Real-Time Water Quality Annual Report

Flora Creek below TLH

July 25 to
October 17, 2024

Newfoundland Labrador

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 (formerly of 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 2024; 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 2024.

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 Department of Environment and Climate Change).
- 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.

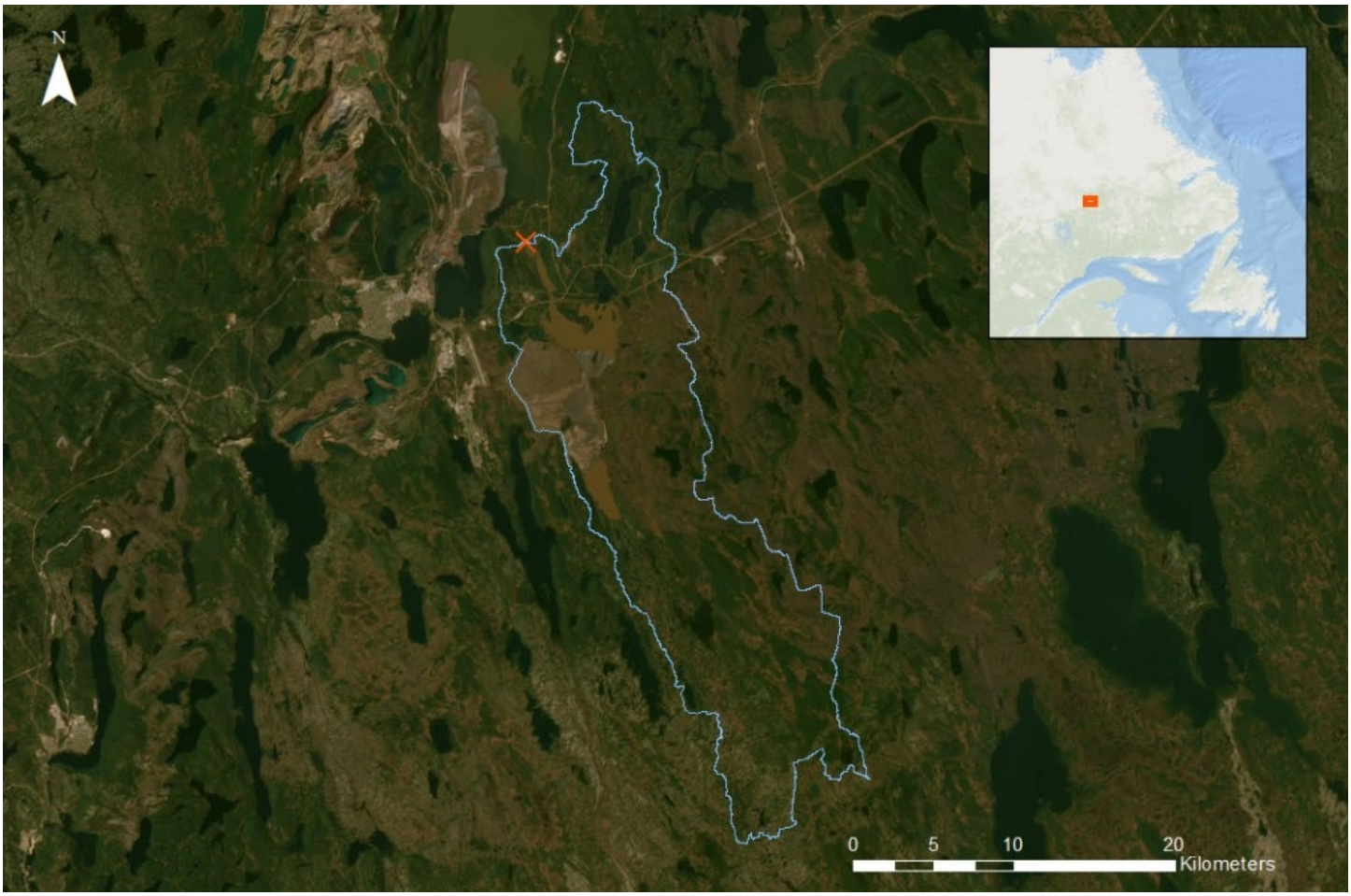

Figure 1: RTWQ Flora Creek station and watershed

- 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 2024 season was on July 25th. This was a later start to the deployment season due to unavailability of helicopter transportation to the site. An attempt to walk to the site was made but was unsuccessful. The instrument was removed for the winter season on October 17th. The following report depicts and discusses water quality events throughout this period.

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 2024 season are summarized in the table below.

Table 1: Water quality instrument deployment start and end dates for 2024

Installation	Removal	Deployment duration (days)
July 25	September 18	55
September 18	October 17	29

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

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

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature 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 deployment periods from July 25 to October 17, 2024, are summarized in Table 3.
- For additional information and explanations of rankings, please refer to the 2024 monthly deployment reports.

Table 3: QA/QC comparison rankings for Flora Creek July 25 to October 17, 2024

	Date		Temperature	pH	Specific Conductivity	Dissolved Oxygen	Turbidity
Flora Creek	25-Jul-24	Deployment	Good	Excellent	Excellent	Good	Excellent
	18-Sep-24	Removal	Excellent	Good	Excellent	Excellent	Excellent
	18-Sep-24	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	17-Oct-24	Removal	Excellent	Good	Excellent	Excellent	Excellent

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from July 25th, 2024 to October 17th, 2024 at Flora Creek.

- Water Survey Canada operates the hydrometric component of this station. Due to differences in protocols, Water Survey Canada hydrometric data is quality controlled on a less frequent basis than water quality data. The hydrometric data shown in this report is provisional and has not undergone quality control checks. Corrected hydrometric data can be obtained at https://wateroffice.ec.gc.ca/ or upon request to Water Survey Canada.

Flora Creek below TLH

- Water temperature ranged from 2.36 to 23.53°C during the 2024 deployment season. The median value was 15.06°C (Figure 2).
- Water temperature corresponded to increases/decreases in ambient air temperature. Overall, water temperature decreased over the course of this deployment season.

