



Real-Time Water Quality Deployment Report

Flora Creek below TLH

July 28 to
September 9, 2021



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

Contents

| | |
|---|----|
| General | 2 |
| Quality Assurance and Quality Control..... | 2 |
| Data Interpretation | 4 |
| Flora Creek below TLH | 4 |
| Conclusions | 11 |
| Appendix 1 - Air Temperature & Precipitation..... | 12 |
| Appendix 2 - QA/QC Grab Sample Results | 13 |

General

- The Water Resources Management Division, in partnership with Tacora Resources Inc. – Wabush Mines, maintains one real-time water quality and water quantity station at Flora Creek.
- This station is situated downstream of the former Wabush Mines tailings disposal area in Flora Lake.
- Water Resources Management Division staff monitor the real-time web pages regularly.
- On July 28, 2021, a real-time water quality monitoring instrument was deployed at the station Flora Creek below TLH. The instrument was deployed for a period of 43 days. This was the second deployment for 2021.

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 Sonde is temporarily deployed along side 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 1).

Table 1: 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 dependant, temperature compensated and temperature independent. Because 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 station on Flora Creek deployed between July 28 and September 9, 2021 are summarized in Table 2.

Table 2: Comparison rankings for Flora Creek below TLH station July 28 – September 9, 2021.

| Station | Date | Action | Comparison Ranking | | | | |
|-----------------------|--------------|------------|--------------------|-----------|--------------|------------------|-----------|
| | | | Temperature | pH | Conductivity | Dissolved Oxygen | Turbidity |
| Flora Creek below TLH | Jul 28, 2021 | Deployment | Excellent | Excellent | Excellent | Excellent | Excellent |
| | Sept 9, 2021 | Removal | Excellent | Fair | Excellent | Excellent | Excellent |

- At deployment, all parameters ranked ‘excellent’.
- At removal, all parameters except pH ranked ‘excellent’. pH ranked ‘fair’. The field sonde read a value of 8.17, while the QA/QC sonde read a value of 7.38. When the field sonde is compared to the value of the QA/QC grab sample that was collected at the time, this ranking is ‘good’. The value for pH of the grab sample is 7.72.
- There are few circumstances which may cause less than ideal QA/QC rankings to be obtained. These include: the placement of the QA/QC sonde in relation to the field sonde, the amount of time each sonde was given to stabilize before readings were recorded; and deteriorating performance of one of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality related events from July 28 to September 9 at the station Flora Creek below TLH.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion 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 13.09 to 23.34°C during this deployment period (Figure 1).
- Overall, water temperature increased over this deployment period, corresponding with ambient air temperature (Figure 1).

