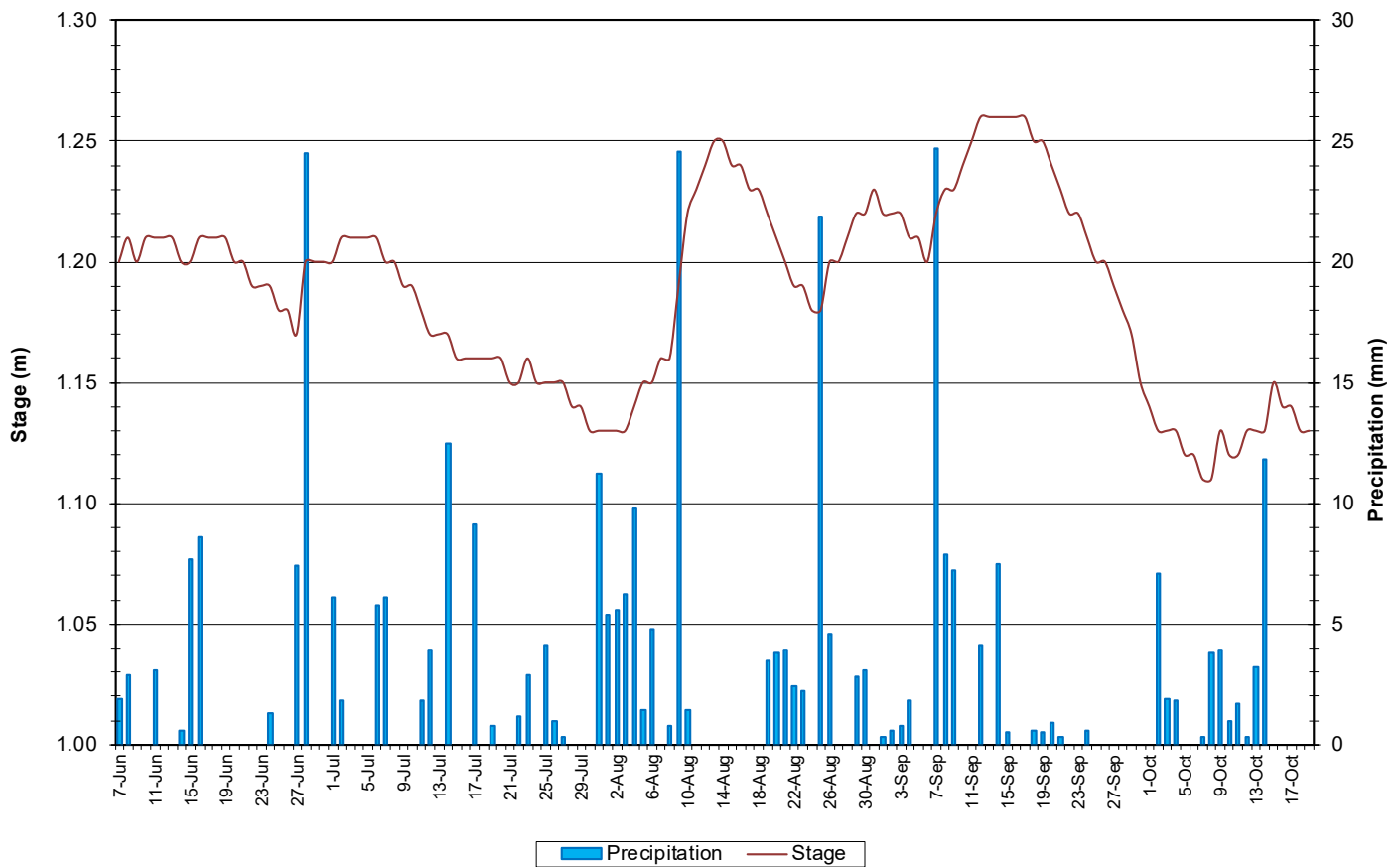


Figure 6: Turbidity and Precipitation - Flora Creek below TLH

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Flora Creek (Figure 7).
- Increases in stage corresponded with significant precipitation events.
- 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. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

**Average Stage & Daily Precipitation: Flora Creek Below TLH
June 7 to October 19, 2023**



**Figure 7: Average Stage and Daily Precipitation - Flora Creek below TLH
(Weather data collected from climate station near Moosehead Lake)**

