Real-Time Water Quality Deployment Report

Flora Creek below TLH

July 8 to
August 18, 2015

Newfoundland Labrador

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

Contents

General

- The Water Resources Management Division, in partnership with Cliffs Natural Resources – 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 monitors the real-time web pages regularly.
- On July 8, 2015, a real-time water quality monitoring instrument was deployed at the station Flora Creek below TLH. The instrument was deployed for a period of 41 days. The instrument was removed on August 18th, 2015.

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

	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 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.

Flora Creek below TLH, Newfoundland and Labrador

- Deployment and removal comparison rankings for the station on Flora Creek deployed between July 8 and August 18, 2015 is summarized in Table 2.

Table 2: Comparison rankings for Flora Creek below TLH station July 8 – August 18, 2015.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Flora Creek below TLH	July 8, 2015	Deployment	Good	Excellent	Good	Fair	Excellent
	August 18, 2015	Removal	Good	Good	Poor	Fair	Good

- At deployment, all parameters besides dissolved oxygen ranked either 'excellent' or 'good'. Dissolved oxygen ranked 'fair', the field instrument read a value of 9.41 mg/L while the QA/QC instrument read a value of 8.74 mg/L.

- At removal, temperature, pH and turbidity ranked 'good'. Conductivity ranked 'poor', the field sonde read a value of 77.2 µs/cm and the QA/QC instrument read a value of 108.3 µs/cm. Dissolved oxygen ranked 'fair', the field sonde read a value of 9.59 mg/L, while the QA/QC instrument read a value of 9.02 mg/L.

- These 'poor' and 'fair' rankings could be due to the placement of the QA/QC instrument in relation to the field sonde, or the amount of time the instrument was given to stabilize. The conductivity sensors on these instruments are known to take a significant amount of time to stabilize.

Data Interpretation

- The following graphs and discussion illustrate water quality-related events from July 8 to August 18 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 12.17 to 21.40°C during this deployment period (Figure 1).
- Water temperature corresponded with ambient air temperature (Figure 2).