**Water and Air Temperature : Flora Creek below TLH
July 28 to September 9, 2021**

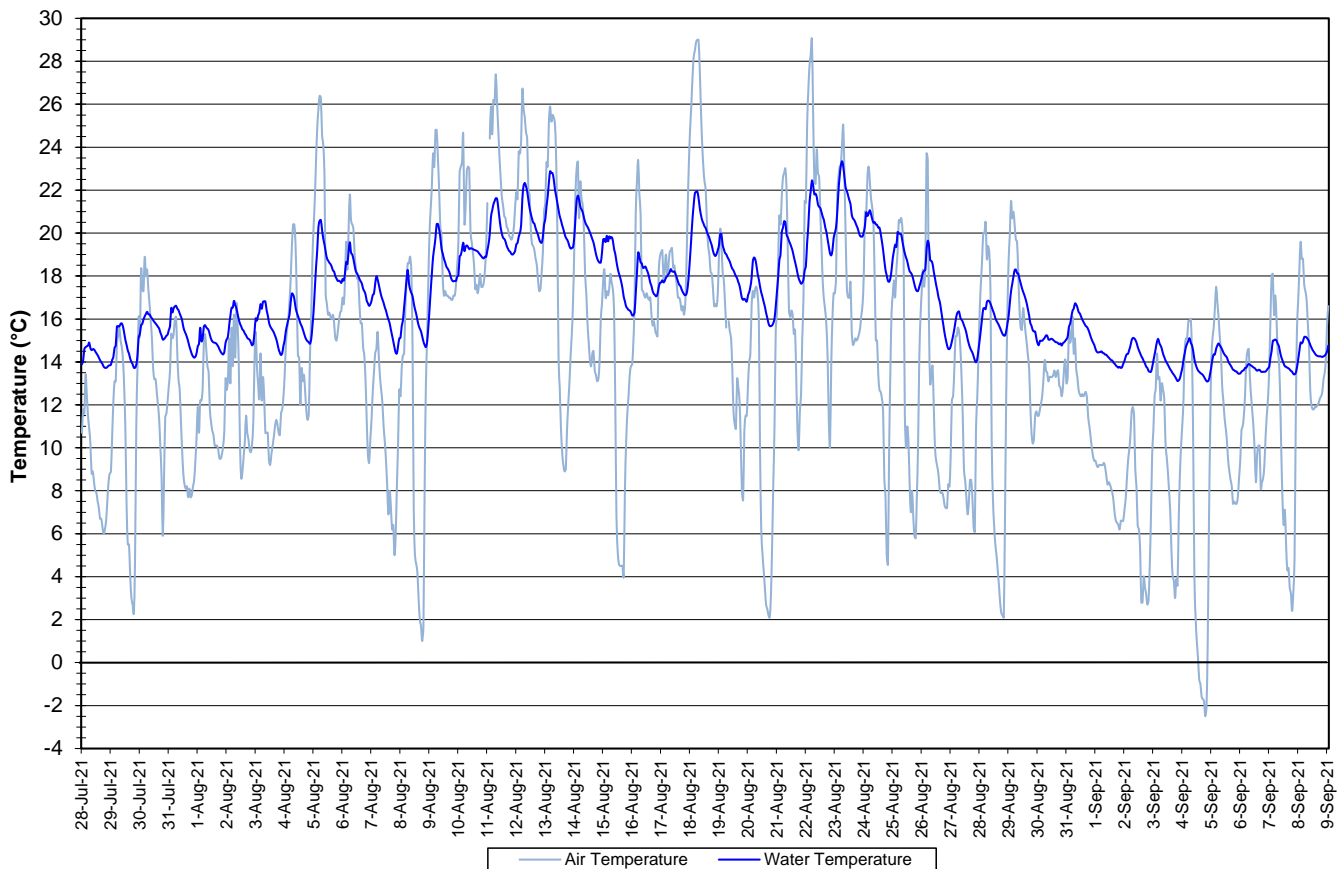


Figure 1: Water and Air Temperature - Flora Creek below TLH

(Weather data collected at Moosehead Lake)

- pH ranged between 8.05 and 8.59 pH units throughout the deployment period, with a median value of 8.26 units (Figure 2).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.

**Water pH and Stage : Flora Creek below TLH
July 28 to September 9, 2021**

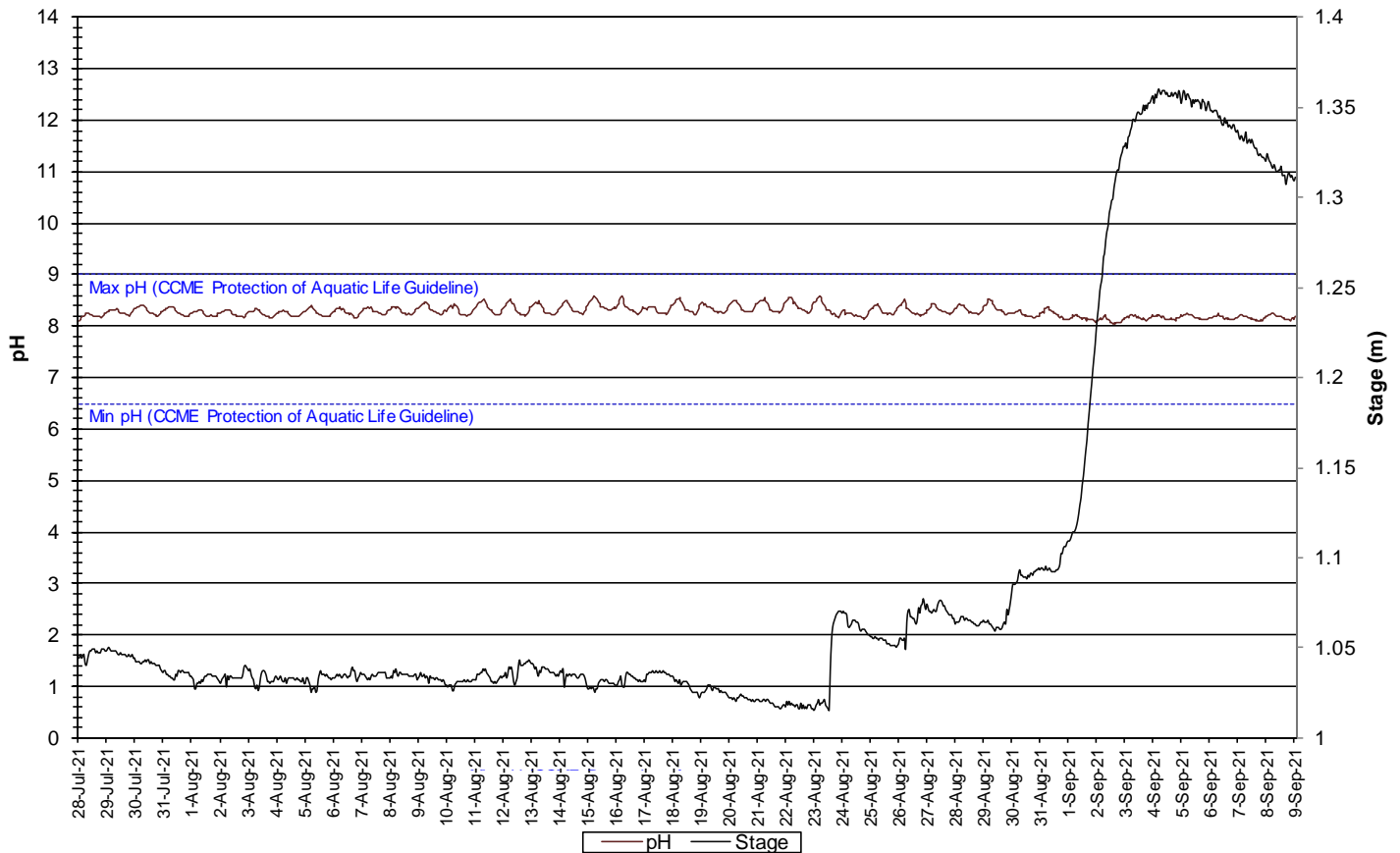


Figure 2: Water pH and Stage - Flora Creek below TLH

- Specific conductivity ranged from 66.6 to 73.4 $\mu\text{S}/\text{cm}$ (Figure 3).
- Specific conductivity increased over the deployment period.
- There are a few noticeable decreases in conductivity that correspond with precipitation events. This can be expected after rainfall. As the amount of water in the creek increases, this dilutes the solids that are present, decreasing the conductivity.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion 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 of Water and Stage : Flora Creek below TLH
July 28 to September 9, 2021**

