Real-Time Water Quality Deployment Report

Lower Churchill River Network

July 7/8/27 to
August 17/18, 2021

Newfoundland Labrador

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

Contents

Real Time Water Quality Monitoring 1

Quality Assurance and Quality Control 2

Data Interpretation 4

Churchill River below Metchin River 6

Churchill River above Grizzle Rapids 12

Churchill River below Muskrat Falls 18

Churchill River at English Point 25

Conclusions 31

References 32

APPENDIX A - Water Parameter Description 33

APPENDIX B - Grab Sample Results 35

Prepared by:
Brenda Congram
Environmental Scientist
Department of Environment and Climate Change
Water Resources Management Division
brendacongram@gov.nl.ca

Newfoundland Labrador

Real-Time Water Quality Deployment Report

Lower Churchill River Network

July 7/8/27 to August 17/18, 2021

Real Time Water Quality Monitoring

- Staff with the Department of Environment and Climate Change monitor real-time water quality data on a regular basis.
- This deployment report discusses water quality related events occurring at four stations on the Lower Churchill River: Churchill River below Metchin River, Churchill River above Grizzle Rapids, Churchill River below Muskrat Falls and Churchill River at English Point.
- A real-time water quality monitoring instrument was deployed at Churchill River above Grizzle Rapids on July 7th. Instruments were deployed at Churchill River below Muskrat Falls and Churchill River at English Point on July 8th. An instrument was deployed at Churchill River below Metchin River on July 27th.
- Instruments at Churchill River above Grizzle Rapids and below Muskrat Falls were removed on August 17th for deployment periods of 41 and 40 days, respectively. The instrument at Churchill River at English Point was removed on August 18th for deployment period of 41 days.
- The instrument at Churchill River below Metchin River was not removed from the water until October 12th; however, for the purposes of this report, data from this station will be reported as if it had been removed on August 17th, for a deployment period of 21 days.
- The station at Churchill River above Muskrat Falls was not able to be deployed during this deployment period. This station was relocated in October 2016 as it was situated in the flood zone of the Muskrat Falls Reservoir and needed to be moved back to ensure the station did not flood as the reservoir water levels were raised. Even at raised water levels, the above Muskrat Falls station is situated quite far from the water, making it impractical to install monitoring equipment. Additionally, safety requirements with regards to working in and around the reservoir for the Muskrat Falls project further hindered the ability to deploy the instrument at this station.

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. This 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 1).

Table 1: Instrument Performance 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 > 35µS/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. Because 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 Lower Churchill River stations deployed from July 7/8/27 to August 17/18, 2021 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations July 7/8/27 to August 17/18, 2021

Churchill River Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	July 27, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Poor
	August 17, 2021	Removal	N/A	N/A	N/A	N/A	N/A
Above Grizzle Rapids	July 7, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
	August 17, 2021	Removal	Excellent	Excellent	Excellent	Good	Excellent
Below Muskrat Falls	July 8, 2021	Deployment	Excellent	Excellent	Excellent	Excellent	Fair
	August 17, 2021	Removal	Excellent	Excellent	Excellent	Good	Excellent
At English Point	July 8, 2021	Deployment	Good	Good	Excellent	Excellent	Fair
	August 18, 2021	Removal	Excellent	Excellent	Good	Good	Excellent
Above Muskrat Falls	Not deployed	Deployment	N/A	N/A	N/A	N/A	N/A
	Not deployed	Removal	N/A	N/A	N/A	N/A	N/A

- **Churchill River below Metchin River**
  - At deployment, all parameters ranked as ‘excellent’ with the exception of turbidity, which ranked as ‘poor’. This may have been due to the instrument not being given sufficient time to acclimate, as the ranking was much closer between the QA/QC sonde and the grab sample.
  - Comparison rankings are not available for removal since this instrument wasn’t physically removed from the water on August 17, 2021.
- **Churchill River above Grizzle Rapids**
  - At deployment, all parameters ranked as ‘excellent’.
  - At removal, all parameters ranked as either ‘excellent’ or ‘good'.
- **Churchill River below Muskrat Falls**
  - At deployment, all parameters ranked at ‘excellent’, while turbidity ranked as ‘fair’.
  - At removal, all parameters again ranked as either ‘excellent’ or ‘good’.

- **Churchill River at English Point**
    - At deployment, conductivity and dissolved oxygen were 'excellent', temperature and pH were 'good', while turbidity was 'fair'.
    - At removal, all parameters ranked as either 'excellent' or 'good'.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring from July 7/8/27 to August 17/18, 2021 on the Lower Churchill River Network.
- With the exception of water quantity data (stage & flow), all data used in the preparation of the graphs and subsequent discussion below adhere to stringent QA/QC protocol. Water Survey of Canada is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

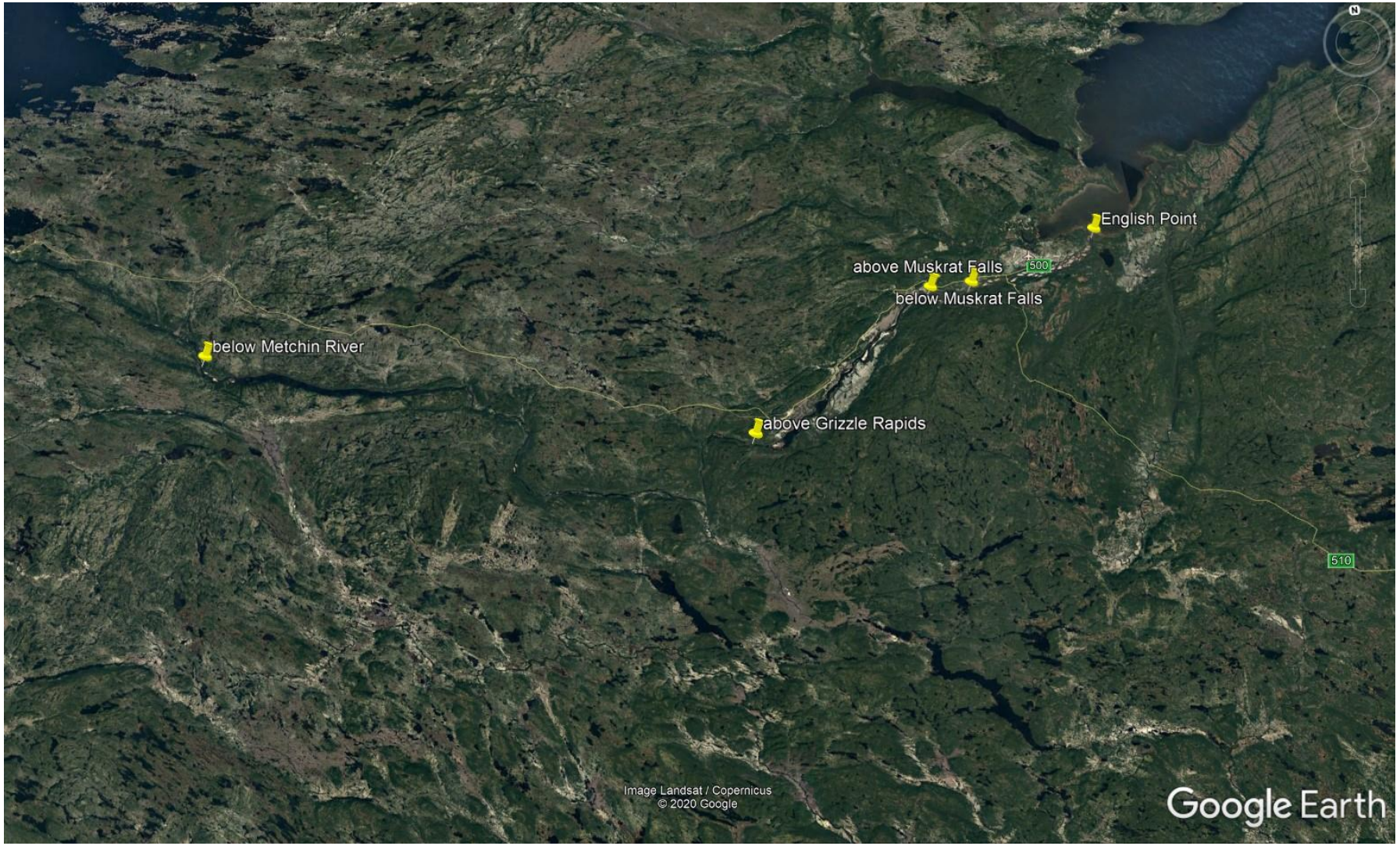

Figure 1: Lower Churchill Network of Real-Time Water Quality Stations

Churchill River below Metchin River

Water Temperature

- Over the deployment period, water temperature ranged from 15.6°C to 18.4°C, with a median value of 16.8°C (Figure 2). Air temperature data was obtained from the Metchin River near TLH Weather Station.
- Water temperature was slowly increasing over the course of deployment, which is to be expected as air temperatures were also slowly increasing across the summer season. Water temperature data exhibits a diurnal pattern as expected, and closely correlates with ambient air temperatures.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