Conclusions

- The instrument at the water quality monitoring station on Flora Creek was deployed on June 7th, 2023 and removed on October 19th, 2023 for the winter season.
- Deployment periods ranged from 36 to 55 days.
- In most cases, weather related events or increases/decreases in water level explain the data fluctuations.
- Most values recorded were within ranges as suggested by the CCME Water Quality Guidelines for the Protection of Aquatic Life.
- The instrument performed well for the 2023 season with no issues. The station however, initially had an issue transmitting the water quality data, but was quickly rectified.
- Water temperature followed the seasonal trend of increasing during the summer and decreasing into the fall. Water temperature corresponded with air temperature.
- All pH values were within the acceptable range of the CCME Water Quality Guidelines for Protection of Aquatic Life.
- Specific conductivity increased slightly during the 2023 deployment season.
- When the water was warmest, dissolved oxygen values were below the minimum CCME Water Quality Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l. All values were above the CCME Water Quality Guideline for the Protection of Aquatic Life for Cold water Biota at Other Life Stages of 6.5 mg/l.
- This station tends to have high turbidity values. Highest values usually occur during the late winter melt/freshet. There were also turbidity spikes noted after significant rainfall events.

Path Forward

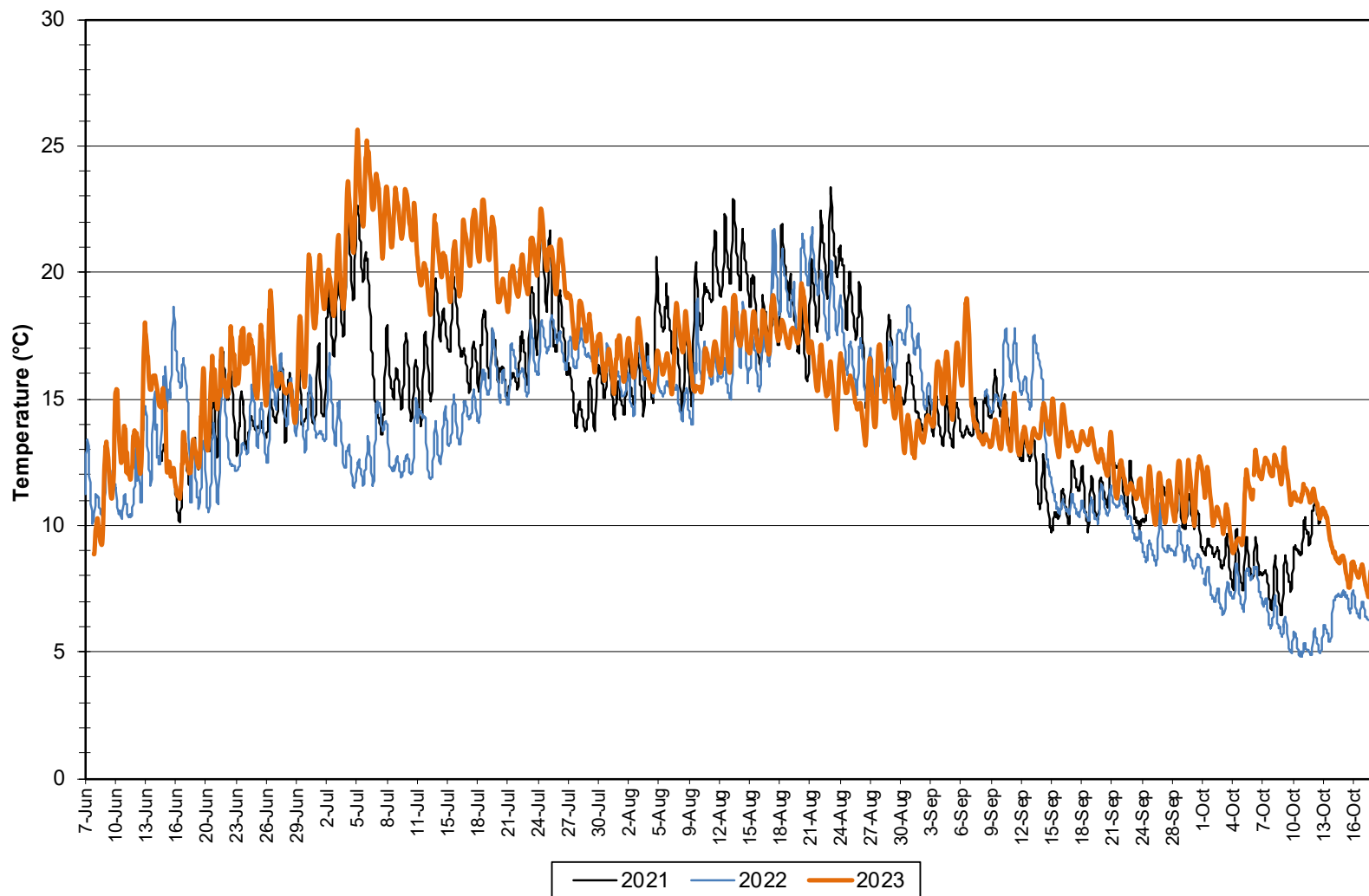
- The field instrument will undergo proficiency testing and evaluation during the winter of 2023-2024. ECC will inform Tacora Resources of any instrument performance issues.
- ECC staff will deploy real time water quality instruments in spring 2024 when ice conditions allow and perform regular site visits throughout the 2024 deployment season for calibration and maintenance of the instrument.
- If necessary, deployment techniques will be evaluated and modified, ensuring secure and suitable conditions for RTWQ monitoring.
- ECC will continue to work on its Automatic Data Retrieval System, to incorporate new capabilities in data management and data display.
- Open communication lines will continue to be maintained between ECC, ECCC and Tacora Resources in order to respond to emerging issues on a proactive basis. Tacora Resources will receive monthly deployment reports and an annual report, summarizing the events of the deployment season.