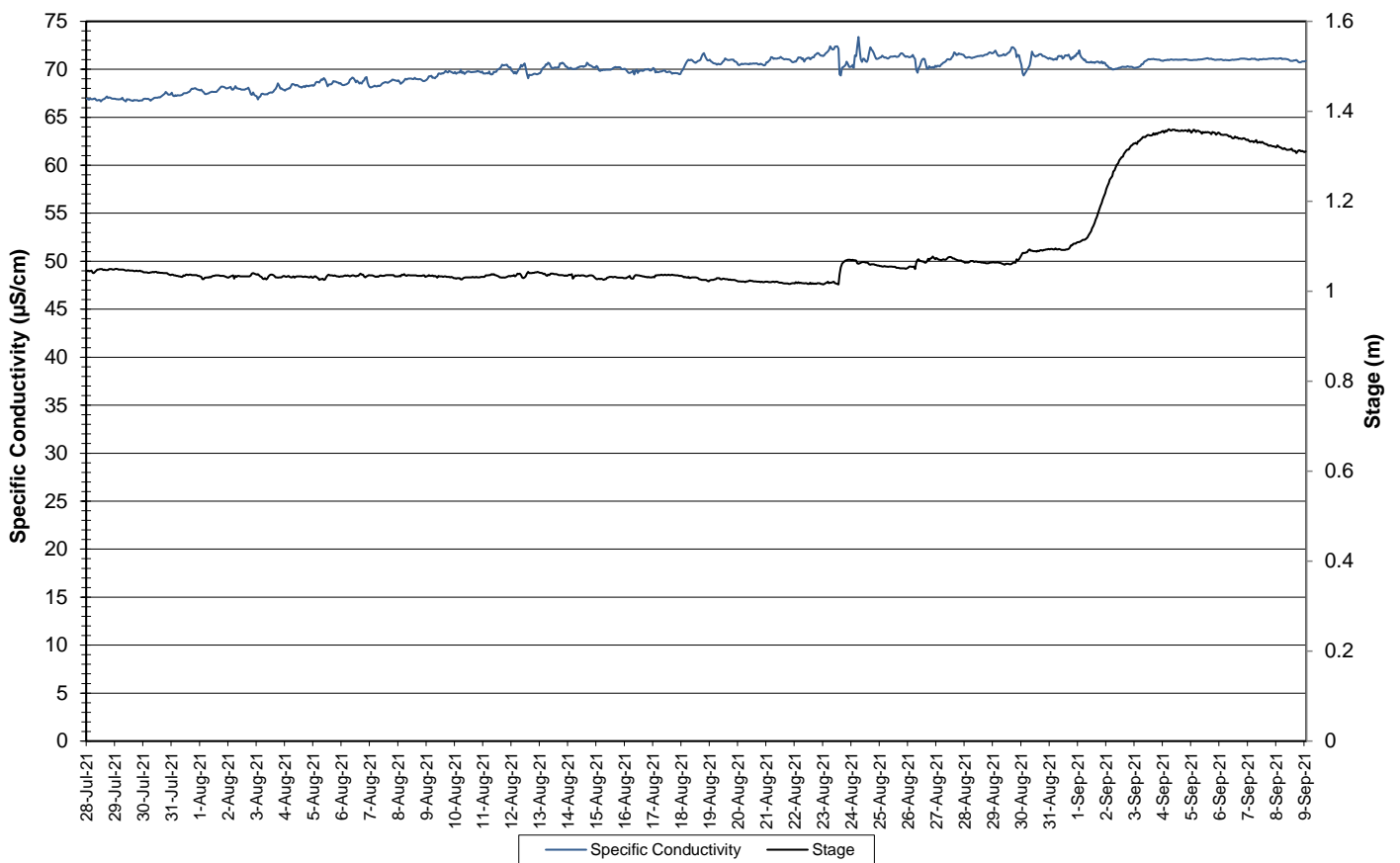


Figure 3: Specific Conductivity of Water and Stage - Flora Creek below TLH

Flora Creek below TLH, Newfoundland and Labrador

- The saturation of dissolved oxygen ranged from 89.3 to 102.5% and a range of 8.20 to 9.77 mg/l was found for the concentration of dissolved oxygen with a median value of 9.20 mg/l (Figure 4).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stages for Cold Water Biota of 6.5 mg/l. Most values were below the minimum CCME Guideline for the Protection of Early Life Stage for Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in blue on Figure 4.
- Dissolved oxygen content fluctuates diurnally and displays an inverse relationship to water temperature. DO decreases in August due to increasing water temperatures.