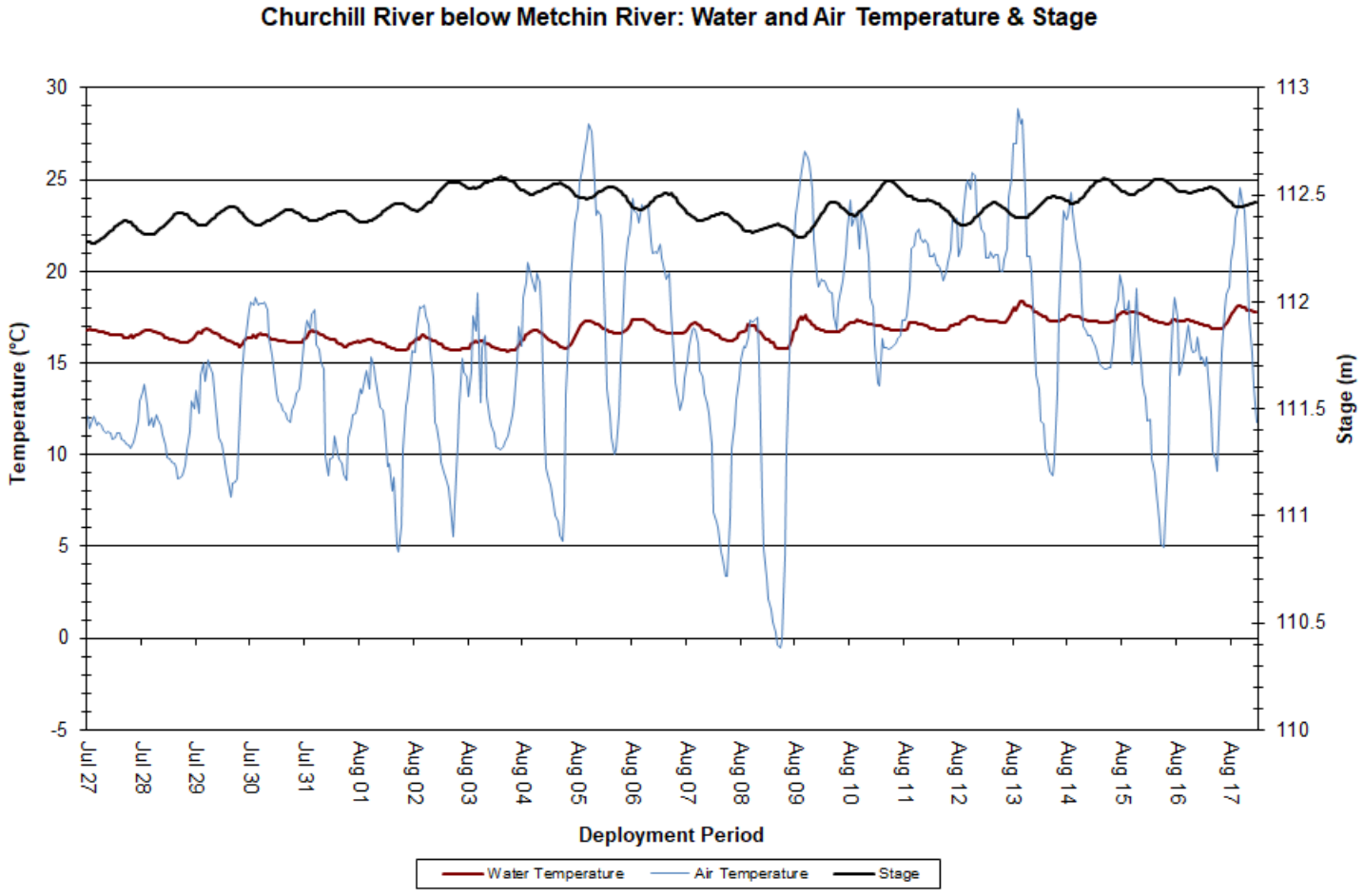

Figure 2: Water and Air Temperature & Stage at Churchill River below Metchin River

pH

- Over the deployment period, pH values ranged from 6.97 to 7.17 pH units, with a median value of 7.09 (Figure 3).
- pH values were quite stable over the course of deployment, remaining within the CCME's Guidelines for the Protection of Aquatic Life for the duration of deployment.
- Photosynthesis uses up hydrogen molecules; this causes the concentration of hydrogen ions to decrease, which in turn causes pH to increase. For this reason, pH may be higher during daylight hours and during the growing season when photosynthesis is at a maximum. This is illustrated by the diurnal fluctuations in pH values (Figure 3).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

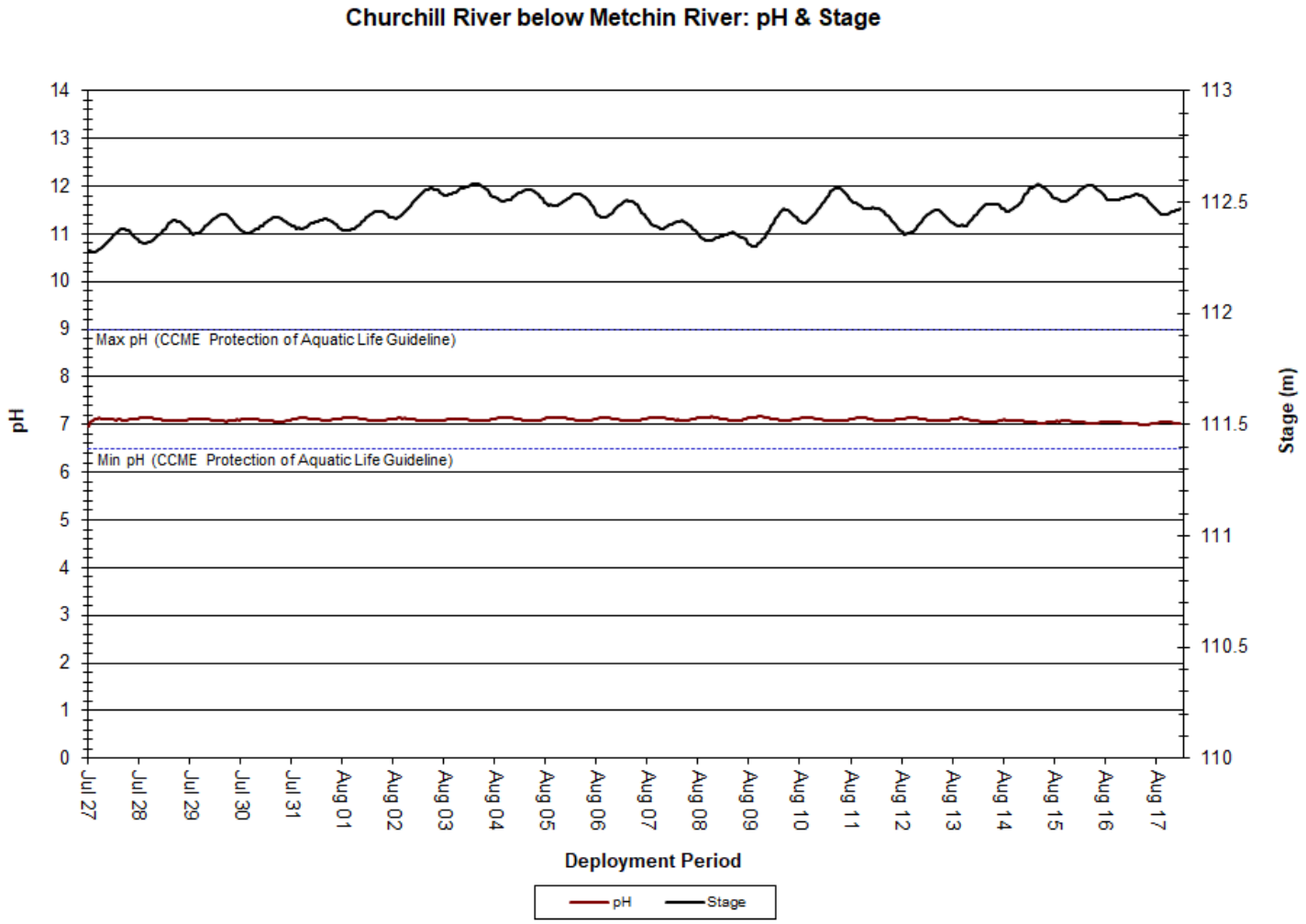

Figure 3: pH & Stage at Churchill River below Metchin River

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 20.4µS/cm to 21.8µS/cm, with a median value of 20.9µS/cm (Figure 4).
- The relationship between conductivity and stage is generally inversed. When stage levels increase, specific conductivity levels decrease as the increased amount of water in the river system dilutes solids that are present. This relationship is somewhat evident in the graph below (Figure 4).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