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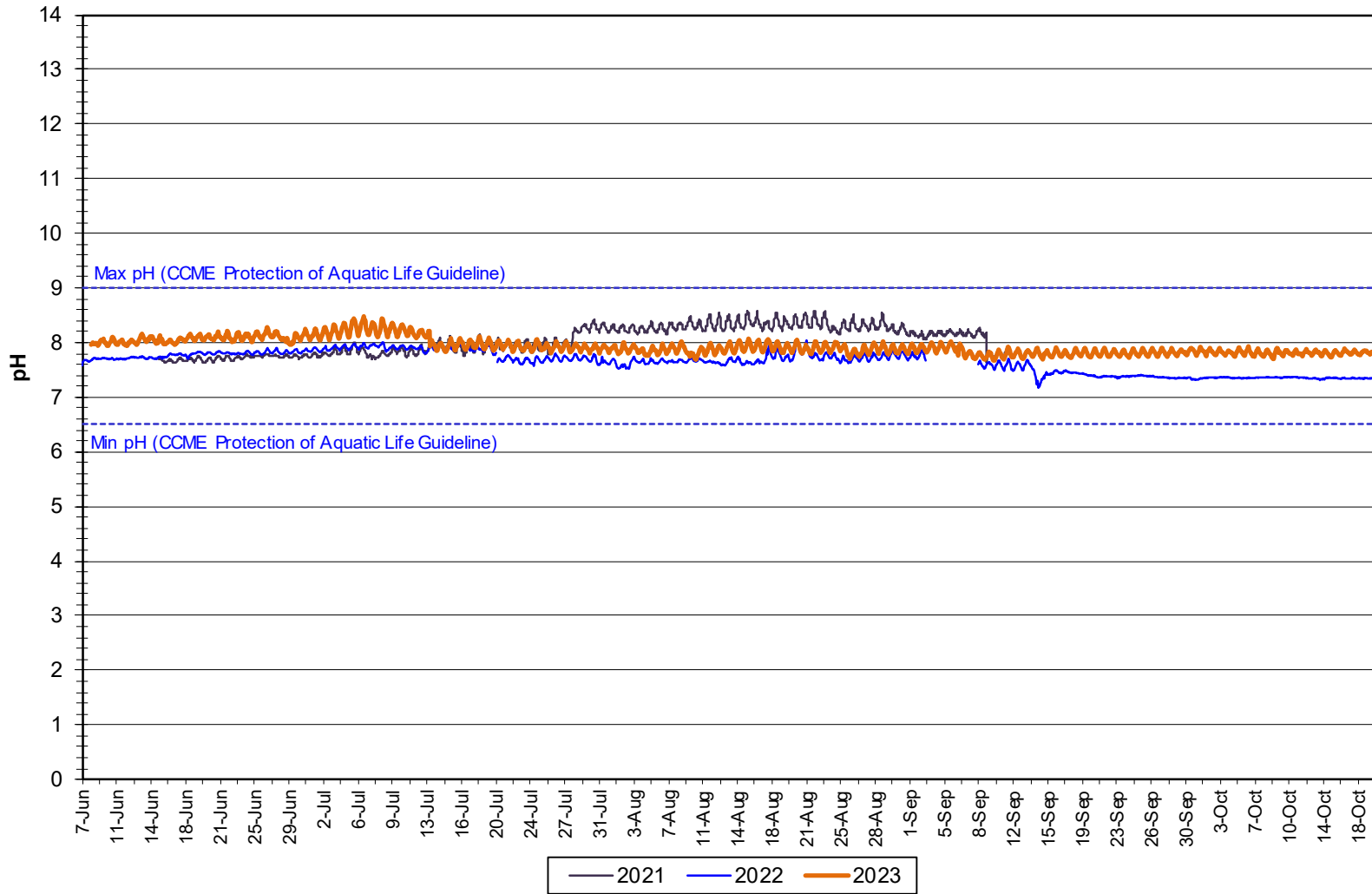
Appendix 1