**Dissolved Oxygen Concentration and Saturation : Flora Creek below TLH
July 28 to September 9, 2021**

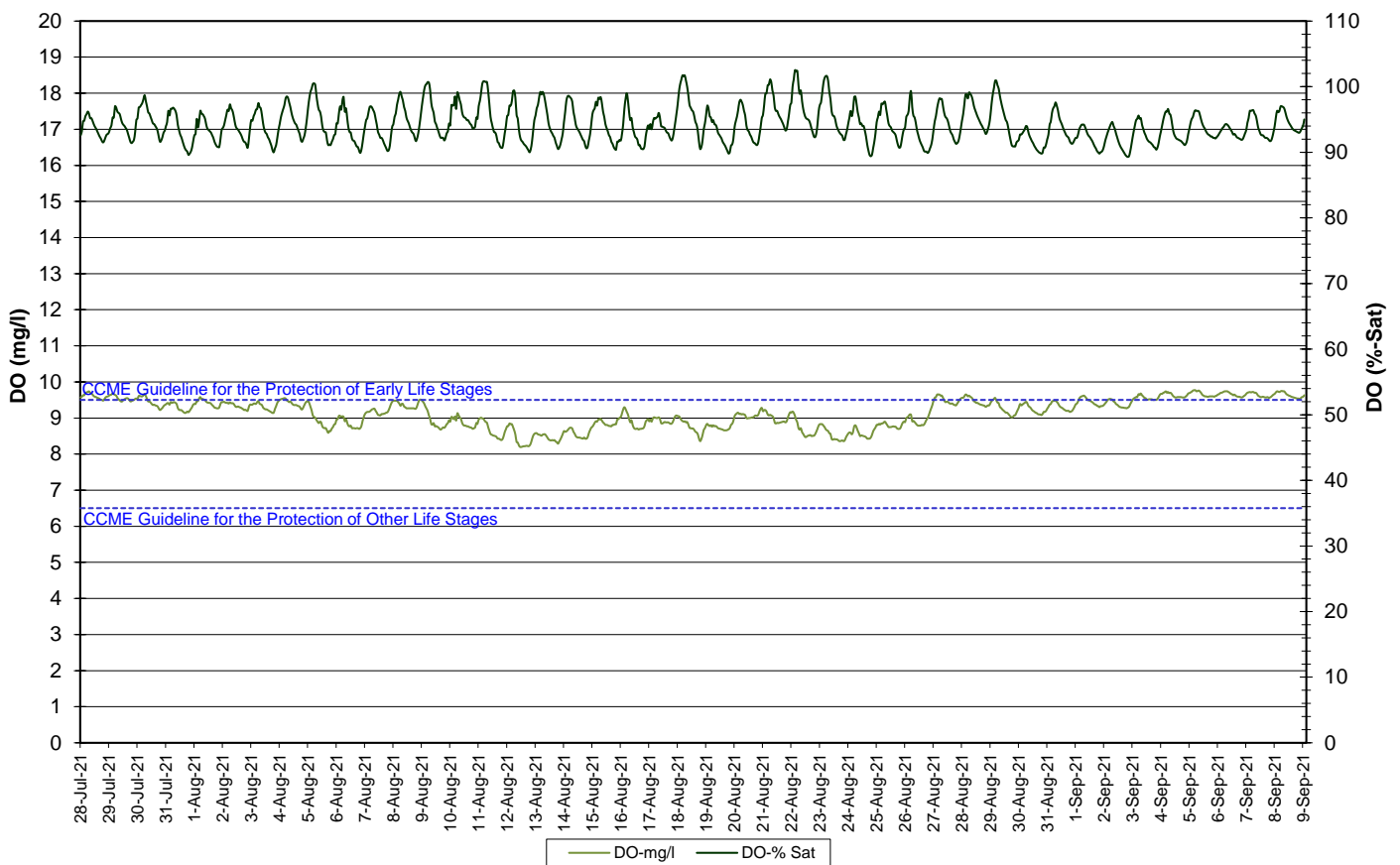


Figure 4: Dissolved Oxygen and Saturation - Flora Creek below TLH

Flora Creek below TLH, Newfoundland and Labrador

- Turbidity values range from 3.6 NTU to 1047.0 NTU.
- There are two events resulting in high turbidity during this deployment period. There was a period of prolonged turbidity in August for several days before returning to baseline values. This may be the result of accumulated sediment around the sensor.
- The second significant increase was short lived and thus likely due to dirt or debris passing by the sensor.
- This site has very turbid water at times.