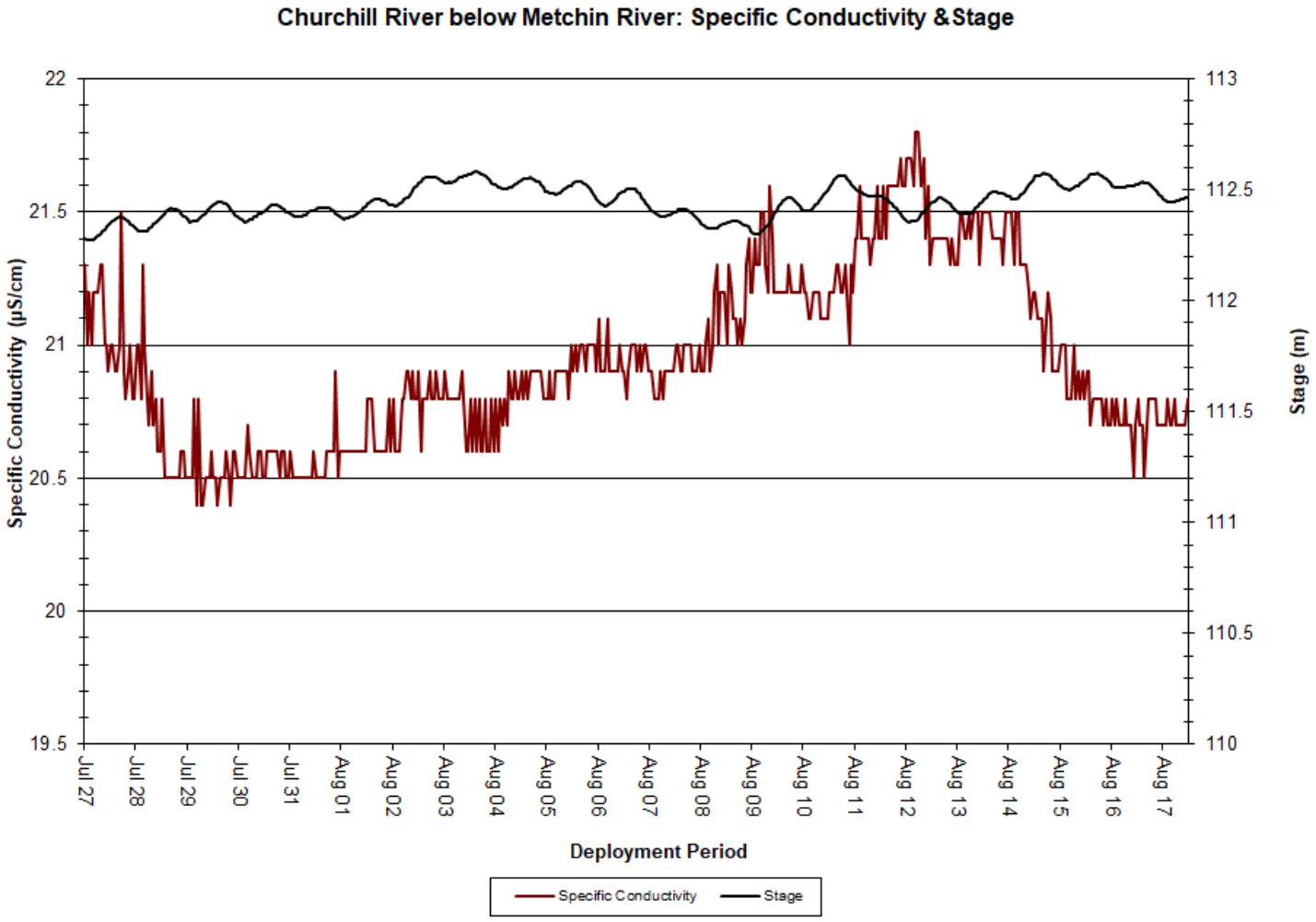

Figure 4: Specific Conductivity & Stage at Churchill River below Metchin River

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 9.01mg/L to 9.40mg/L, with a median value of 9.21mg/L. Saturation of dissolved oxygen ranged from 91.9% to 98.5%, with a median value of 94.9% (Figure 5).
- There is an evident relationship between water temperature and dissolved oxygen. Over the deployment period, dissolved oxygen levels were slowly decreasing, as water temperatures were slowly increasing. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures. Generally, dissolved oxygen levels are higher in a waterbody during cooler temperatures.
- Dissolved oxygen levels remained below the CCME's Guideline for the Protection of Early Life Stages for the duration of deployment, which is to be expected as water temperatures remained high over the same period. Dissolved oxygen levels remained above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment.

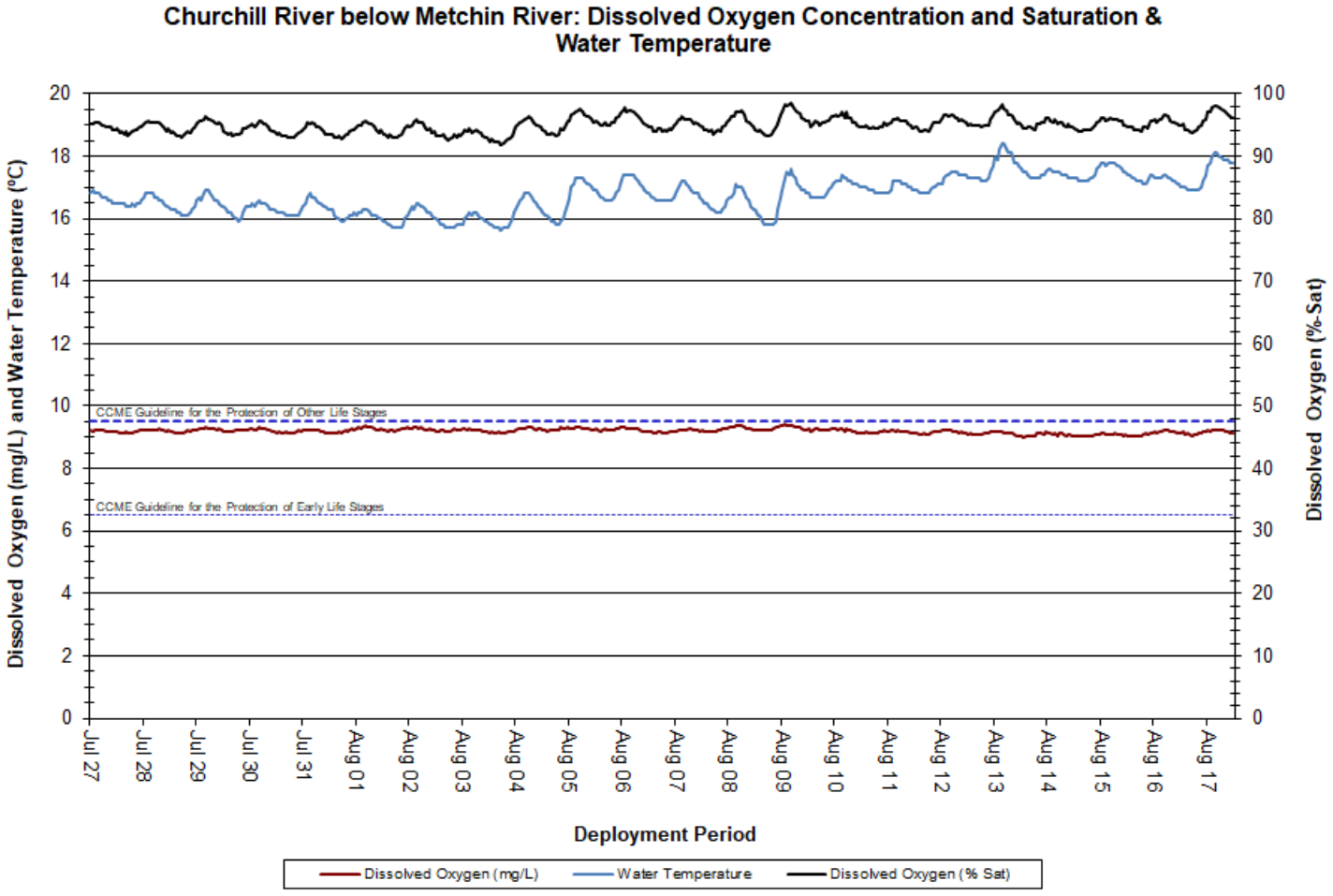

Figure 5: Dissolved Oxygen & Water Temperature at Churchill River below Metchin River

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 18.6NTU, with a median value of 15.4NTU (Figure 6). A median value of 15.4NTU indicates a low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Metchin River near TLH Weather Station.
- This station is located at a wide and deep section of the Churchill River and therefore turbidity levels are typically less susceptible to precipitation events as compared to other areas; however, it is unusual that turbidity levels remained elevated for the duration of deployment with very few spikes. This may be due to a slight calibration error, or may be due to sediment build-up around the sensor given the sandy nature of the riverbed at this site.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