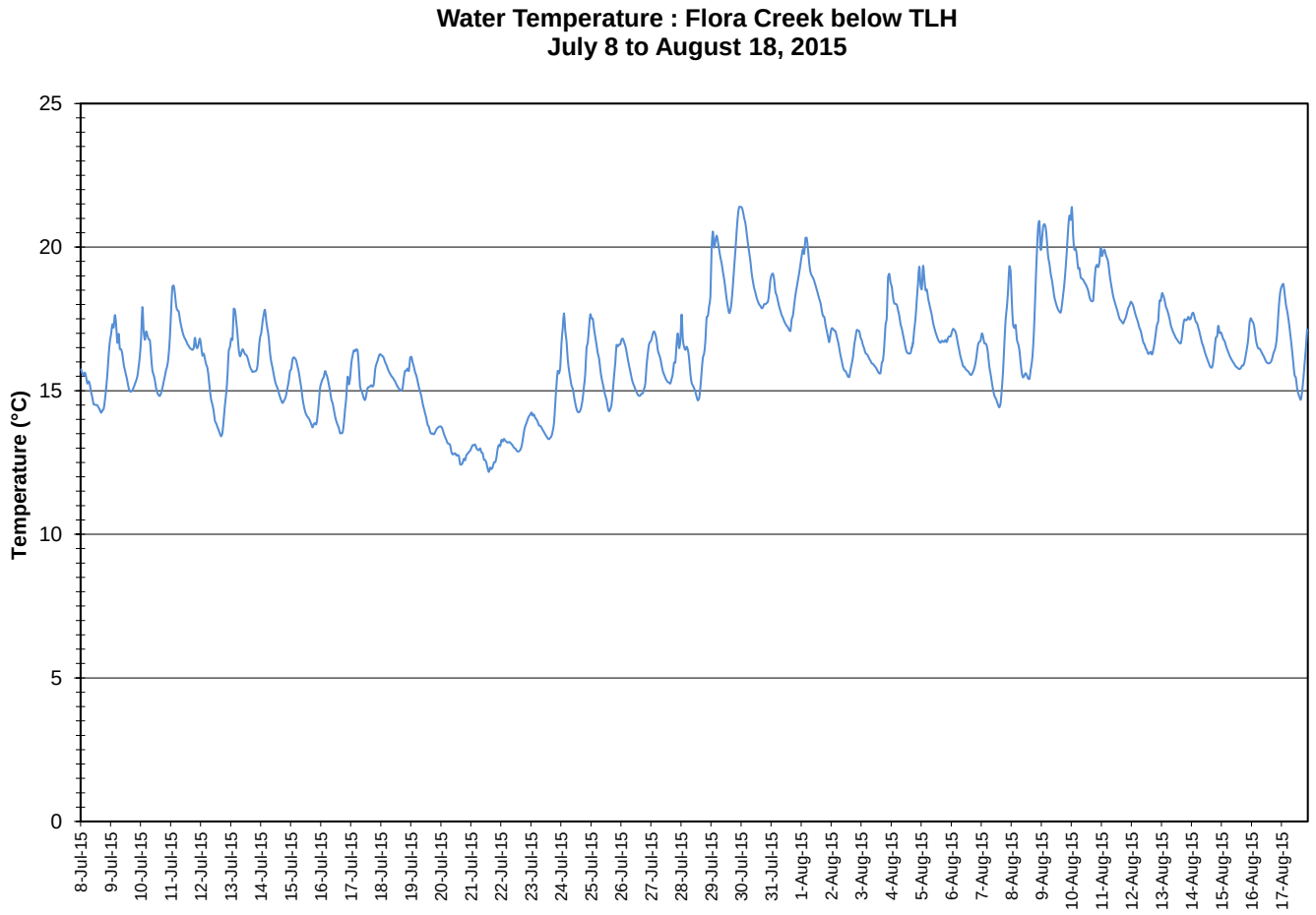

Figure 1: Water temperature - Flora Creek below TLH

Flora Creek below TLH, Newfoundland and Labrador

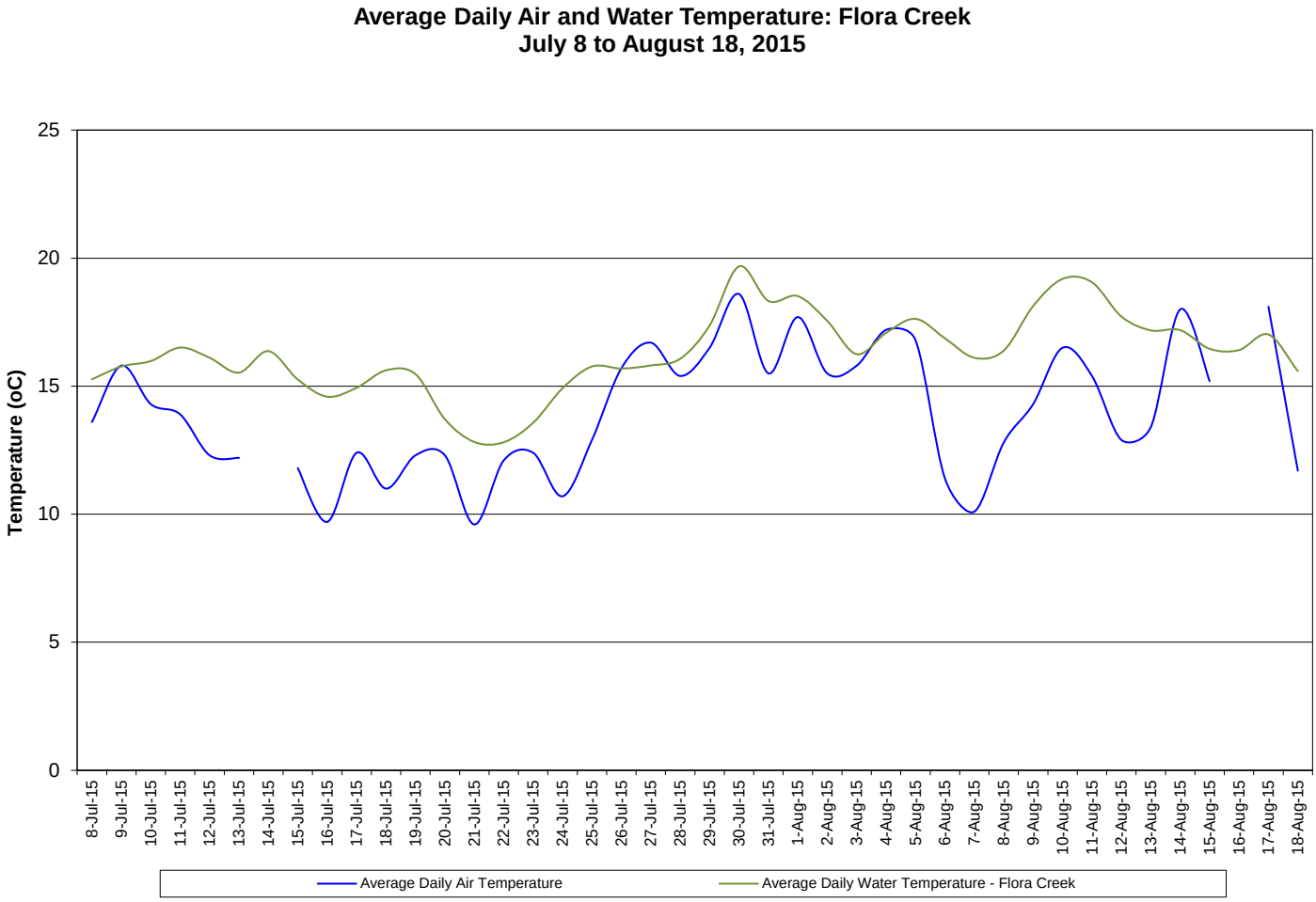

Figure 2: Average daily air and water temperatures - Flora Creek below TLH

(Weather data collected at Churchill Falls)

Flora Creek below TLH, Newfoundland and Labrador

- pH ranged between 7.46 and 7.83 pH units throughout the deployment period, with a median value of 7.56 units (Figure 3).
- 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.