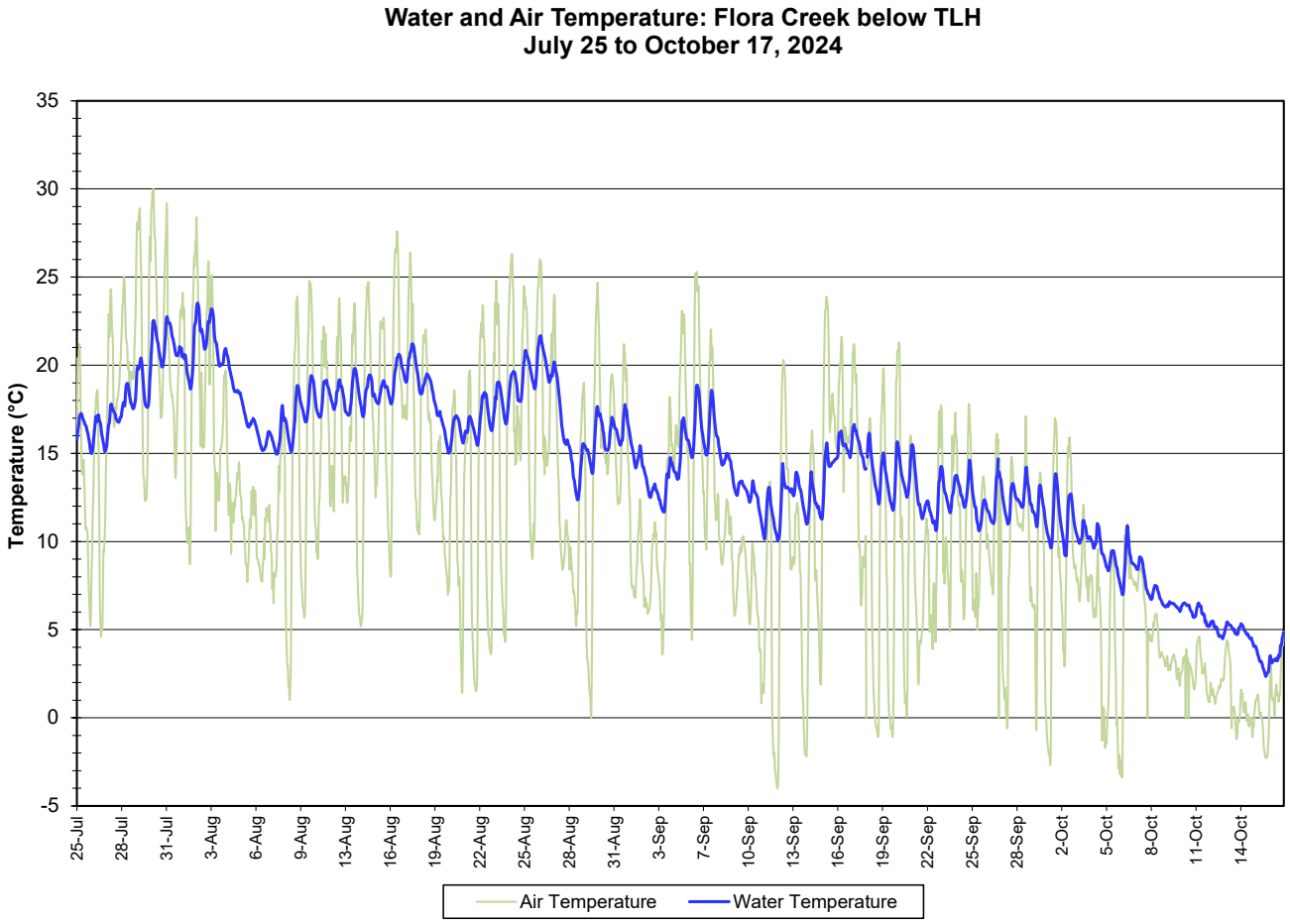

Figure 2: Water and Air Temperature – Flora Creek below TLH

(Weather data collected from climate station near Moosehead Lake)

- pH ranges from 7.67 to 8.16 pH units at Flora Creek, throughout the 2024 deployment season (Figure 3). The median pH is 7.87.
- pH increased slightly during the first few weeks of deployment and then was relatively stable during the remainder of the deployment season. pH fluctuates daily. Peaks are observed during late afternoon and early evening. There were less fluctuations during the last week of deployment.
- 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).