3 Year Comparisons

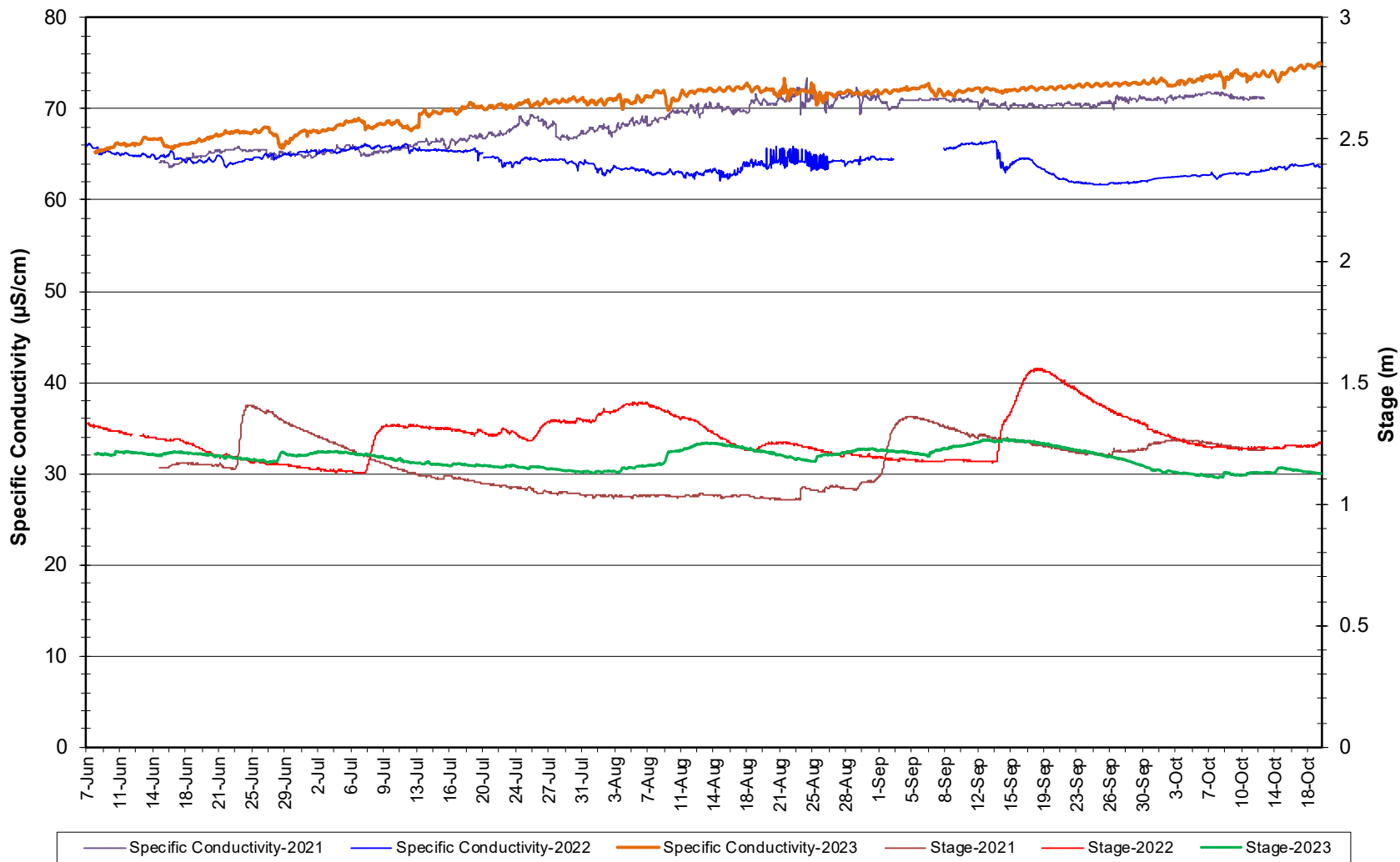
Water Temperature: Flora Creek below TLH 2021-2023