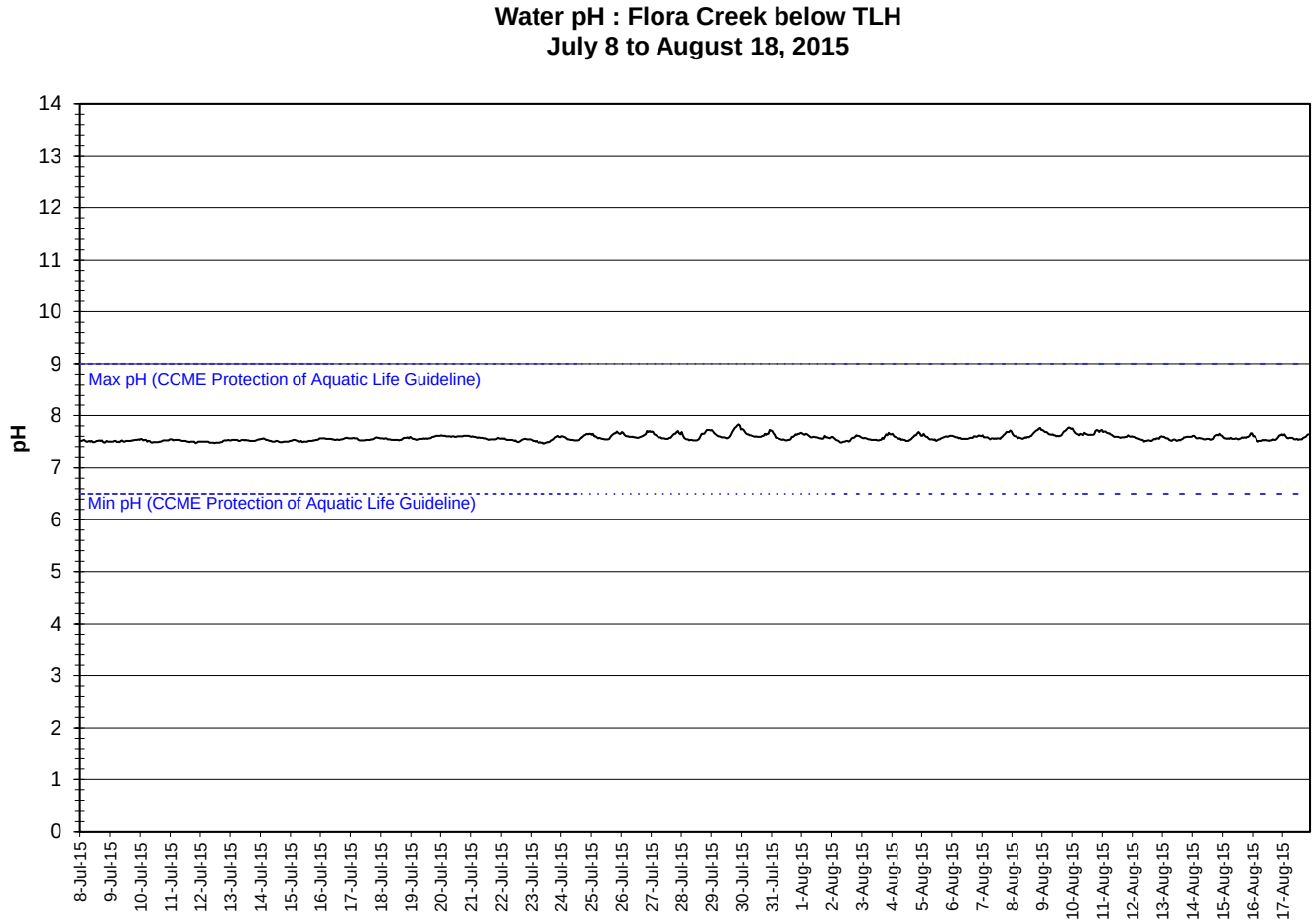

Figure 3: pH - Flora Creek below TLH

- Specific conductivity ranged from 71.8 to 77.8 µs/cm (Figure 4).
- Specific conductivity was relatively stable during the deployment period, slightly increasing during the later portion of the period, while stage was stable.
- 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.

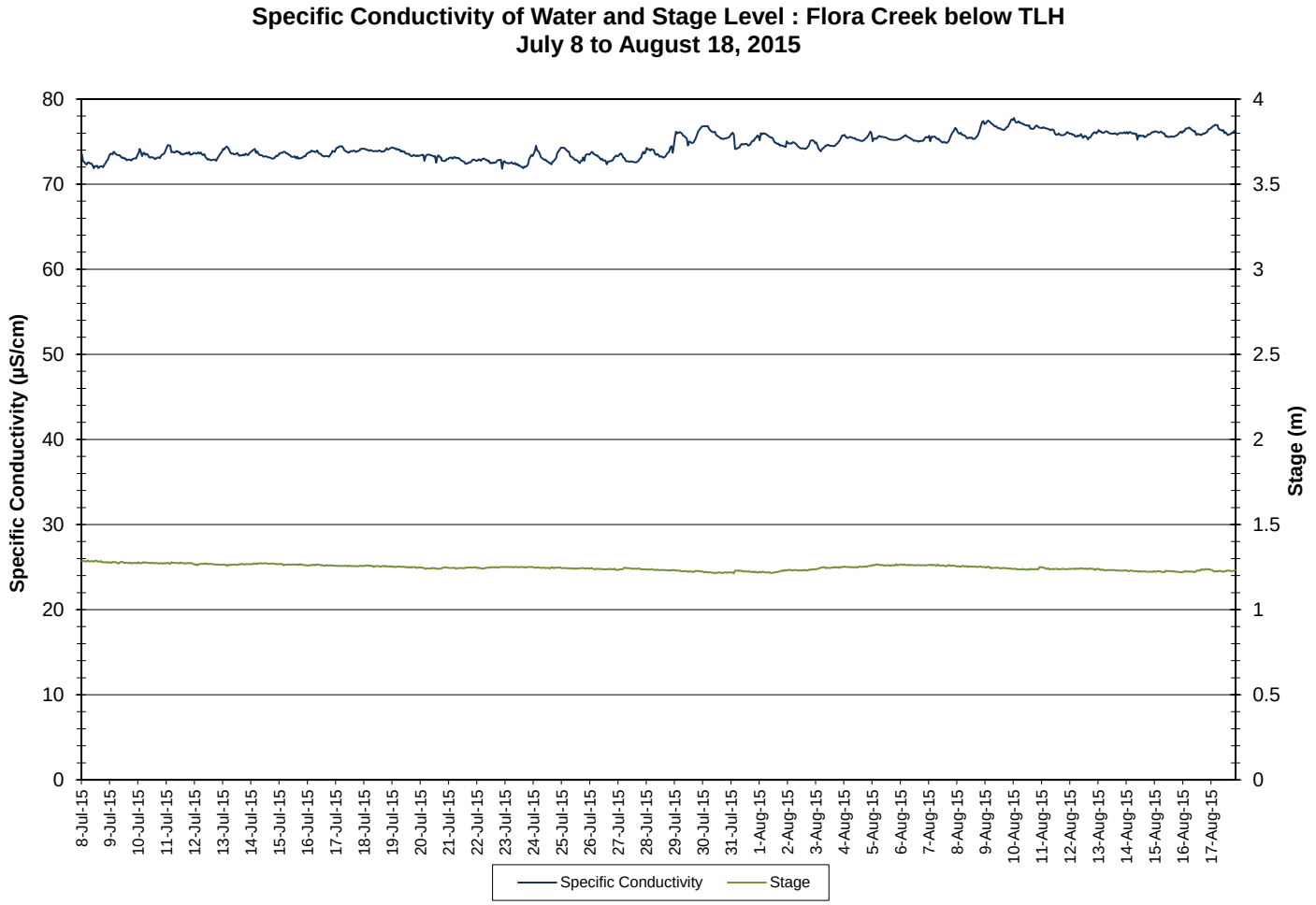

Figure 4: Specific conductivity and stage level - Flora Creek below TLH

- The saturation of dissolved oxygen ranged from 92.0 to 107.0% and a range of 8.94 to 10.19 mg/l was found in the concentration of dissolved oxygen with a median value of 9.46 mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. Most values were below the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l due to warmer water temperatures. The guidelines are indicated in blue on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature.