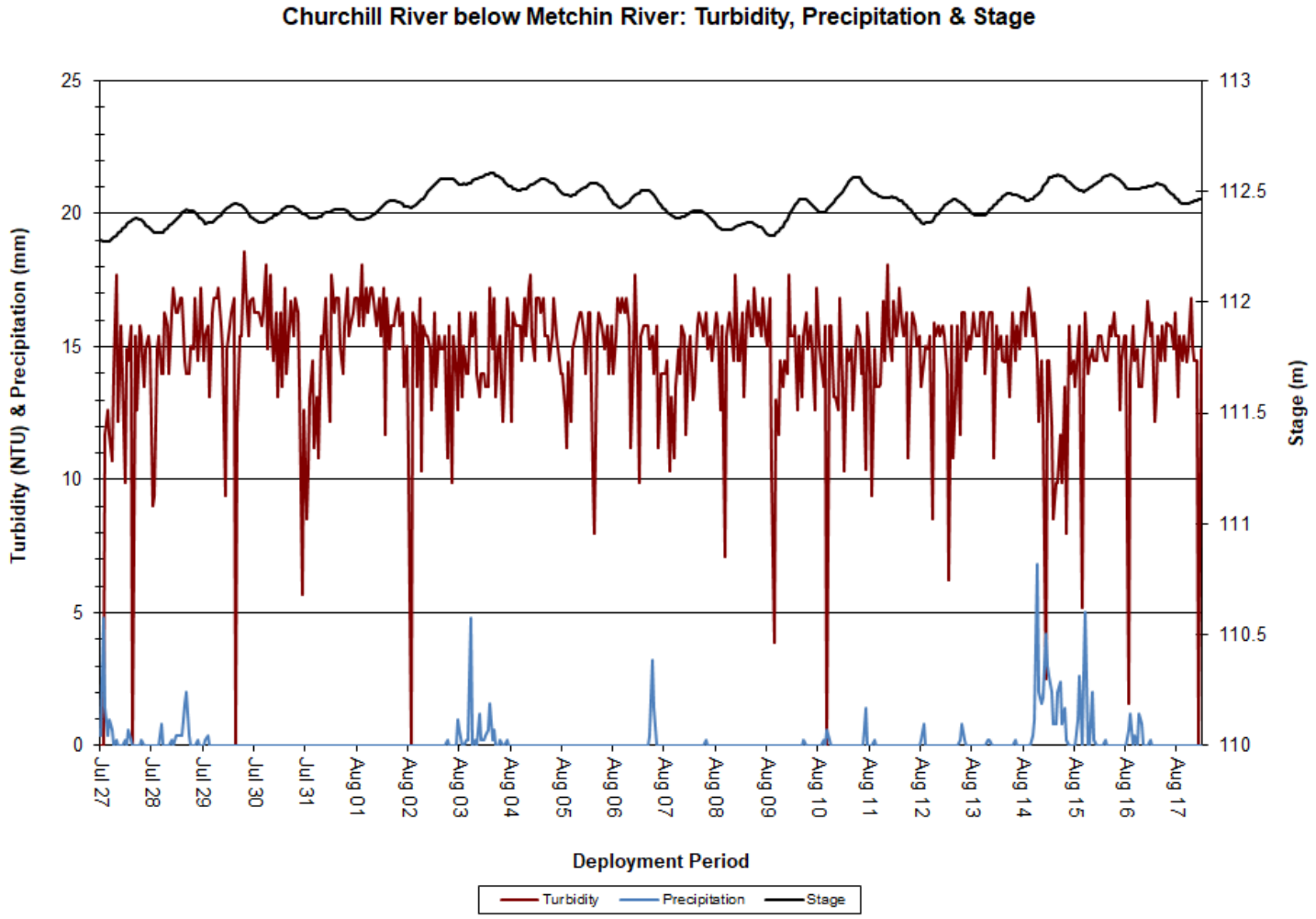

Figure 6: Turbidity, Precipitation & Stage at Churchill River below Metchin River

Stage and Flow

- Over the deployment period, stage levels ranged from 112.275m to 112.584m, with a median value of 112.445m. Flow ranged from 915.822m^3/s to 1053.136m^3/s, with a median value of 996.19m^3/s (Figure 7). Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Stage and flow were relatively low and stable, but very slowly increasing, over the course of deployment. Precipitation events across the same period generally correlate with increases in both stage and flow (Figure 8).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

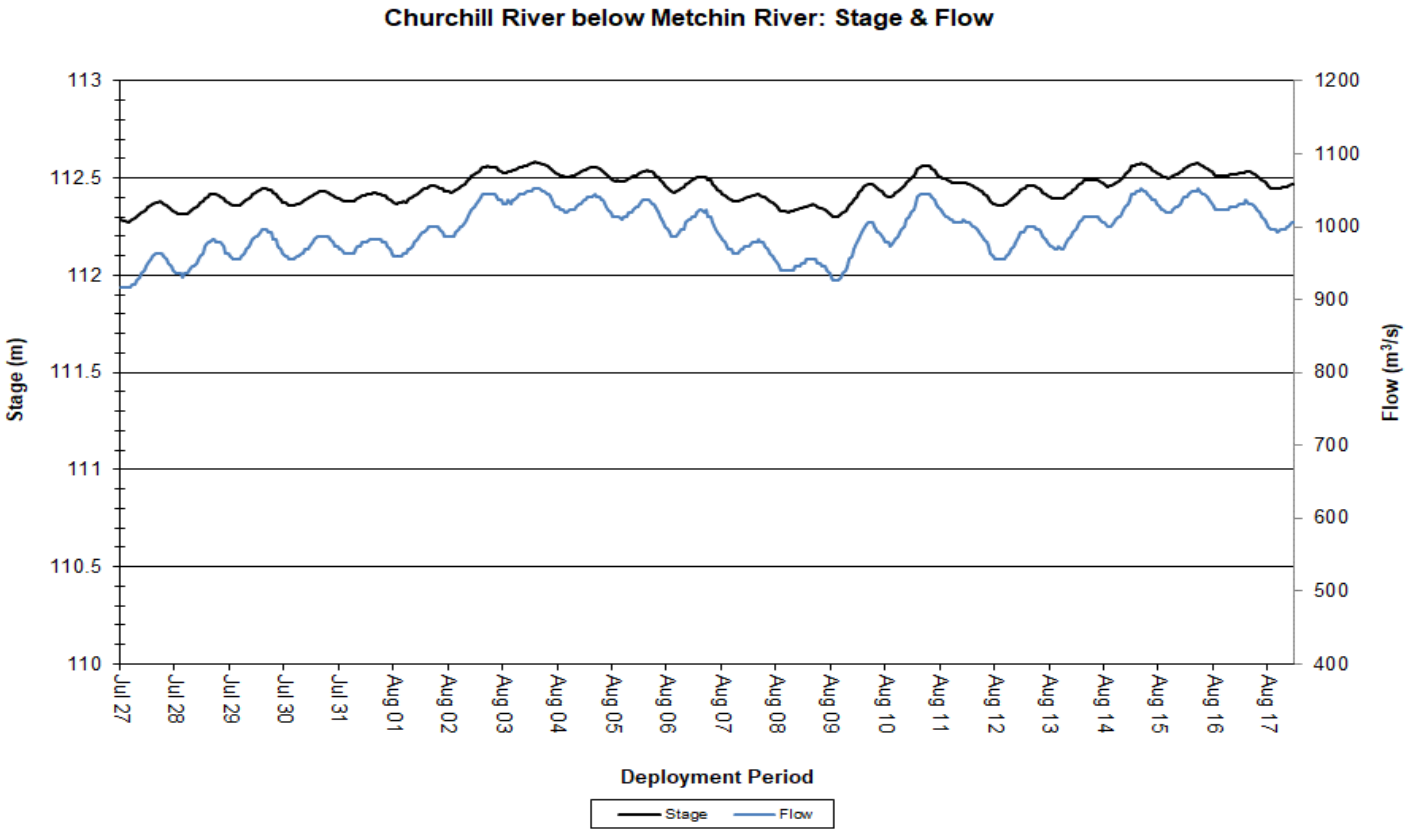

Figure 7: Stage & Flow at Churchill River below Metchin River

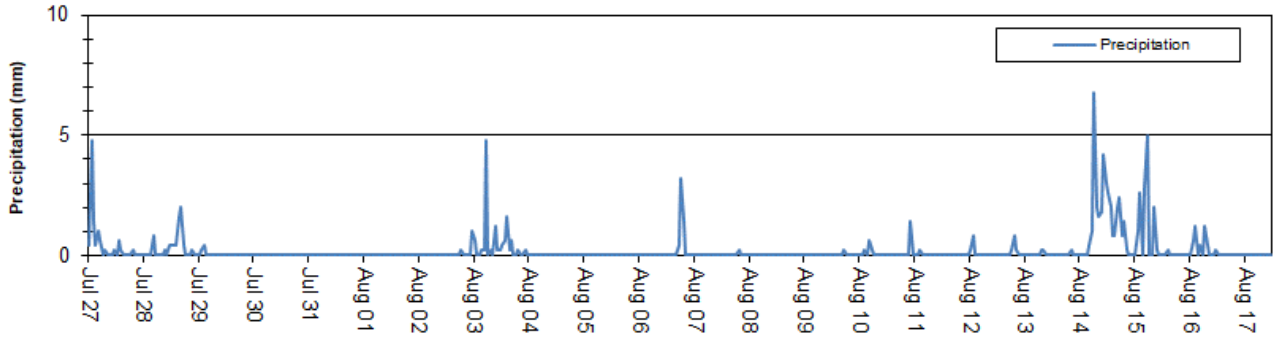

Figure 8: Precipitation at Churchill River below Metchin River

Churchill River above Grizzle Rapids

Water Temperature

- Over the deployment period, water temperature ranged from 14.9°C to 18.6°C, with a median value of 16.8°C (Figure 9). Air temperature data was obtained from the Muskrat Falls MET Station.
- Water temperature slowly increased across the deployment period. This trend is to be expected as air temperatures also increased through the summer season. Water temperature data exhibits a diurnal pattern, and closely correlates with ambient air temperatures.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