**Water Turbidity and Precipitation : Flora Creek below TLH
July 28 to September 9, 2021**

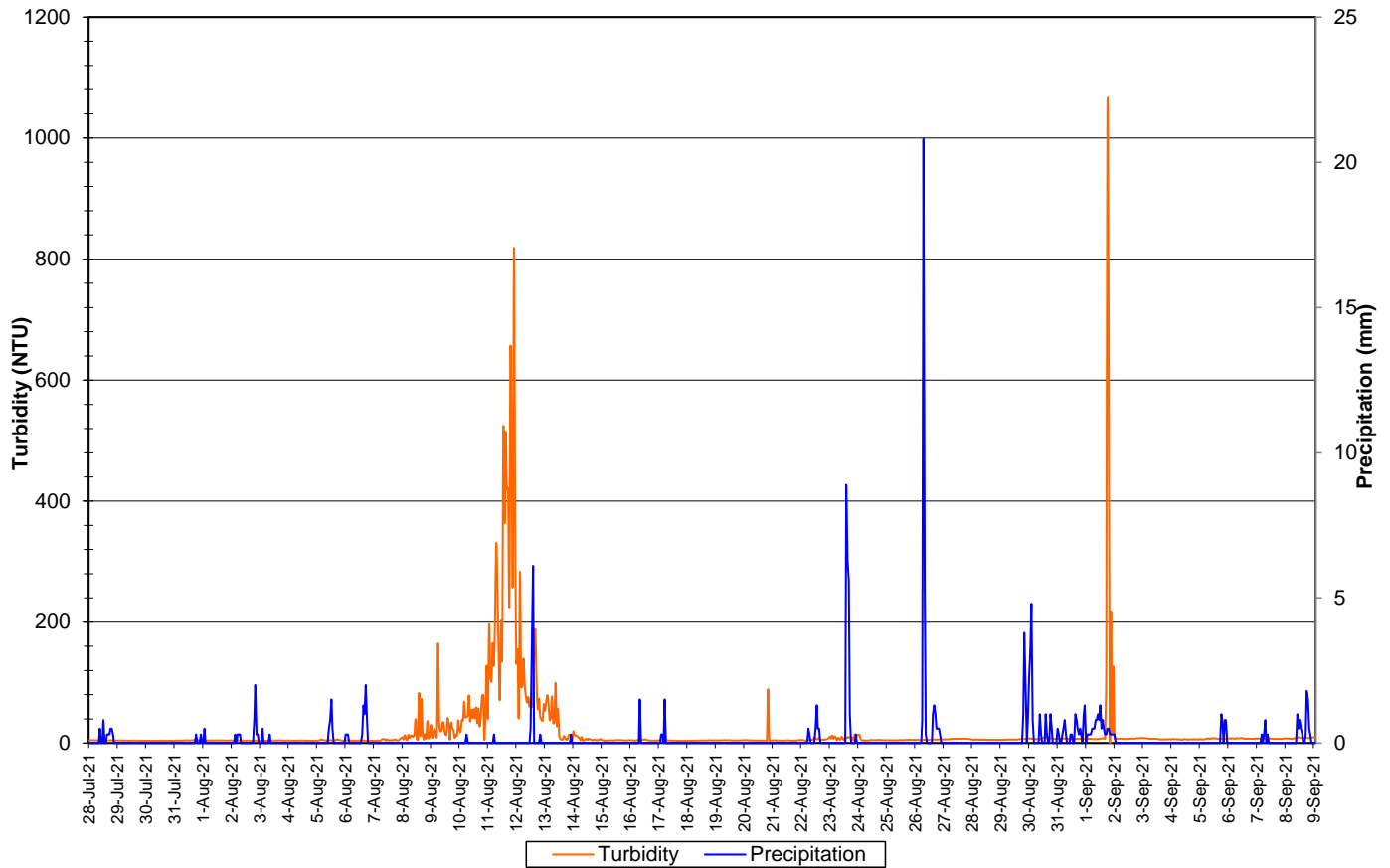


Figure 5a: Turbidity - Flora Creek below TLH

Water Turbidity <200 NTU and Precipitation : Flora Creek below TLH
July 28 to September 9, 2021