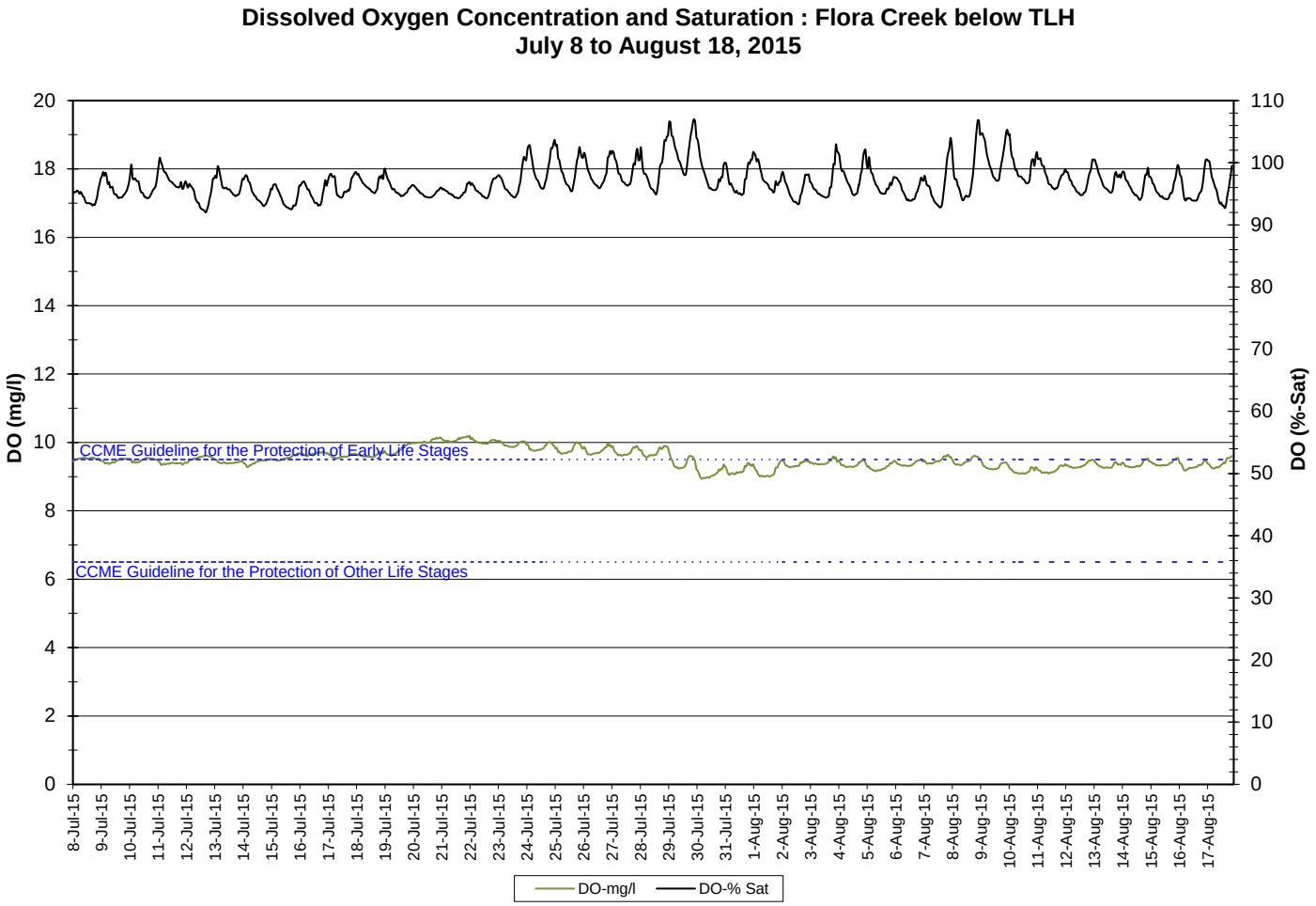

Figure 5: Dissolved oxygen and percent saturation - Flora Creek below TLH

Flora Creek below TLH, Newfoundland and Labrador

- Turbidity values range from 80.0 NTU to 198.3 NTU, the highest readings being recorded at the beginning of the deployment period. Turbidity gradually decreases during the first portion of the deployment period, and then is relatively stable for the rest of the period (Figure 6).
- In some instances, turbidity spikes can be attributed to precipitation at the time (weather data collected at Churchill Falls). They are indicated on the graph in red.
- This site has very turbid water at times. However, the turbidity has decreased significantly since the last deployment period.