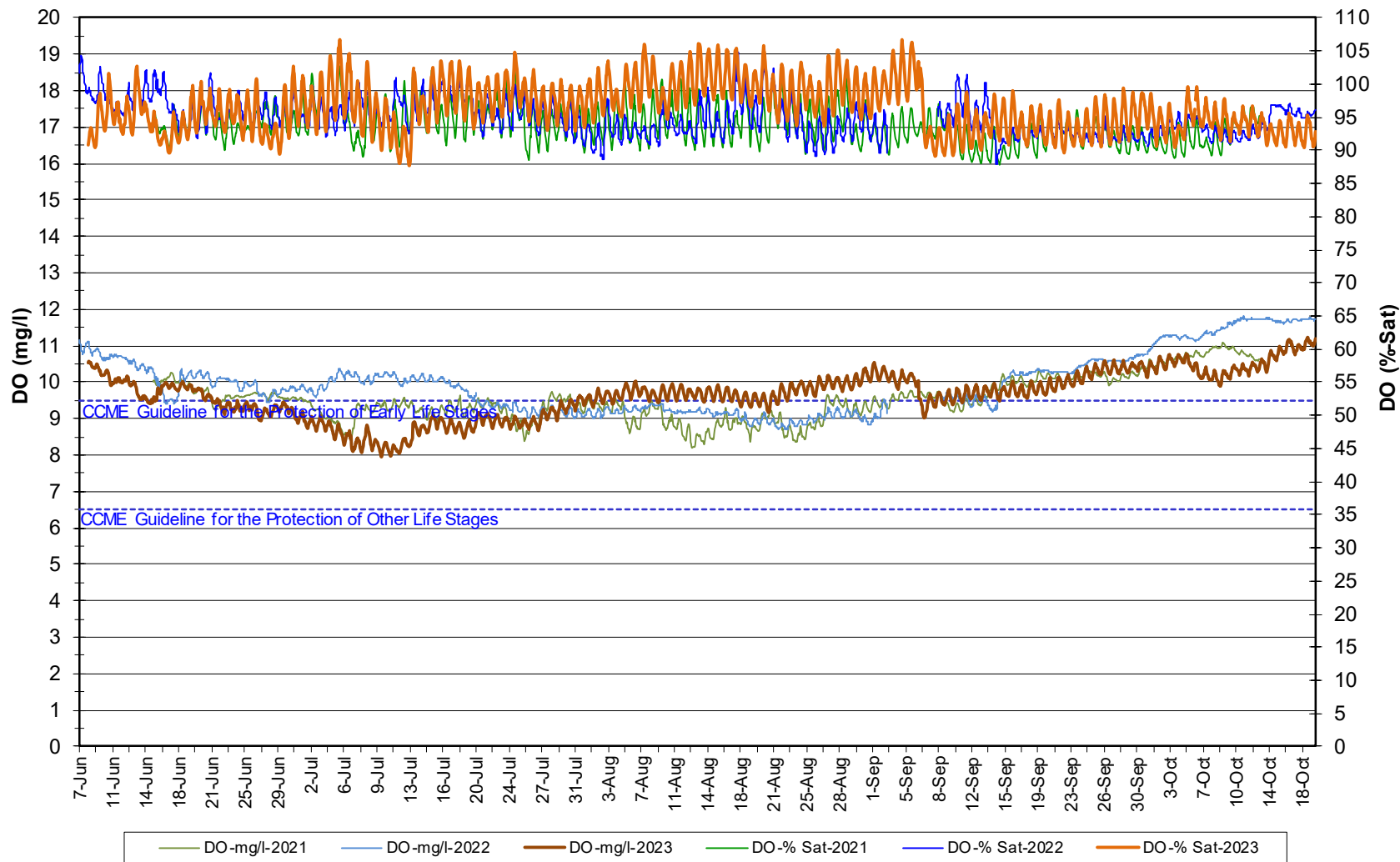
Water pH: Flora Creek below TLH 2021-2023