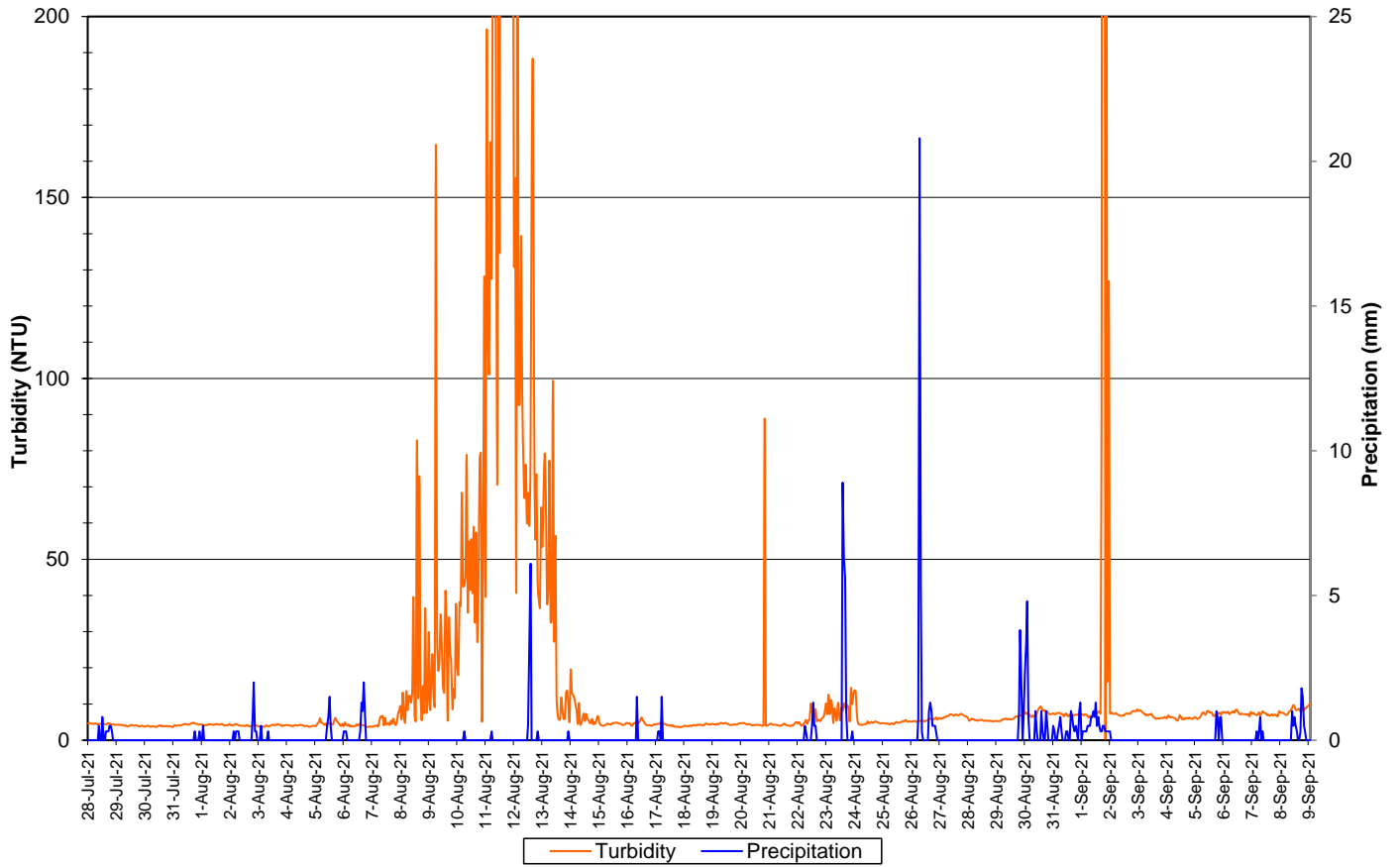


Figure 5b: Turbidity <200 NTU - Flora Creek below TLH

- Precipitation and stage during the deployment period are graphed below (Figure 6). Stage increased during the last week of deployment.
- 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.