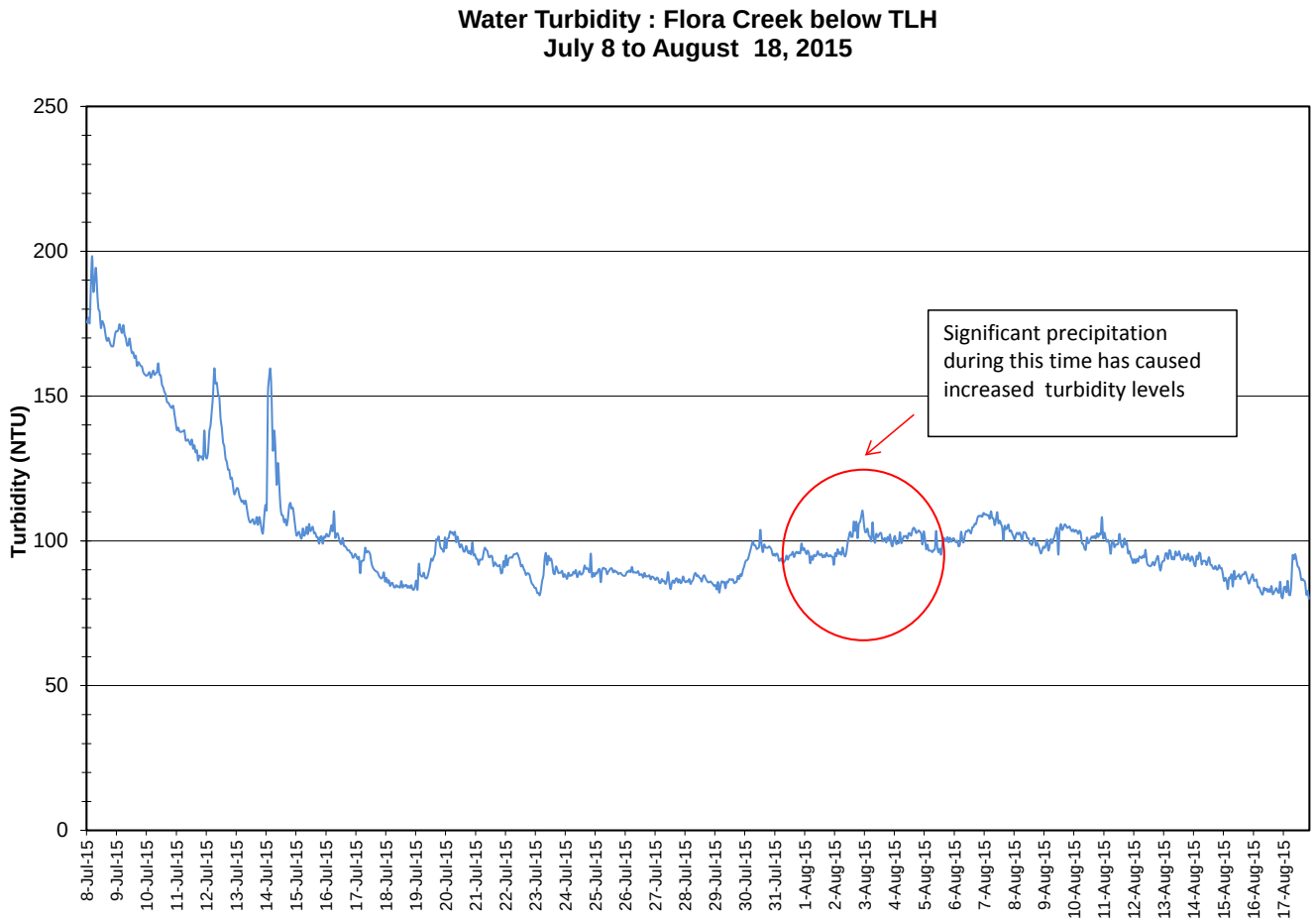

Figure 6: Turbidity - Flora Creek below TLH

- Precipitation and stage during the deployment period is graphed below (Figure 7). Stage decreased significantly during the first portion of the deployment period and then increased for a short period of time after a few days of precipitation, before decreasing again.
- It is important to note that weather data was collected from Churchill Falls, ~200 km away. Data from the local area was not available for this period.
- 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.