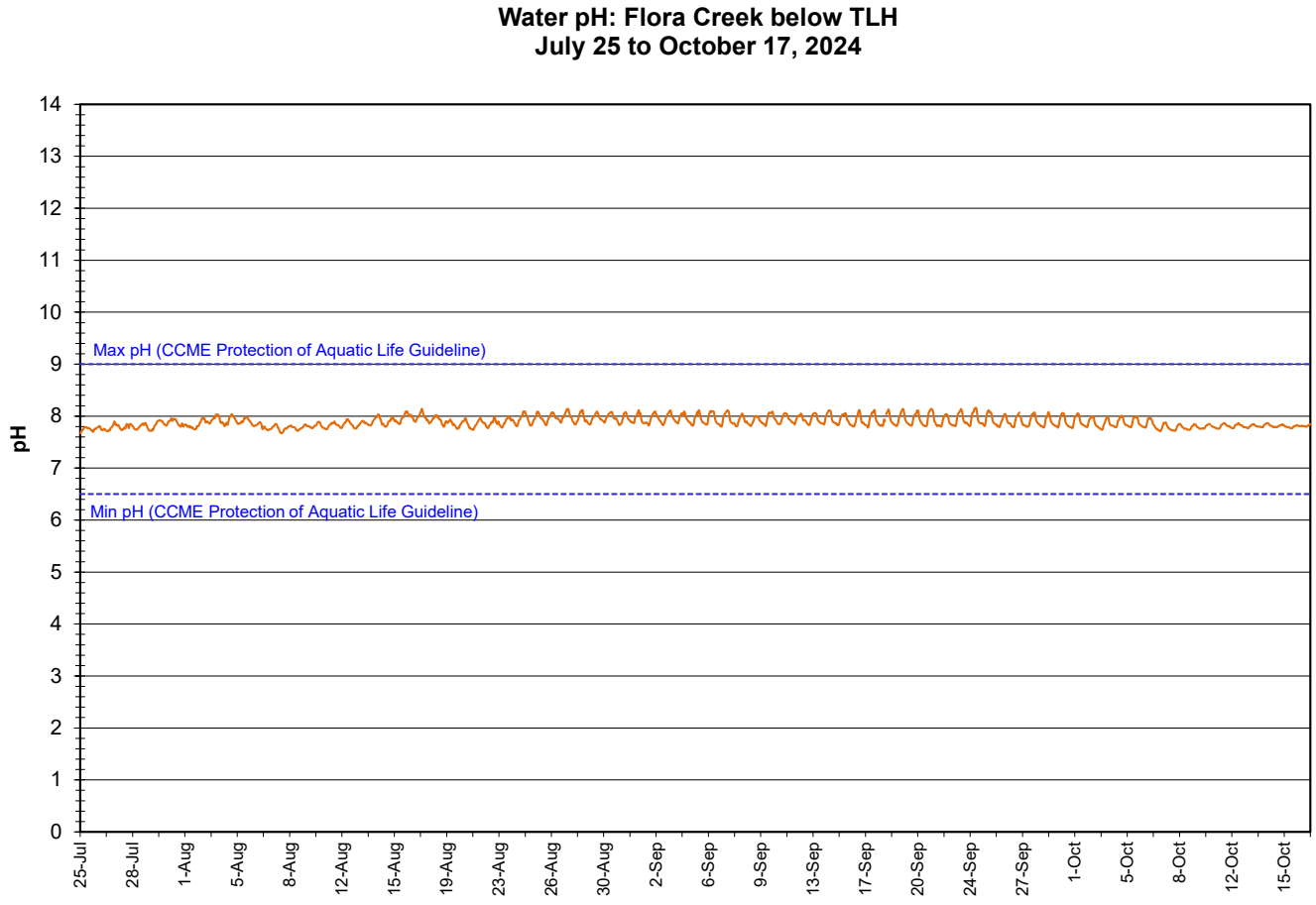

Figure 3: pH – Flora Creek below TLH

- Throughout the 2024 deployment season, specific conductivity ranged from 65.2 to 74.9 µs/cm, with a median value of 71.6 µs/cm at Flora Creek (Figure 4).
- Conductivity increased over the course of this deployment season, occasionally fluctuating in response to increases/decreases in stage; two instances are identified on the graph in red. These are noticeable, albeit small decreases in conductivity that correspond with increases in stage.
- Water Survey Canada operates the hydrometric component of this station. Due to differences in protocols, Water Survey Canada hydrometric data is quality controlled on a less frequent basis than water quality data. The hydrometric data shown in this report is provisional and has not undergone quality control checks. Corrected hydrometric data can be obtained at https://wateroffice.ec.gc.ca/ or upon request to Water Survey Canada.

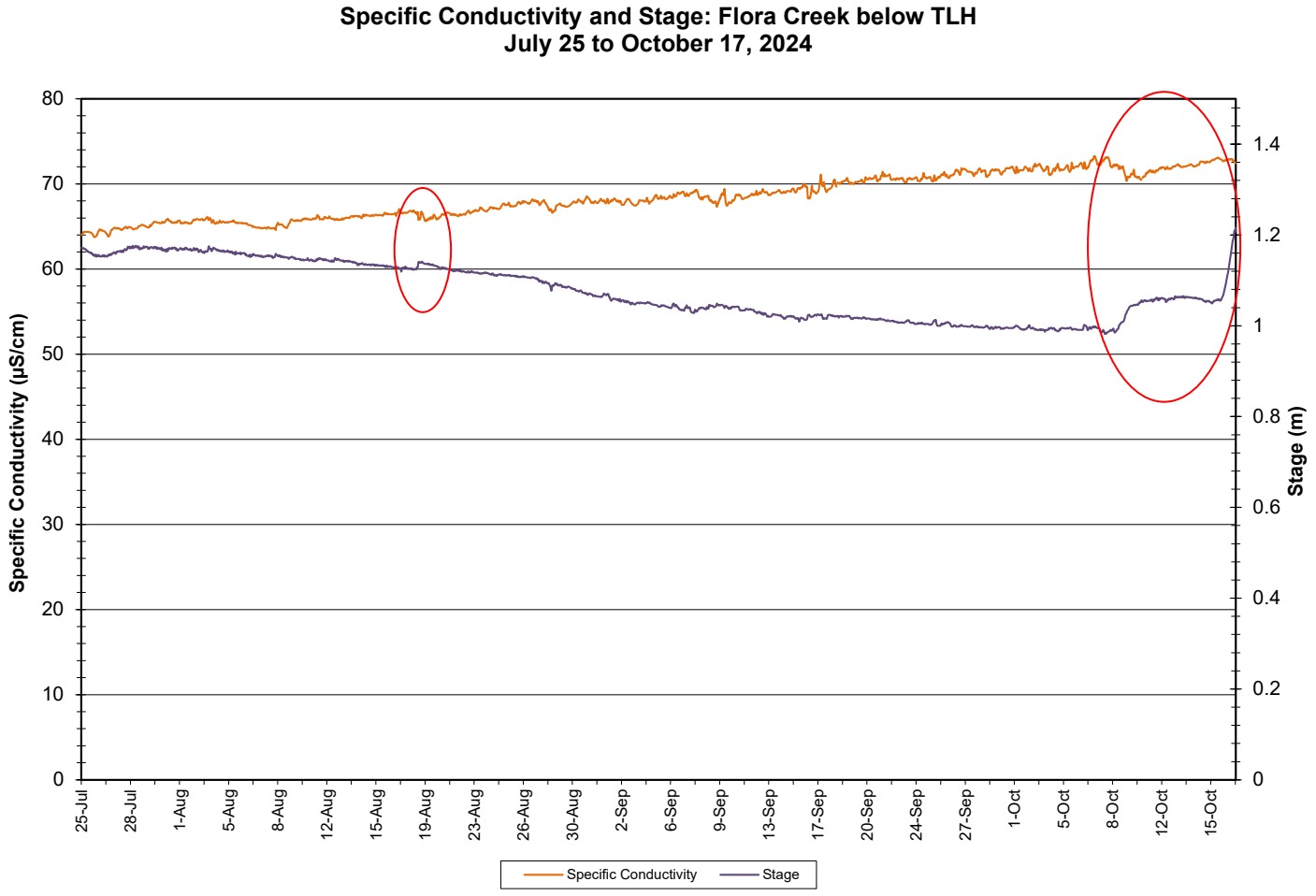

Figure 4: Specific Conductivity and Stage – Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 89.3 to 106.7%, while the dissolved oxygen content ranged from 8.45 to 12.79 mg/l, with a median value of 9.88 mg/l (Figure 5).
- Dissolved oxygen fluctuated daily with decreases observed at night.
- Dissolved oxygen decreases slightly during the first week of deployment, due to rising water temperatures in summer. Overall, it increases throughout the remainder of the deployment period, with brief decreases occurring when water temperature rises.
- 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.