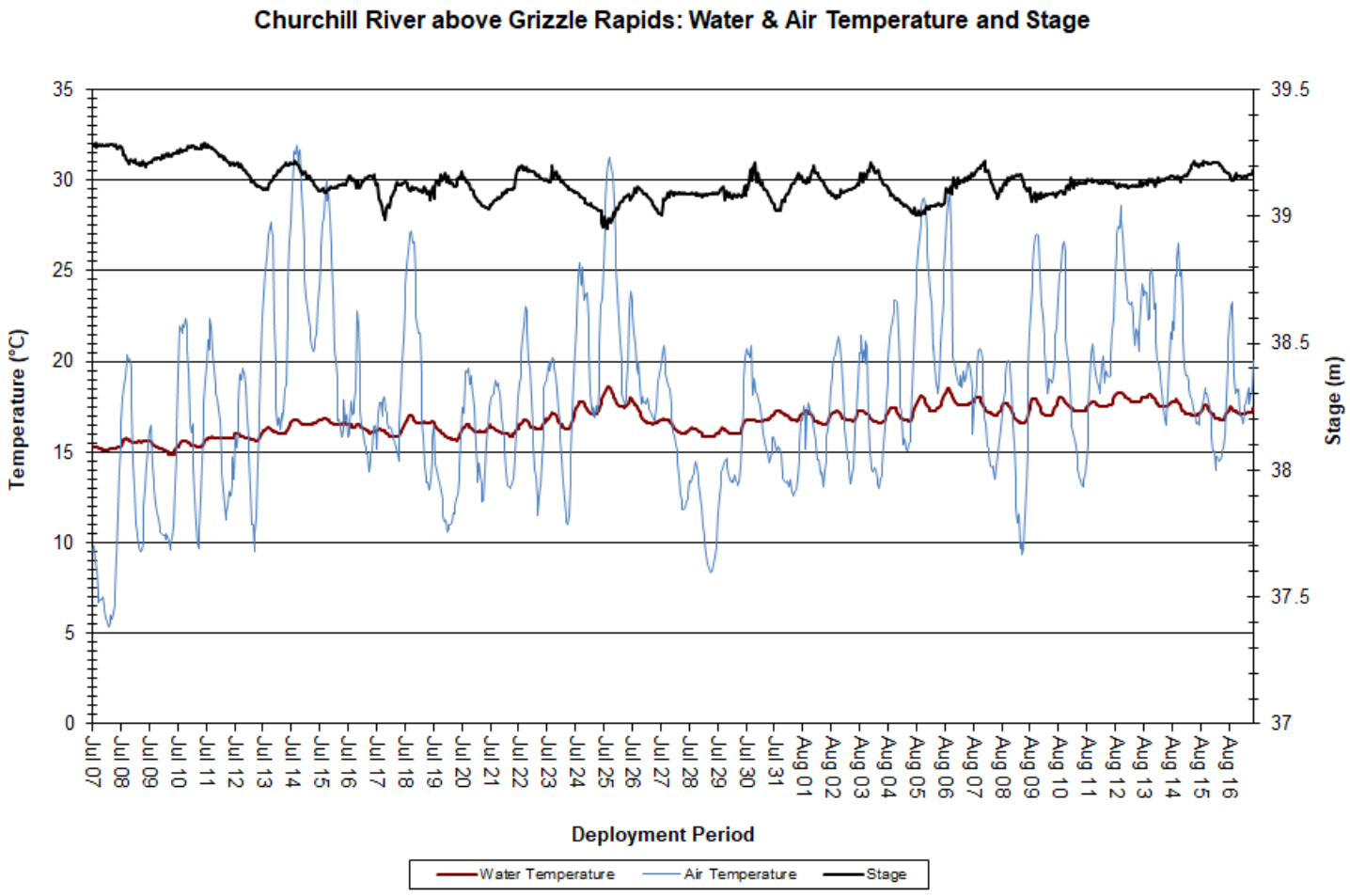

Figure 9: Water and Air Temperature & Stage at Churchill River above Grizzle Rapids

pH

- Over the deployment period, pH values ranged from 6.79 pH units to 7.20 pH units, with a median value of 7.09 (Figure 10).
- pH values were quite stable and remained within the CCME's Guidelines for the Protection of Aquatic Life for the duration of deployment.
- Photosynthesis uses up hydrogen molecules; this causes the concentration of hydrogen ions to decrease, which in turn causes pH to increase. For this reason, pH may be higher during daylight hours and during the growing season when photosynthesis is at a maximum. This is illustrated by the diurnal fluctuations in pH values (Figure 10).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

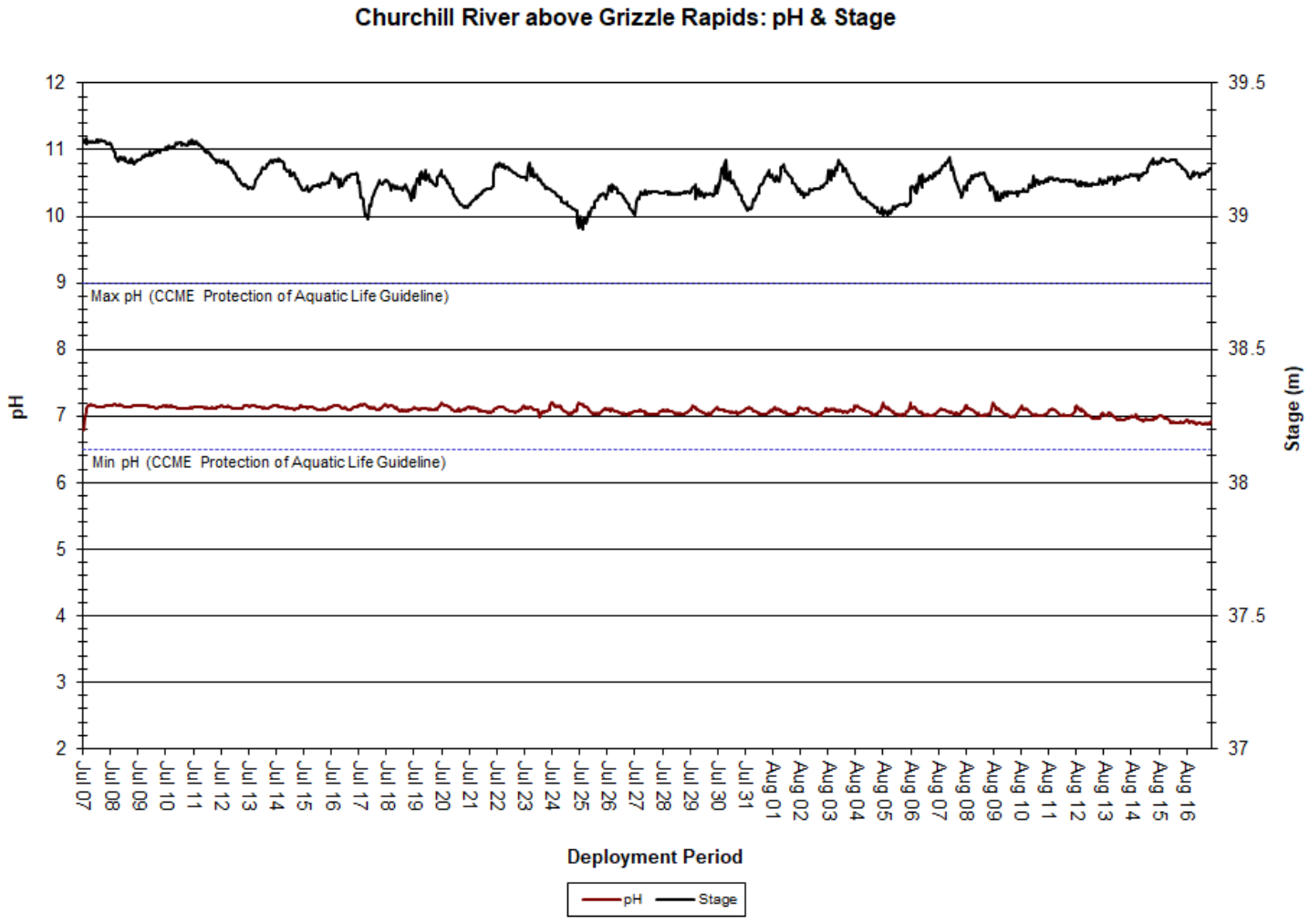

Figure 10: pH & Stage at Churchill River above Grizzle Rapids

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 20.1µS/cm to 24.4µS/cm, with a median of 22.6µS/cm (Figure 11).
- The relationship between conductivity and stage is generally inversed. When stage levels increase, specific conductivity levels generally decrease as the increased amount of water in the river system dilutes solids that are present. This relationship is only somewhat evident in the graph below, likely because this station is located at a deep and wide section of the Churchill River and other factors in the water column influence conductivity levels.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