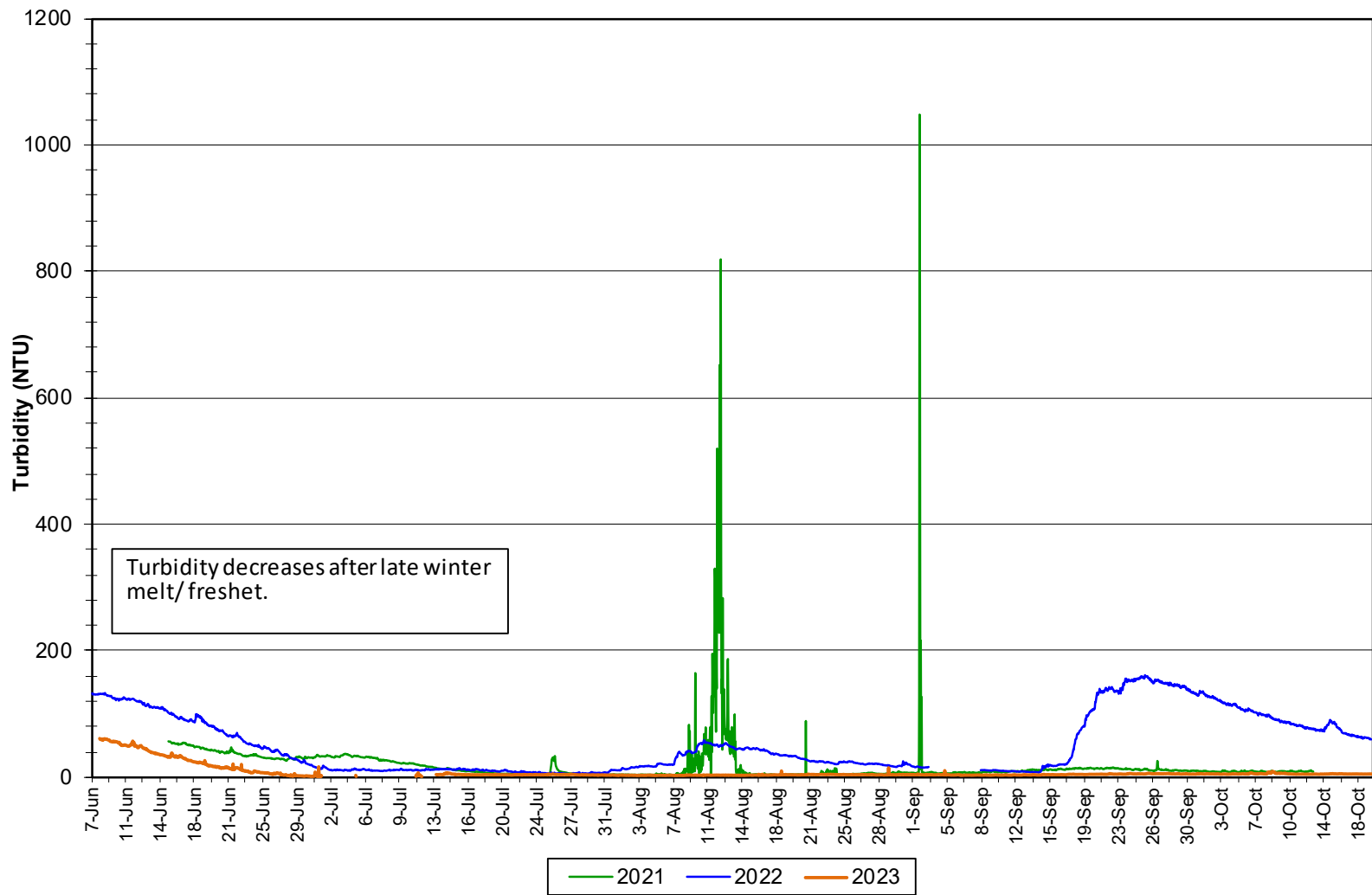
Specific Conductivity and Stage: Flora Creek below TLH 2021-2023