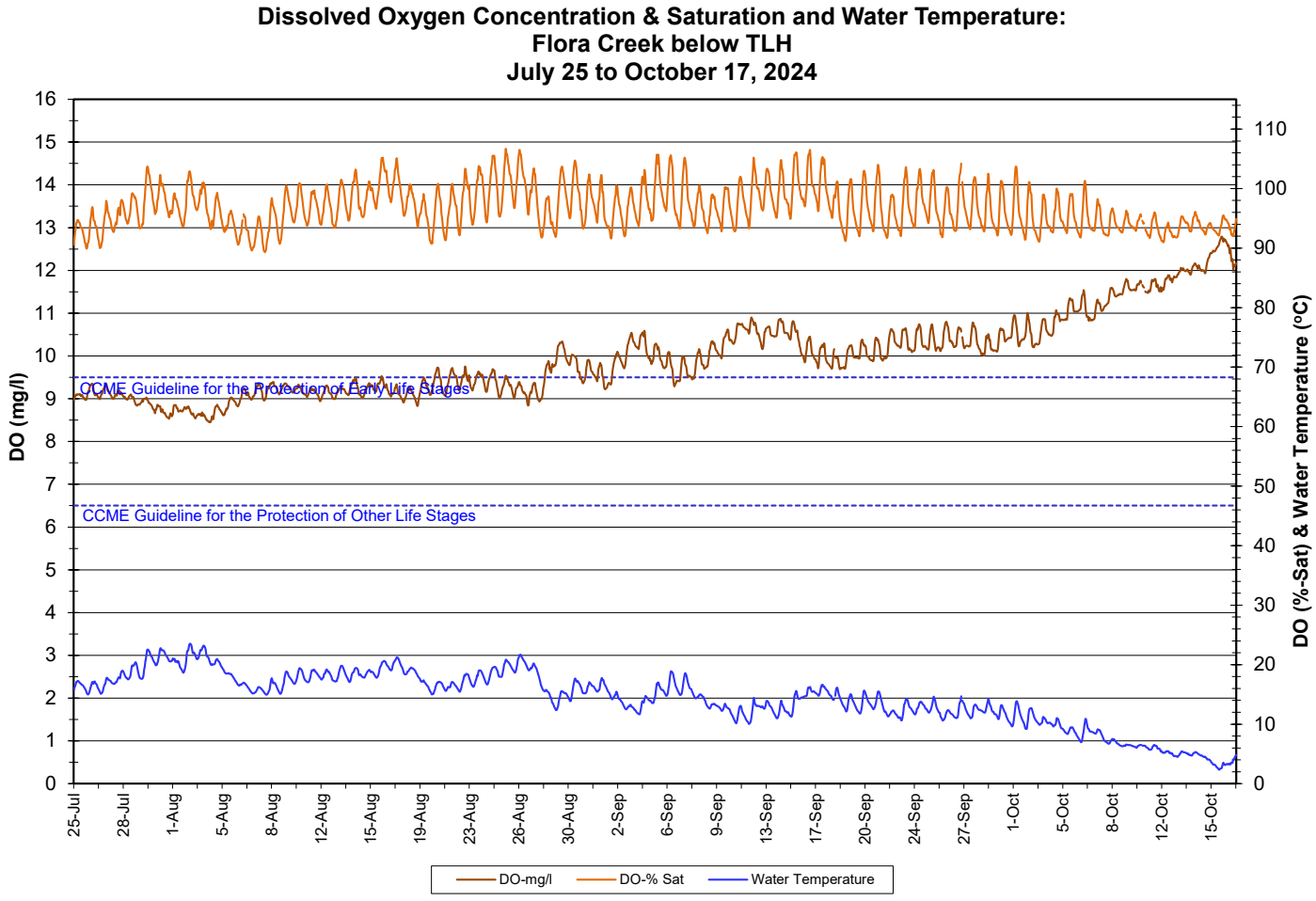

Figure 5: Dissolved Oxygen Concentration and Saturation and Water Temperature – Flora Creek below TLH

- At the Flora Creek station, turbidity values range from 1.6 to 39.9 NTU with a median value of 4.3 NTU (Figure 6).
- Turbidity is highest 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.

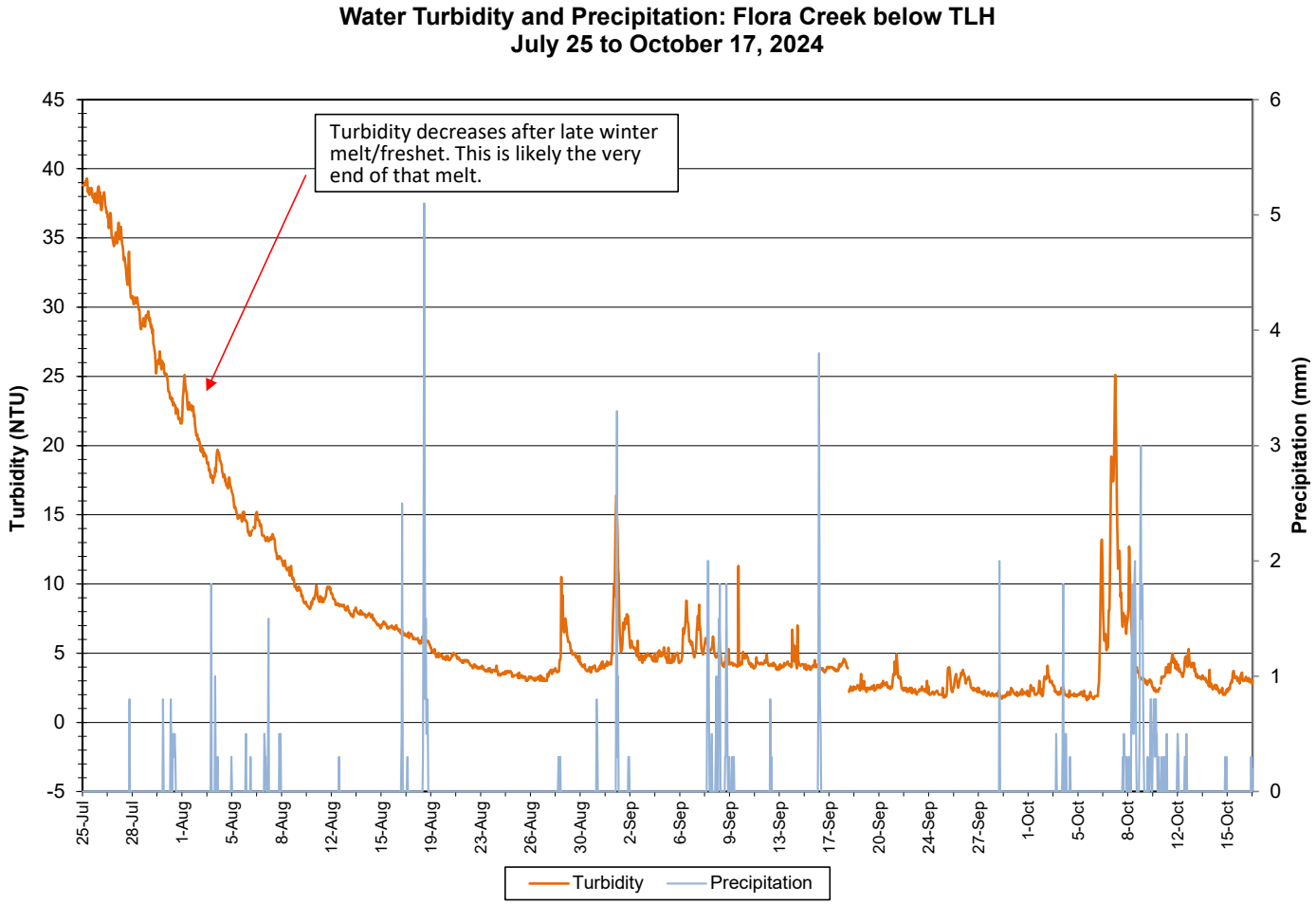

Figure 6: Turbidity and Precipitation - Flora Creek below TLH

- Stage and precipitation are graphed below to show the relationship between rainfall and water level at Flora Creek (Figure 7).
- Increases in stage correspond with significant precipitation events. Overall, stage decreased until the end of the deployment period, then rose again following a large precipitation event.
- Water Survey Canada operates the hydrometric component of this station. Due to differences in protocols, Water Survey Canada hydrometric data is quality controlled on a less frequent basis than water quality data. The hydrometric data shown in this report is provisional and has not undergone quality control checks. Corrected hydrometric data can be obtained at https://wateroffice.ec.gc.ca/ or upon request to Water Survey Canada.