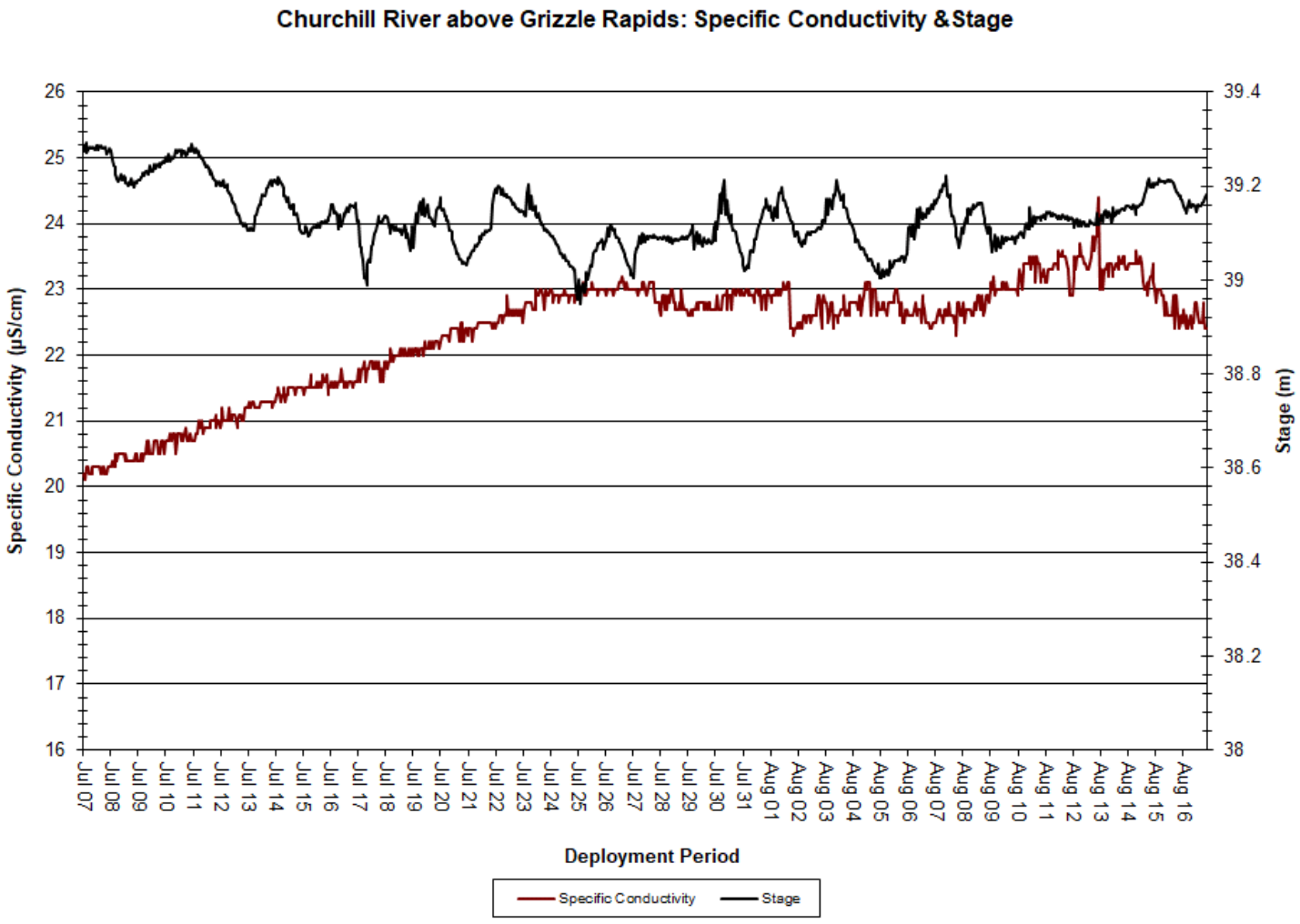

Figure 11: Specific Conductivity & Stage at Churchill River above Grizzle Rapids

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 8.97mg/L to 9.78mg/L, with a median value of 9.26mg/L. Saturation of dissolved oxygen ranged from 92.4% saturation to 98.9% saturation, with a median value of 95.7% (Figure 12).
- There is an evident relationship between water temperature and dissolved oxygen. Over the deployment period, dissolved oxygen levels gradually decreased as water temperatures increased through the summer. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures. Generally, dissolved oxygen levels are higher in a waterbody during cooler temperatures.
- Dissolved oxygen levels were above the CCME's Guideline for the Protection of Early Life Stages for the very beginning of deployment, but quickly fell below and remained there for the rest of the deployment period. Dissolved oxygen levels were above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment.

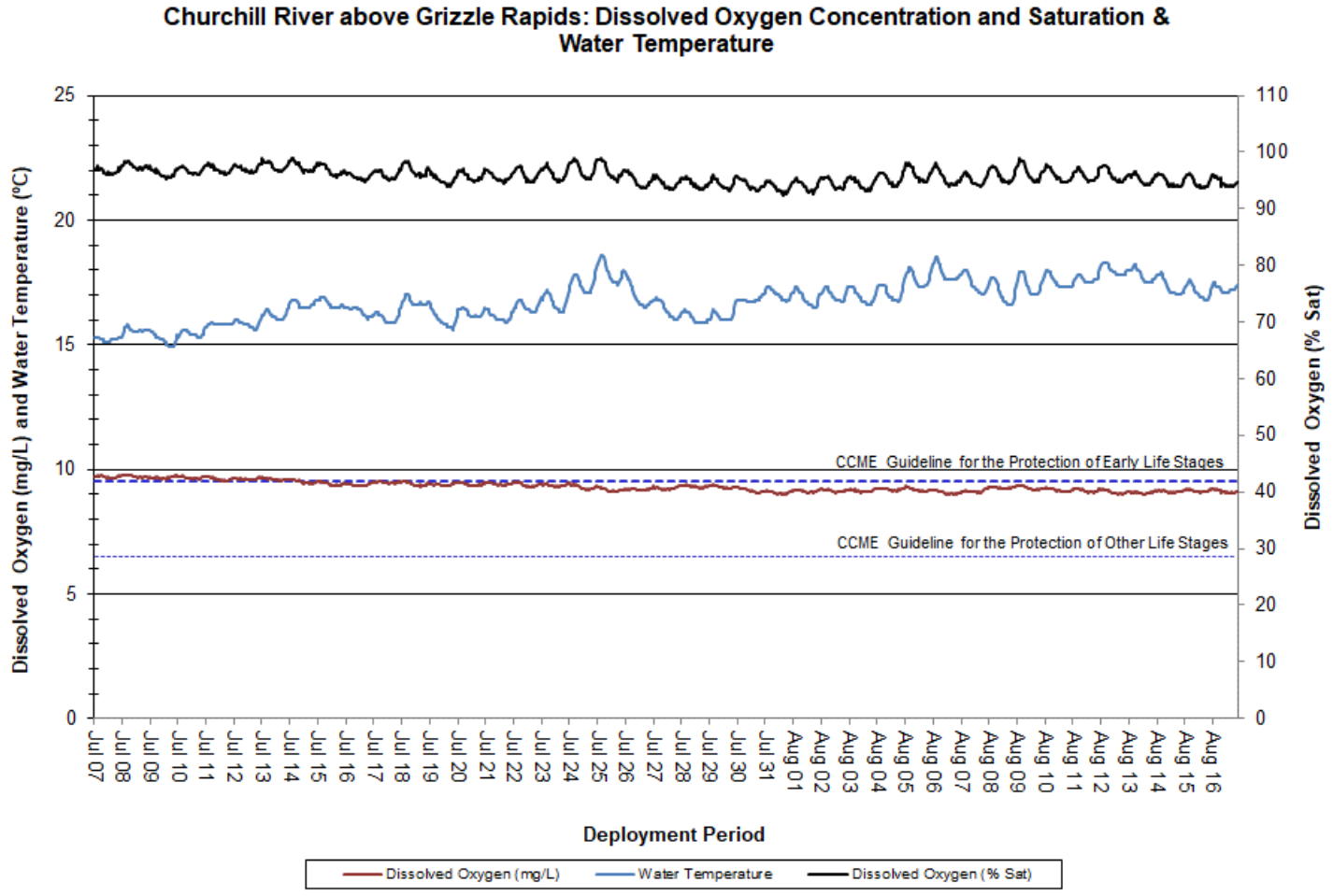

Figure 12: Dissolved Oxygen & Water Temperature at Churchill River above Grizzle Rapids