**Stage & Precipitation: Flora Creek below TLH
July 28 to September 9, 2021**

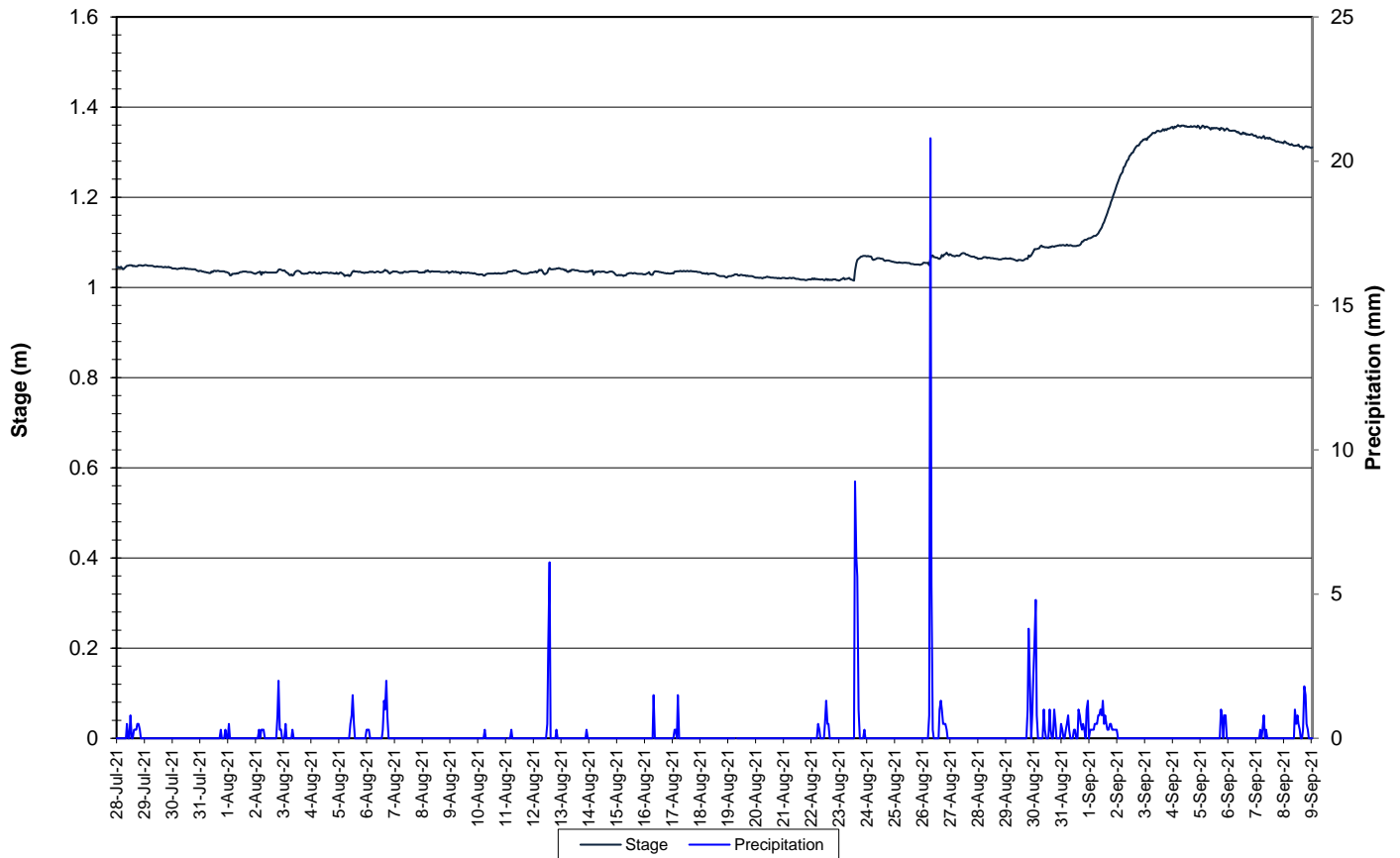


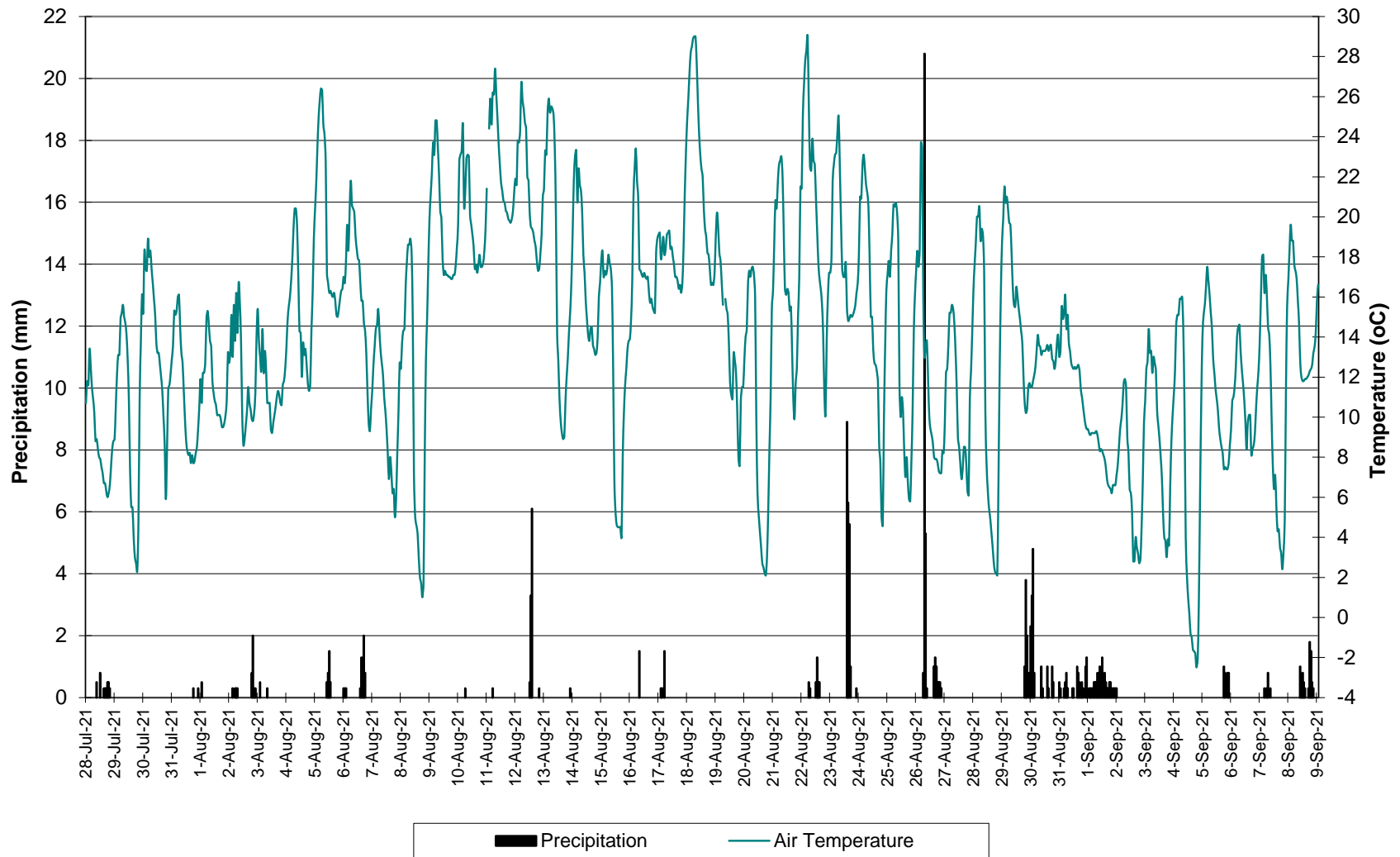
Figure 6: Precipitation and Stage – Flora Creek below TLH

Conclusions

- A clean and calibrated instrument was deployed at the Flora Creek below TLH water quality monitoring station on July 28th and removed on September 9th, 2021. This was the second deployment for 2021.
- In most cases, weather related events or increases/decreases in water level explain parameter fluctuations. Most values recorded were within ranges as suggested by the CCME Guidelines for the Protection of Aquatic Life for pH and dissolved oxygen.
- Water temperature increased during the middle of the deployment period, ranging between 13.09 and 23.34°C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 8.05 and 8.59.
- Specific conductivity ranged from 66.6 to 73.4 µs/cm.
- Dissolved oxygen values were above the minimum CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Other Life Stages of 6.5 mg/l. The majority of values were below the CCME Guideline for the Protection of Aquatic Life for Cold Water Biota at Early Life Stages of 9.5 mg/l.
- There were two high turbidity periods during this deployment period, one which lasted a few days.
- Stage increased during the last week of deployment.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion 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.