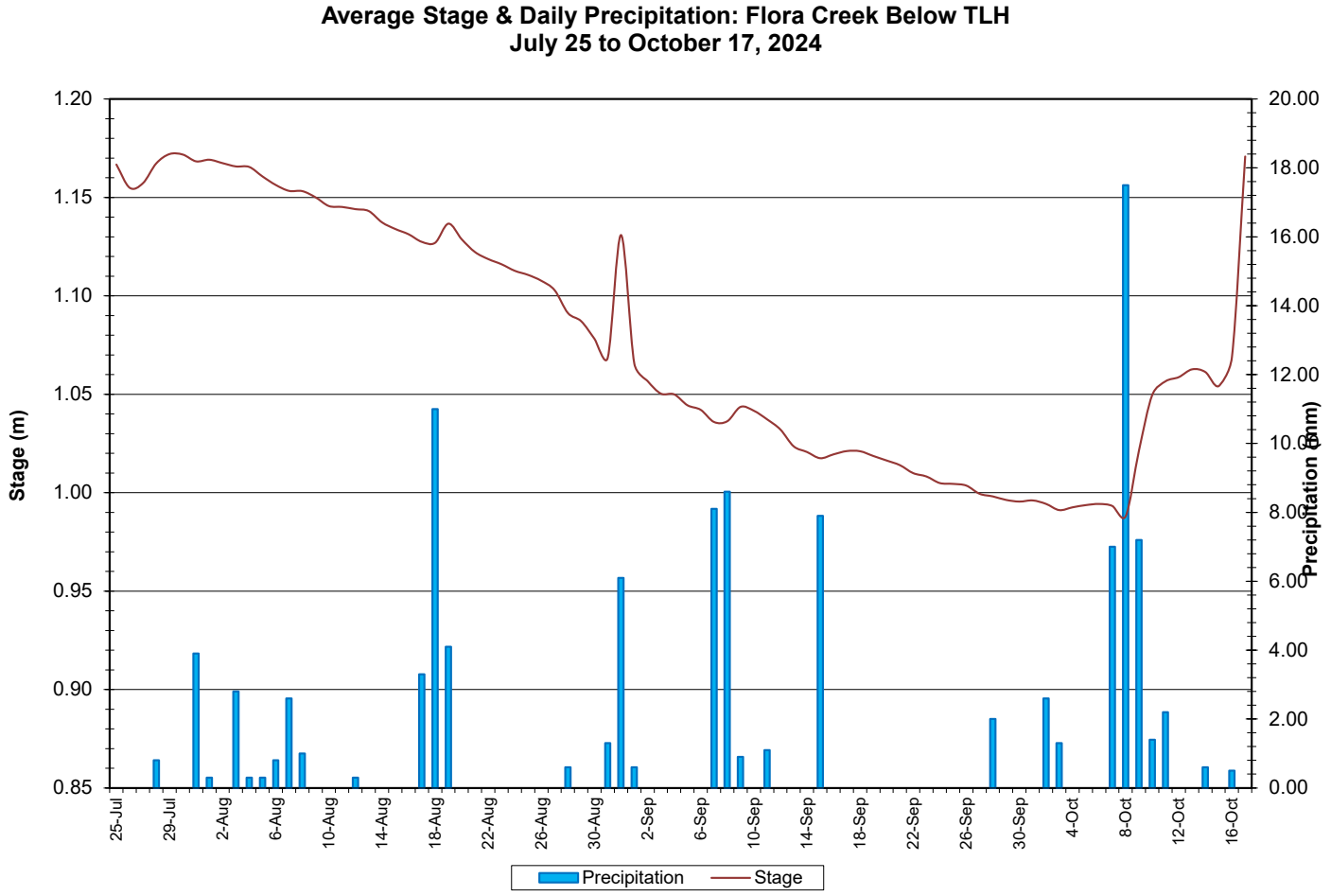

Figure 7: Average Stage and Daily Precipitation - Flora Creek below TLH

(Weather data collected from climate station near Moosehead Lake)

Conclusions

- The instrument at the water quality monitoring station on Flora Creek was deployed on July 25th, 2024 and removed on October 17th, 2024 for the winter season.
- Deployment periods ranged from 29 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 2024 season with no issues.
- Water temperature corresponded with increases/decreases in air temperature. Water temperature followed seasonal trends.
- All pH values were within the acceptable range of the CCME Water Quality Guidelines for Protection of Aquatic Life.
- Specific conductivity increased during the 2024 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. Turbidity spikes were also noted after some significant rainfall events.