Turbidity

- Over the deployment period, turbidity ranged from 0.1NTU to 3.3NTU, with a median value of 0.3NTU (Figure 13). A median value of 0.3NTU indicates a very low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Muskrat Falls MET Station.
- Turbidity spikes observed over the deployment period somewhat correlate with precipitation events (Figure 13). This station is located at a wide and deep section of the Churchill River and therefore turbidity levels are likely less susceptible to precipitation events as compared to other areas. Turbidity levels returned to background levels following each observed increase.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

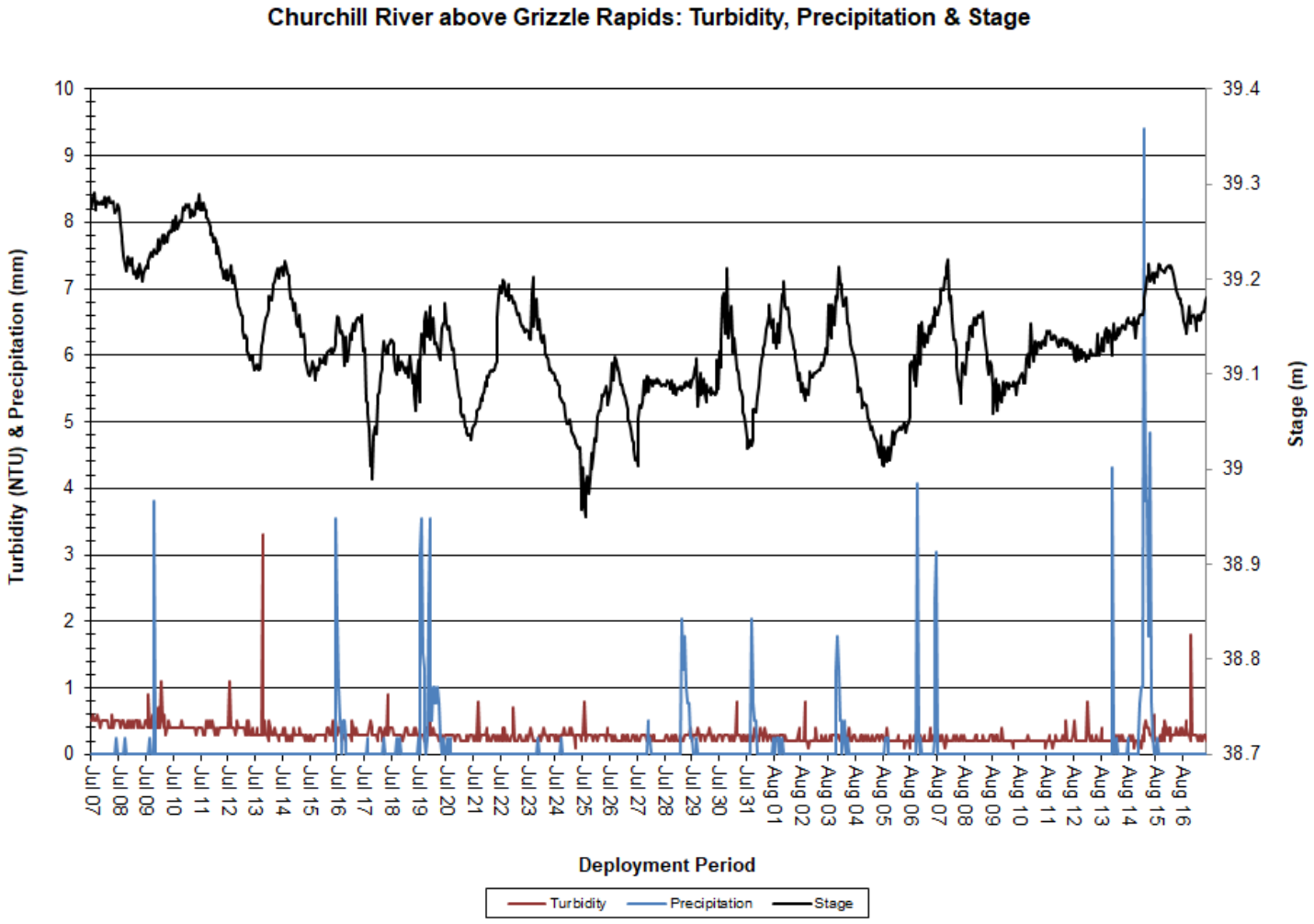

Figure 13: Turbidity, Precipitation & Stage at Churchill River above Grizzle Rapids

Stage

- Over the deployment period, stage ranged from 38.95m to 39.291m, with a median value of 39.129m (Figure 14). Precipitation data was obtained from the Muskrat Falls MET Station.
- Stage was somewhat variable across the deployment period, with precipitation events often correlating with increases in stage (Figure 14).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

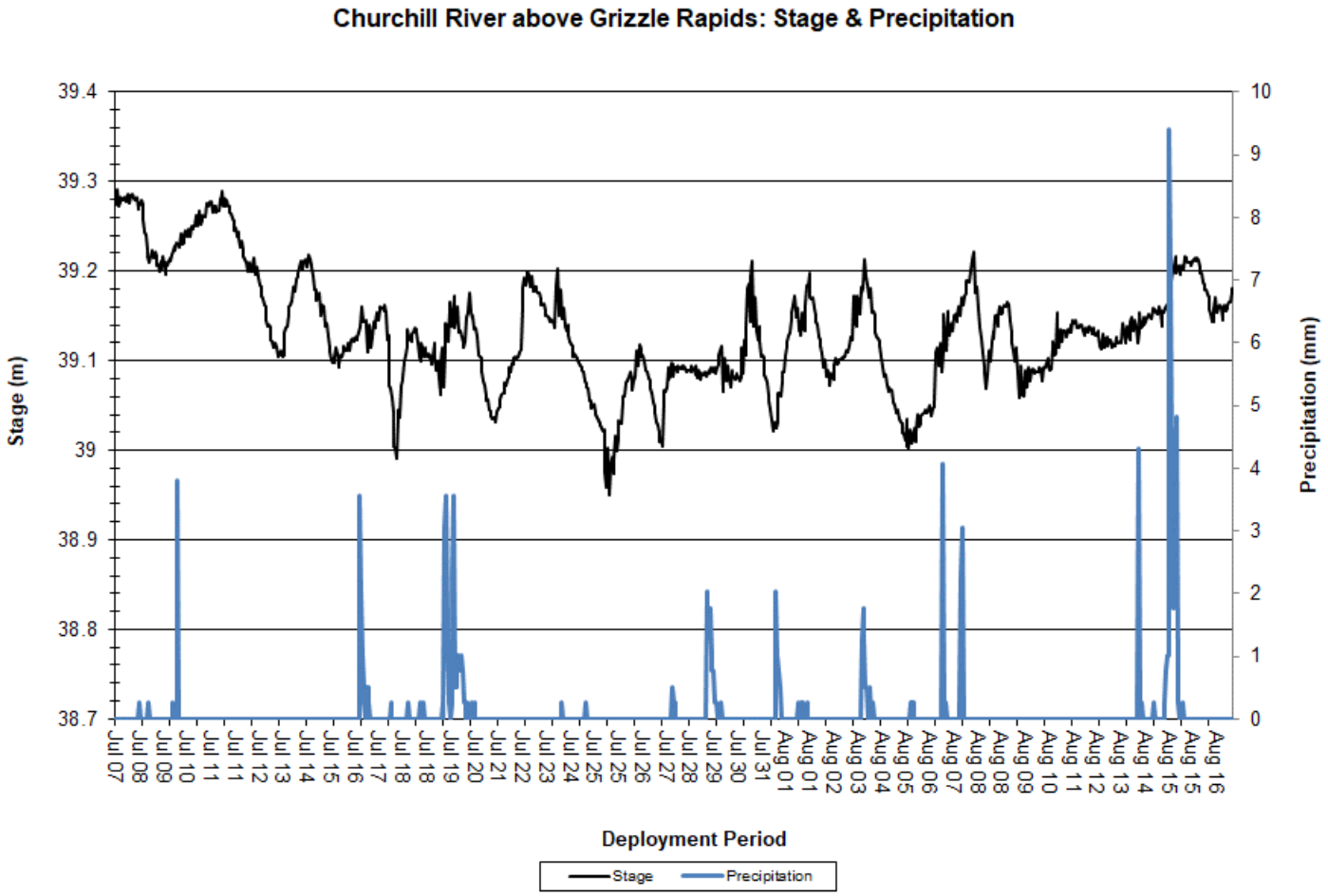

Figure 14: Stage & Precipitation at Churchill River above Grizzle Rapids

Churchill River below Muskrat Falls

Water Temperature

- Over the deployment period, water temperature ranged from 7.0°C to 31.2°C, with a median value of 16.7°C (Figure 15). Air temperature data was obtained from the Muskrat Falls MET Station.
- Water temperature slowly increased over the course of the deployment period. This is to be expected as ambient air temperatures continued to increase through July and August. Water temperatures closely correlate with ambient air temperatures; however, the rapid fluctuations and the fact that water temperatures almost perfectly match ambient air temperatures from July 25 through August 14 indicates that the instrument was out of water during this period.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