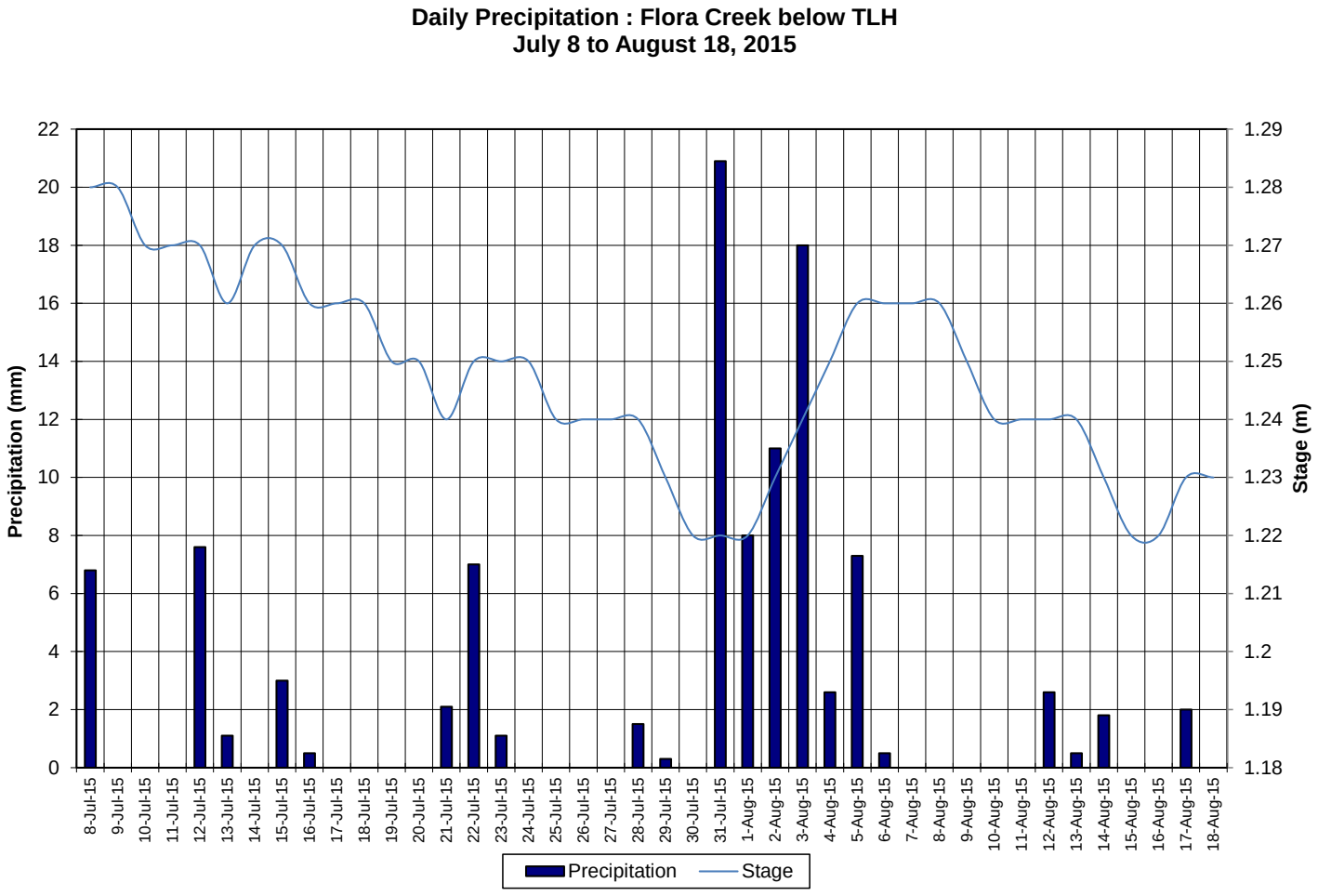

Figure 7: Precipitation and Stage – Flora Creek below TLH

(Weather data collected at Churchill Falls)

Conclusions

- An instrument at the water quality monitoring station on the Flora Creek below TLH station was deployed on July 8 and removed on August 18, 2015.
- In most cases, weather related events or increases/decreases in water level could be used to explain the 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 deployment period. Water temperature corresponded with air temperature. The temperature typically ranged between 12.17 and 21.40^{o}C.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 7.46 and 7.83.
- Specific conductivity ranged from 71.8 to 77.8 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 and most 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.
- Turbidity values decreased significantly during the first portion of the deployment period and were then relatively stable for the remainder of the period.
- Stage decreased significantly during the first portion of the deployment period and then increased for a short period of time after a few days of precipitation, before decreasing again.
- 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.