Path Forward

- The field instrument will undergo proficiency testing and evaluation during the winter of 2024-2025. ECC will inform Tacora Resources of any instrument performance issues.
- ECC staff will deploy real time water quality instruments in spring 2025 when ice conditions allow and perform regular site visits throughout the 2025 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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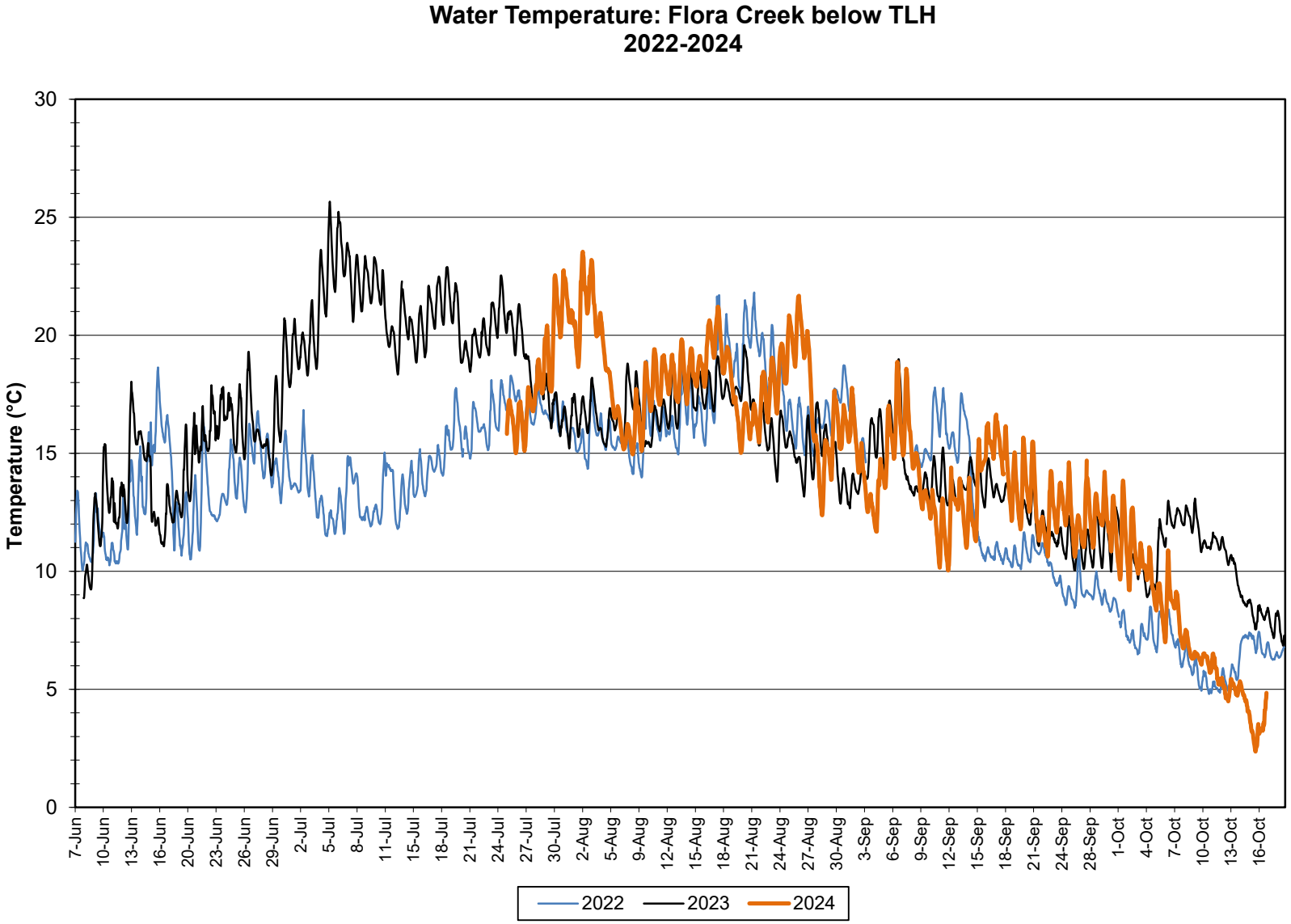
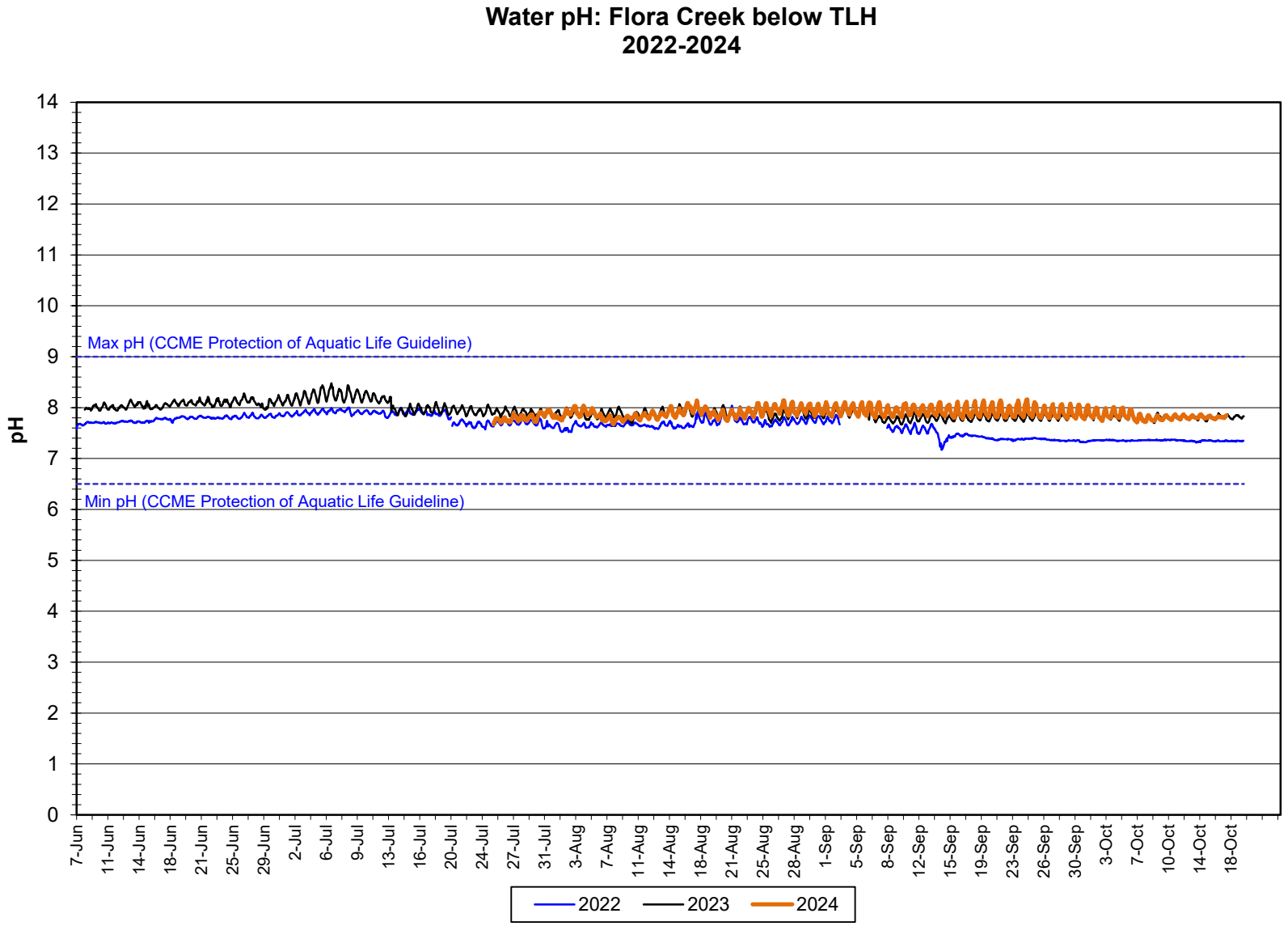
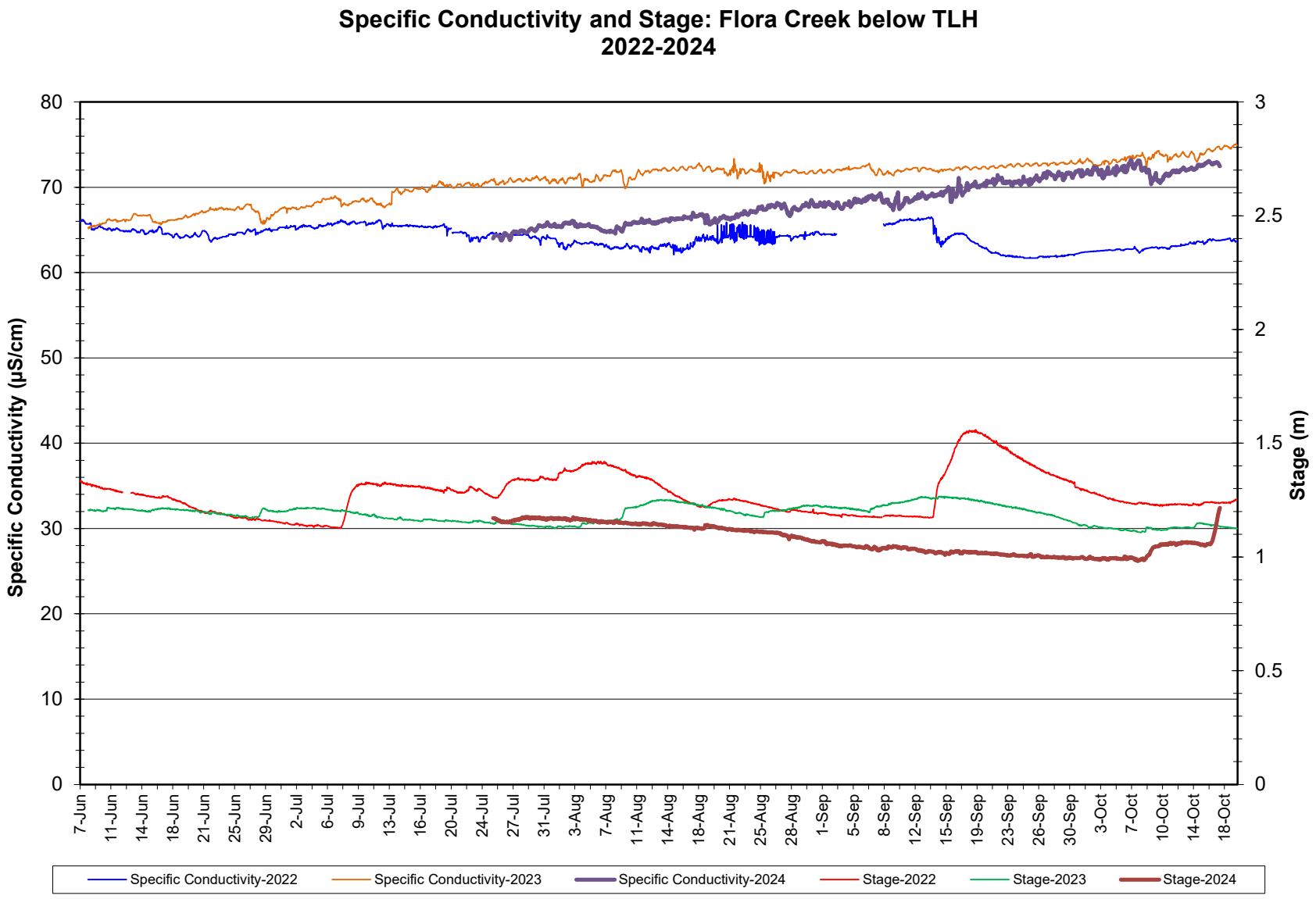
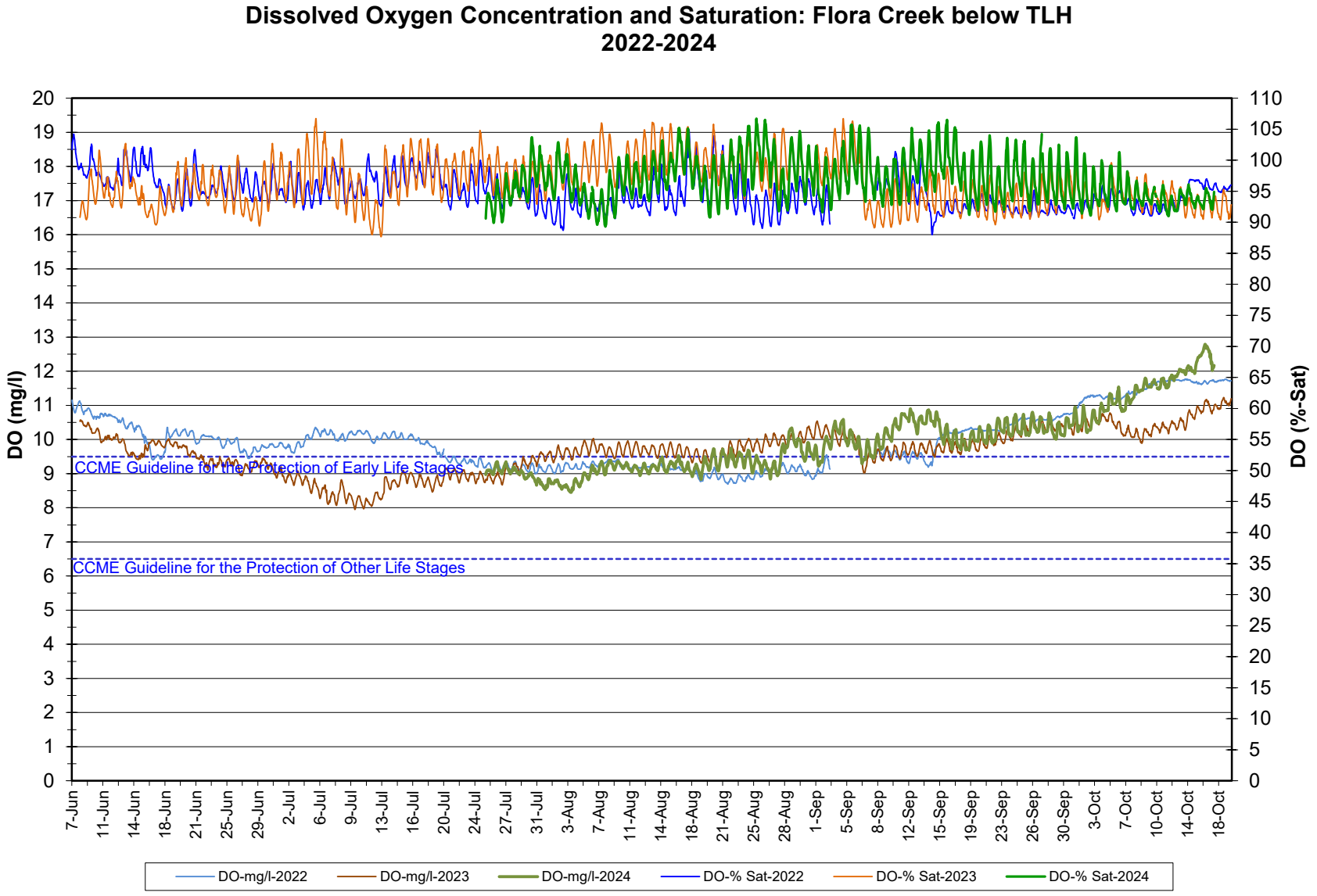
Appendix 1