Appendix 1

Air Temperature and Precipitation: Moosehead Lake July 28 to September 9, 2021



Appendix 2
QA/QC Grab Sample Results



BUREAU
VERITAS

BV Labs Job #: C1L8046
Report Date: 2021/08/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5

| Sample Details/Parameters | A | Result | RDL | UNITS | Extracted | Analyzed | By | Batch |
|--|---|--------------------|----------|-------|------------|------------|-----|---------|
| QGW725 FLORA CREEK | | | | | | | | |
| Sampling Date | | 2021/07/28 10:25 | | | | | | |
| Matrix | | W | | | | | | |
| Sample # | | 2021-6320-00-SI-SP | | | | | | |
| Registration # | | WS-S-0000 | | | | | | |
| RESULTS OF ANALYSES OF WATER | | | | | | | | |
| Calculated Parameters | | | | | | | | |
| Hardness (CaCO3) | - | 31 | 1.0 | mg/L | N/A | 2021/08/09 | | 7499108 |
| Nitrate (N) | - | 0.14 | 0.050 | mg/L | N/A | 2021/08/11 | | 7499111 |
| Total dissolved solids (calc., EC) | - | 36 | 1.0 | mg/L | N/A | 2021/08/09 | | 7499578 |
| Inorganics | | | | | | | | |
| Conductivity | - | 65 | 1.0 | uS/cm | N/A | 2021/08/06 | SHW | 7504276 |
| Chloride (Cl-) | - | ND | 1.0 | mg/L | N/A | 2021/08/11 | FD | 7509337 |
| Bromide (Br-) | - | ND | 1.0 | mg/L | N/A | 2021/08/11 | FD | 7509337 |
| Sulphate (SO4) | - | 3.8 | 1.0 | mg/L | N/A | 2021/08/11 | FD | 7509337 |
| Total Alkalinity (Total as CaCO3) | - | 31 | 5.0 | mg/L | N/A | 2021/08/10 | EMT | 7508188 |
| Colour | - | ND | 5.0 | TCU | N/A | 2021/08/10 | EMT | 7508213 |
| Dissolved Fluoride (F-) | - | ND | 0.10 | mg/L | N/A | 2021/08/06 | SHW | 7504284 |
| Total Kjeldahl Nitrogen (TKN) | - | ND | 0.10 | mg/L | 2021/08/09 | 2021/08/10 | MJ1 | 7508170 |
| Nitrate + Nitrite (N) | - | 0.14 | 0.050 | mg/L | N/A | 2021/08/10 | EMT | 7508231 |
| Nitrite (N) | - | ND | 0.010 | mg/L | N/A | 2021/08/11 | EMT | 7508233 |
| Nitrogen (Ammonia Nitrogen) | - | ND | 0.050 | mg/L | N/A | 2021/08/10 | EMT | 7510192 |
| Dissolved Organic Carbon (C) | - | 1.7 | 0.50 | mg/L | N/A | 2021/08/07 | NGI | 7504348 |
| Total Organic Carbon (C) | - | 1.9 | 0.50 | mg/L | N/A | 2021/08/09 | NGI | 7504414 |
| pH | - | 7.73 | | pH | N/A | 2021/08/06 | SHW | 7504280 |
| Total Phosphorus | - | ND | 0.004 | mg/L | 2021/08/11 | 2021/08/12 | SSV | 7512775 |
| Total Suspended Solids | - | 1.6 | 1.0 | mg/L | 2021/08/04 | 2021/08/11 | MKX | 7499981 |
| Turbidity | - | 2.7 | 0.10 | NTU | N/A | 2021/08/06 | SHW | 7504526 |
| MERCURY BY COLD VAPOUR AA (WATER) | | | | | | | | |
| Metals | | | | | | | | |
| Total Mercury (Hg) | - | ND | 0.000013 | mg/L | 2021/08/09 | 2021/08/09 | NHU | 7504585 |
| ELEMENTS BY ICP/MS (WATER) | | | | | | | | |
| Metals | | | | | | | | |
| Total Aluminum (Al) | - | 0.0057 | 0.0050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Antimony (Sb) | - | ND | 0.0010 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Arsenic (As) | - | ND | 0.0010 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Barium (Ba) | - | 0.0021 | 0.0010 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Boron (B) | - | ND | 0.050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Cadmium (Cd) | - | ND | 0.000010 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Calcium (Ca) | - | 7.3 | 0.10 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Chromium (Cr) | - | ND | 0.0010 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Copper (Cu) | - | ND | 0.00050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Iron (Fe) | - | ND | 0.050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Lead (Pb) | - | ND | 0.00050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Magnesium (Mg) | - | 3.2 | 0.10 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Manganese (Mn) | - | 0.040 | 0.0020 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Nickel (Ni) | - | ND | 0.0020 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |



BUREAU
VERITAS

BV Labs Job #: C1L8046
Report Date: 2021/08/17

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-5

| Sample Details/Parameters | A | Result | RDL | UNITS | Extracted | Analyzed | By | Batch |
|-----------------------------------|---|--------------------|---------|-------|------------|------------|-----|---------|
| QGW725 FLORA CREEK | | | | | | | | |
| Sampling Date | | 2021/07/28 10:25 | | | | | | |
| Matrix | | W | | | | | | |
| Sample # | | 2021-6320-00-SI-SP | | | | | | |
| Registration # | | WS-S-0000 | | | | | | |
| ELEMENTS BY ICP/MS (WATER) | | | | | | | | |
| Metals | | | | | | | | |
| Total Phosphorus (P) | - | ND | 0.10 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Selenium (Se) | - | ND | 0.00050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Sodium (Na) | - | 0.72 | 0.10 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Strontium (Sr) | - | 0.0069 | 0.0020 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Uranium (U) | - | ND | 0.00010 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |
| Total Zinc (Zn) | - | ND | 0.0050 | mg/L | 2021/08/06 | 2021/08/06 | BAN | 7504243 |