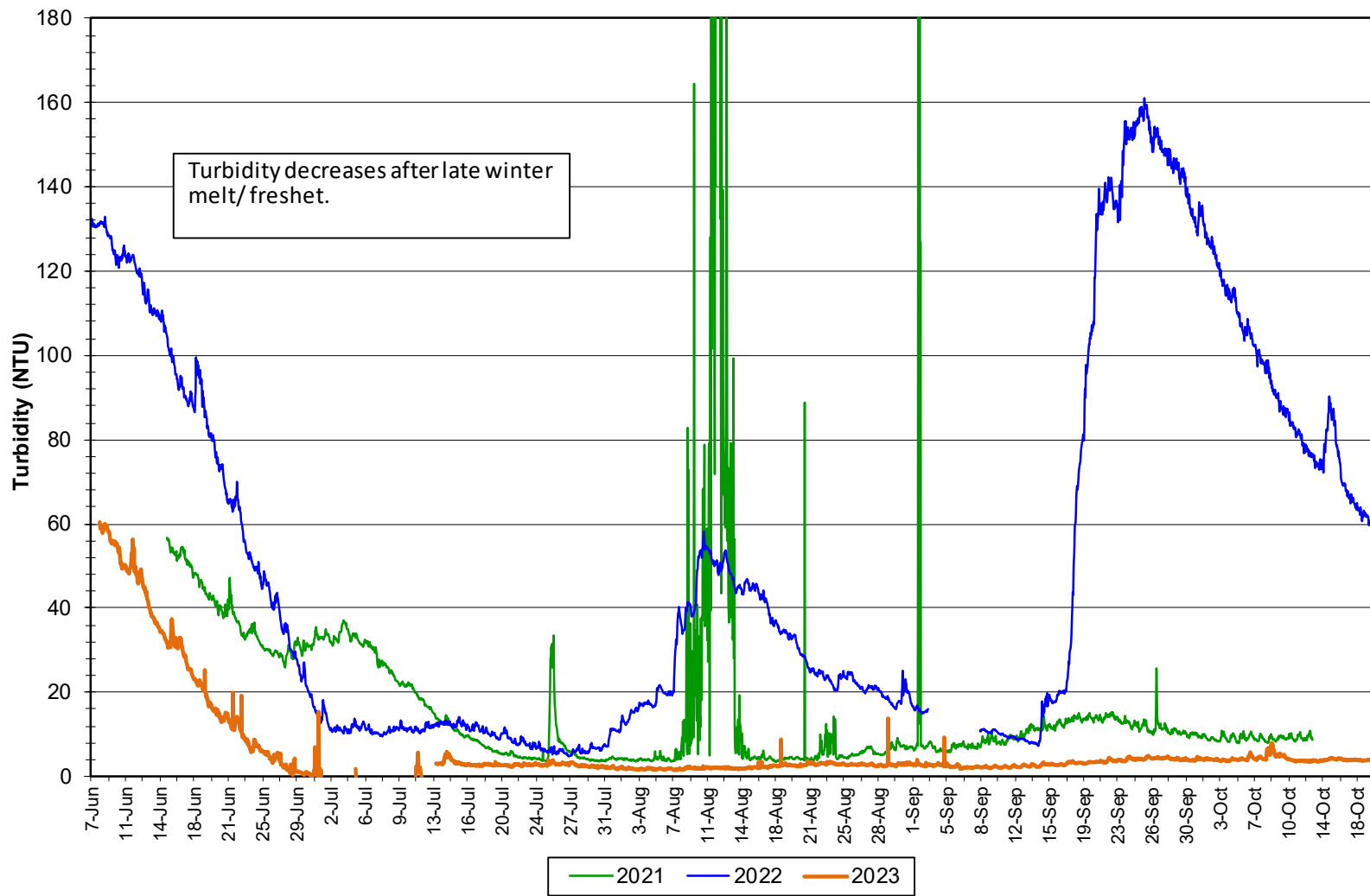
Dissolved Oxygen Concentration and Saturation: Flora Creek below TLH 2021-2023



Water Turbidity: Flora Creek below TLH 2021-2023



Water Turbidity <180 NTU: Flora Creek below TLH 2021-2023



Appendix 2

Air Temperature and Precipitation

Average Daily Air Temperature and Precipitation: Moosehead Lake June 7 to October 19, 2023