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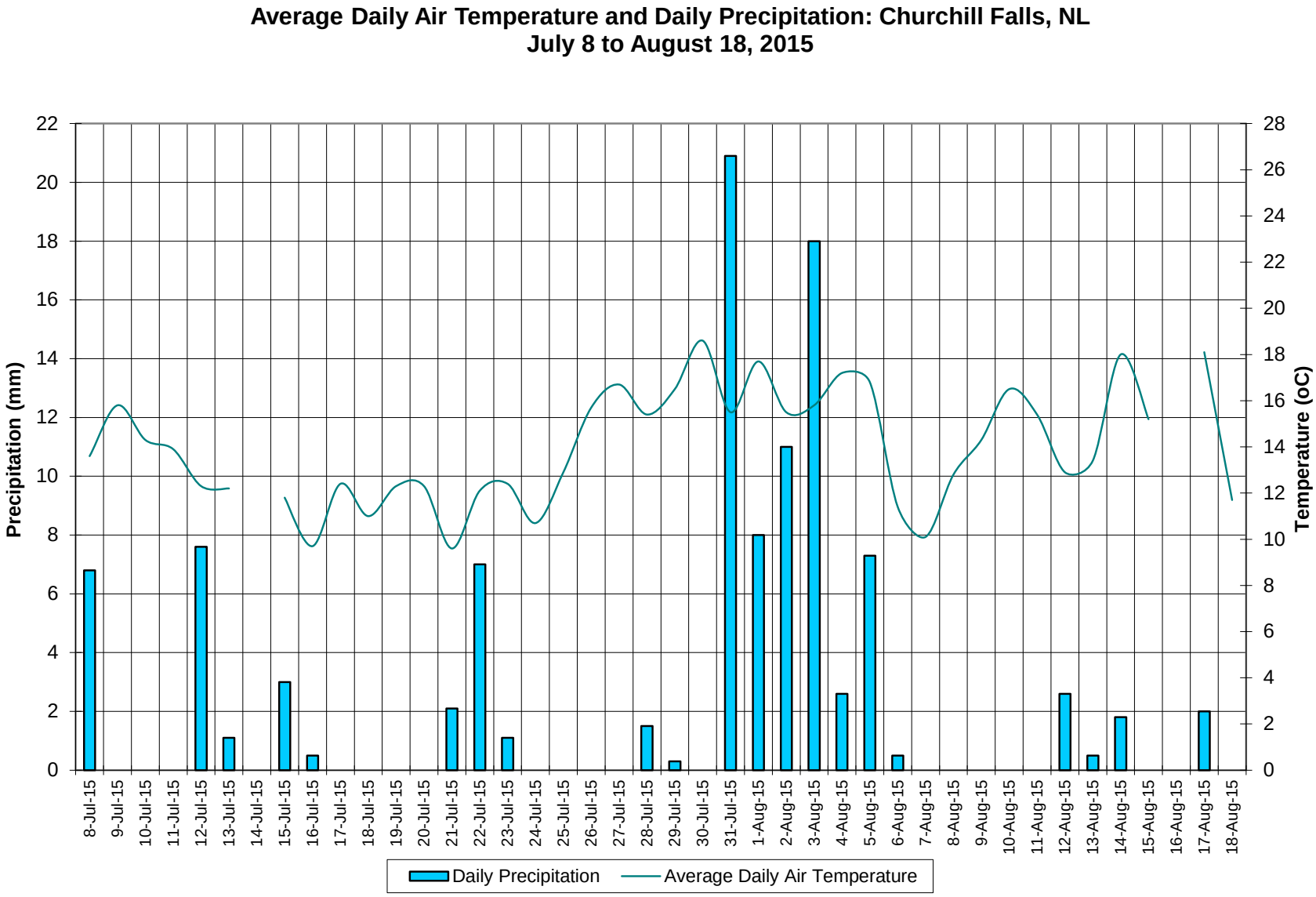
Appendix 1


Average Daily Air Temperature and Daily Precipitation: Churchill Falls, NL
July 8 to August 18, 2015
Precipitation (mm)
Temperature (oC)
0
2
4
6
8
10
12
14
16
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18-Aug-15
Daily Precipitation
Average Daily Air Temperature