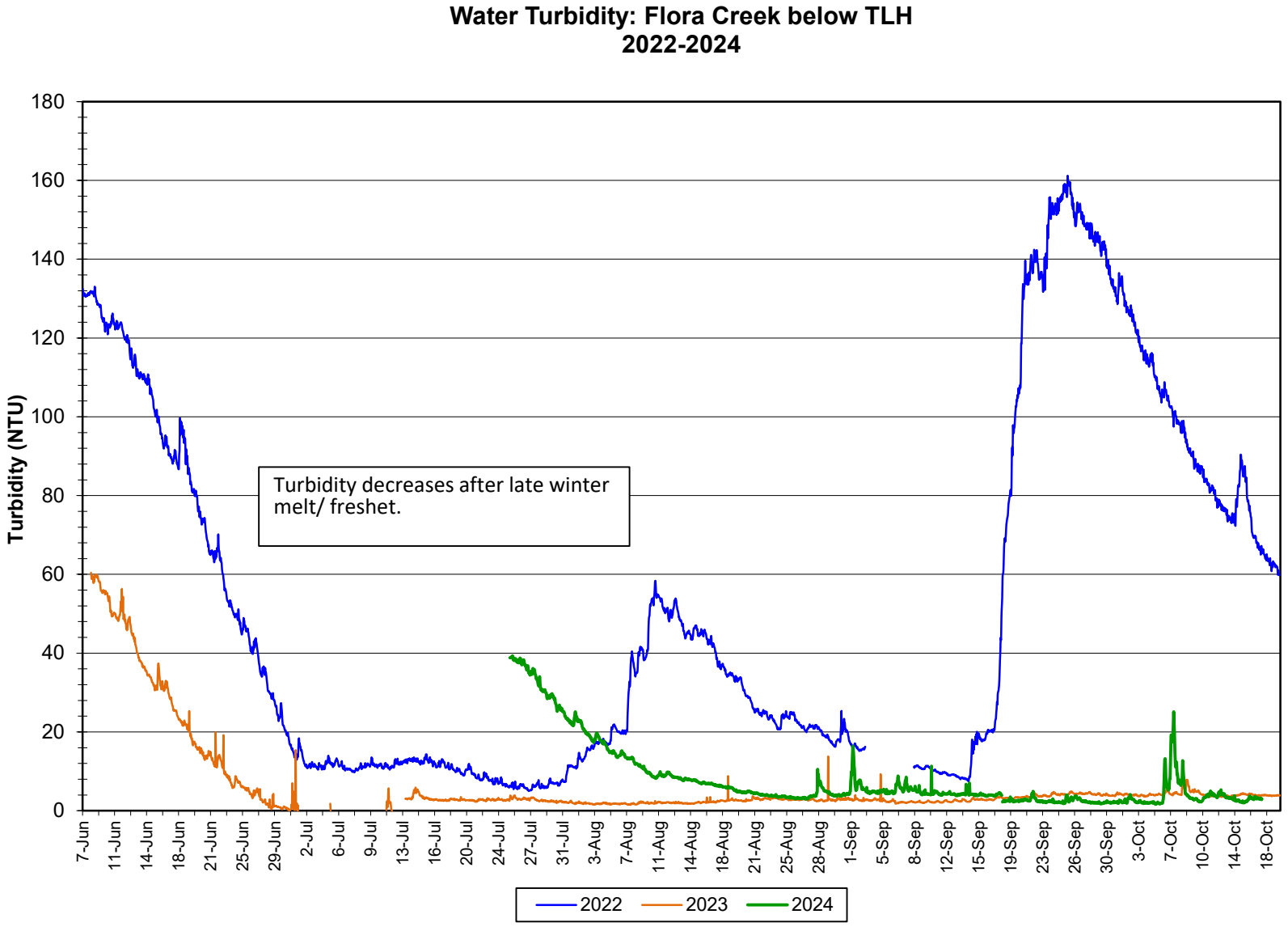
3 Year Comparisons


Water Temperature: Flora Creek below TLH
2022-2024
Temperature (°C)
30
25
20
15
10
5
0
7-Jun
10-Jun
13-Jun
16-Jun
20-Jun
23-Jun
26-Jun
29-Jun
2-Jul
5-Jul
8-Jul
11-Jul
15-Jul
18-Jul
21-Jul
24-Jul
27-Jul
30-Jul
2-Aug
5-Aug
9-Aug
12-Aug
15-Aug
18-Aug
21-Aug
24-Aug
27-Aug
30-Aug
3-Sep
6-Sep
9-Sep
12-Sep
15-Sep
18-Sep
21-Sep
24-Sep
28-Sep
1-Oct
4-Oct
7-Oct
10-Oct
13-Oct
16-Oct
2022
2023
2024


Water pH: Flora Creek below TLH
2022-2024
pH
Max pH (CCME Protection of Aquatic Life Guideline)
Min pH (CCME Protection of Aquatic Life Guideline)
2022
2023
2024


Specific Conductivity and Stage: Flora Creek below TLH
2022-2024
Specific Conductivity (µS/cm)
Stage (m)
0
10
20
30
40
50
60
70
80
0
0.5
1
1.5
2
2.5
3
7-Jun
11-Jun
14-Jun
18-Jun
21-Jun
25-Jun
29-Jun
2-Jul
6-Jul
9-Jul
13-Jul
16-Jul
20-Jul
24-Jul
27-Jul
31-Jul
3-Aug
7-Aug
11-Aug
14-Aug
18-Aug
21-Aug
25-Aug
28-Aug
1-Sep
5-Sep
8-Sep
12-Sep
15-Sep
19-Sep
23-Sep
26-Sep
30-Sep
3-Oct
7-Oct
10-Oct
14-Oct
18-Oct
Specific Conductivity-2022
Specific Conductivity-2023
Specific Conductivity-2024
Stage-2022
Stage-2023
Stage-2024


Dissolved Oxygen Concentration and Saturation: Flora Creek below TLH
2022-2024
DO (mg/l)
DO (%-Sat)
CCME Guideline for the Protection of Early Life Stages
CCME Guideline for the Protection of Other Life Stages
DO-mg/l-2022
DO-mg/l-2023
DO-mg/l-2024
DO-% Sat-2022
DO-% Sat-2023
DO-% Sat-2024


Water Turbidity: Flora Creek below TLH
2022-2024
Turbidity (NTU)
180
160
140
120
100
80
60
40
20
0
Turbidity decreases after late winter melt/ freshet.
7-Jun
11-Jun
14-Jun
18-Jun
21-Jun
25-Jun
29-Jun
2-Jul
6-Jul
9-Jul
13-Jul
16-Jul
20-Jul
24-Jul
27-Jul
31-Jul
3-Aug
7-Aug
11-Aug
14-Aug
18-Aug
21-Aug
25-Aug
28-Aug
1-Sep
5-Sep
8-Sep
12-Sep
15-Sep
19-Sep
23-Sep
26-Sep
30-Sep
3-Oct
7-Oct
10-Oct
14-Oct
18-Oct
2022
2023
2024

Appendix 2
Air Temperature and Precipitation

Average Daily Air Temperature and Precipitation: Moosehead Lake
July 25 to October 17, 2024