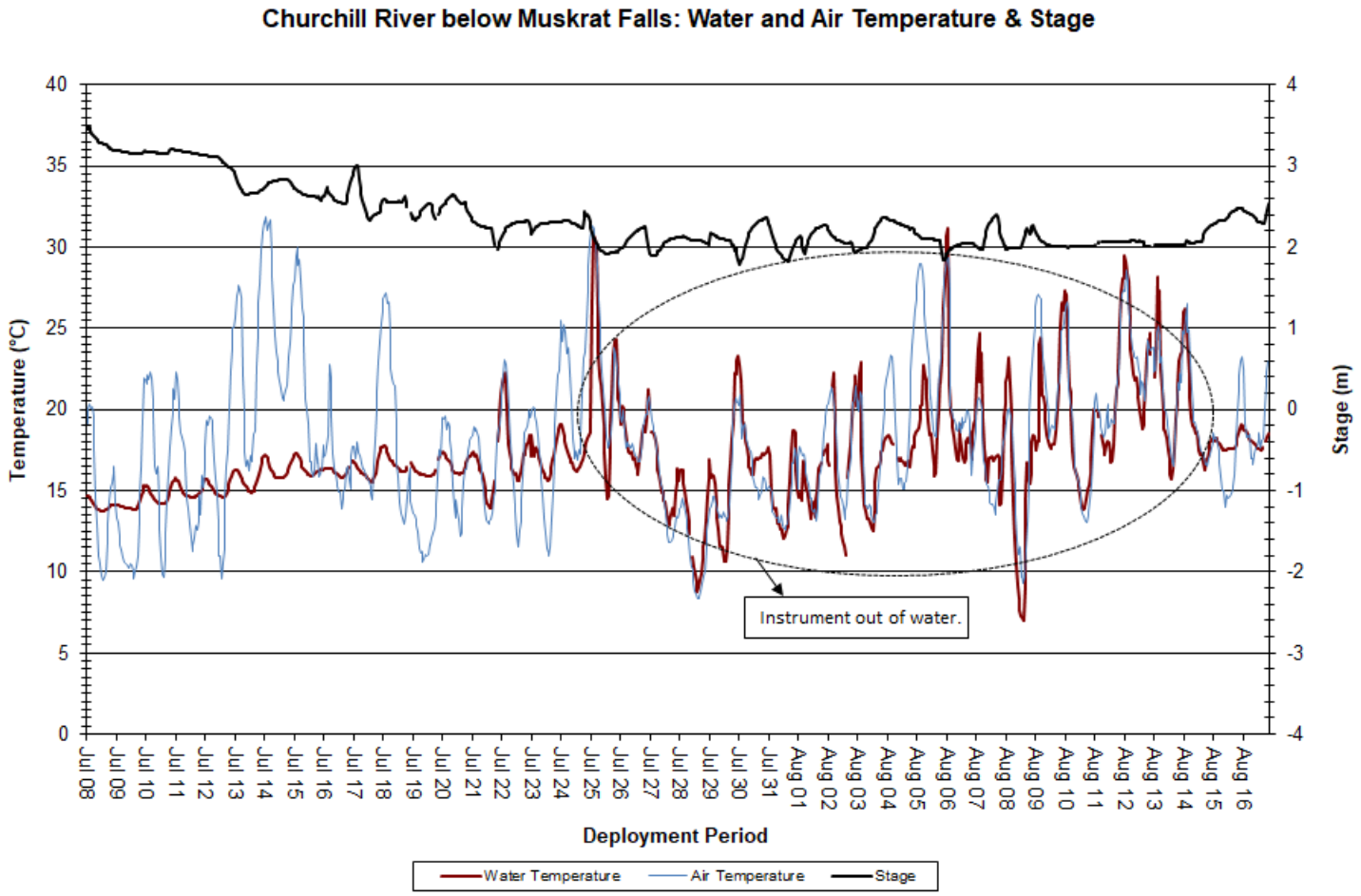

Figure 15: Water and Air Temperature & Stage at Churchill River below Muskrat Falls

pH

- Over the deployment period, pH ranged from 0 pH units to 13.58 pH units, with a median value of 6.95 (Figure 16). These high and low values are another indication that the instrument was out of the water from July 21 to August 14. All values within this time period are invalid.
- The valid pH values at the beginning and end of deployment were relatively stable over the course of deployment, and remained within the CCME's Guidelines for the Protection of Aquatic Life.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

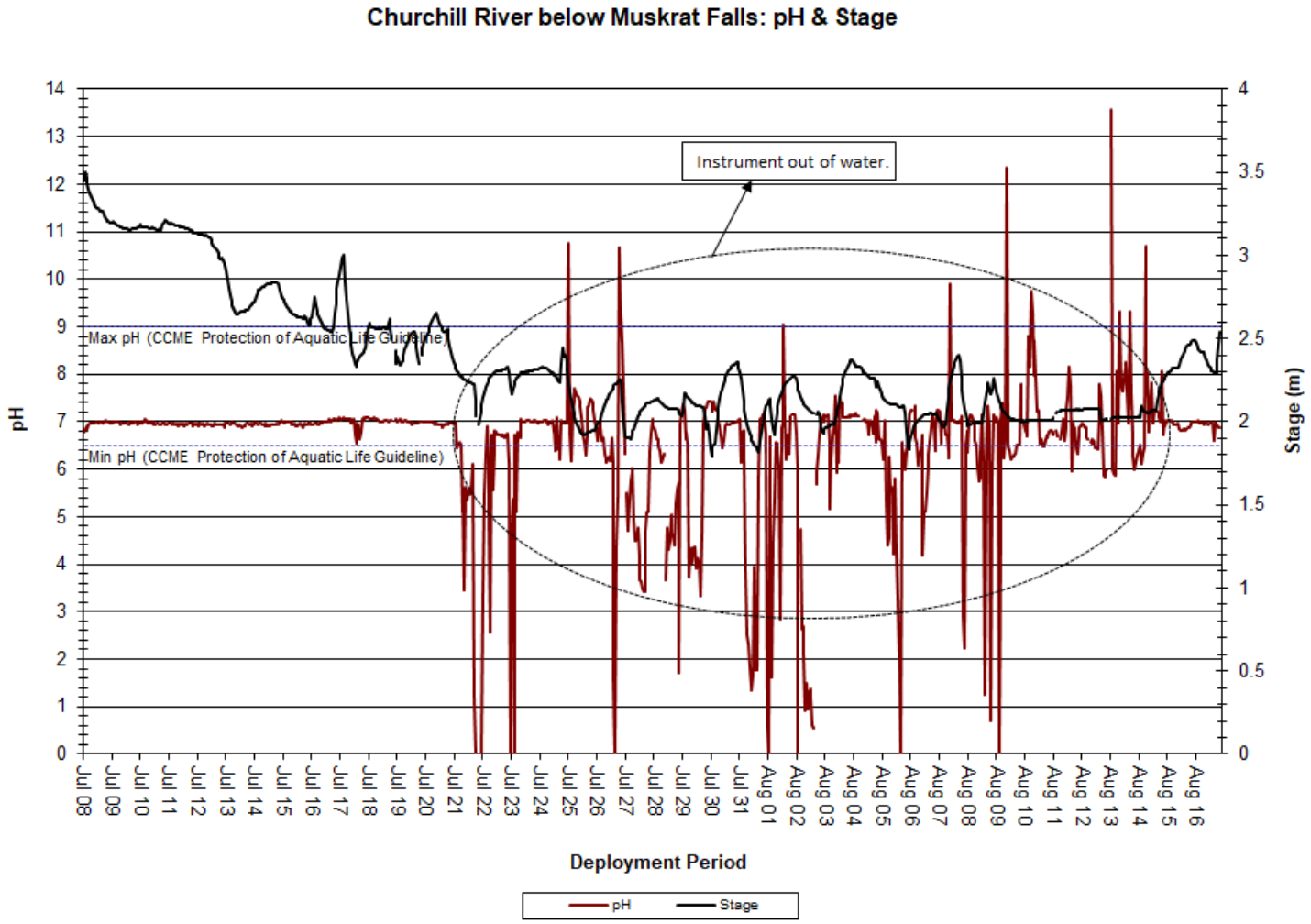

Figure 16: pH & Stage at Churchill River below Muskrat Falls

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 0µS/cm to 25.9µS/cm, with a median value of 8.8µS/cm (Figure 17).
- The relationship between conductivity and stage is generally inversed. When stage decreases, specific conductivity increases as the decreased amount of water in the river system concentrates solids that are present, and vice versa. This relationship is only somewhat evident in the graph below, likely because this station is located at a deep and wide section of the Churchill River and other factors in the water column influence conductivity levels (Figure 17).
- The period of sporadic specific conductivity readings observed from July 21 through August 14 is being attributed to the instrument being out of water.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

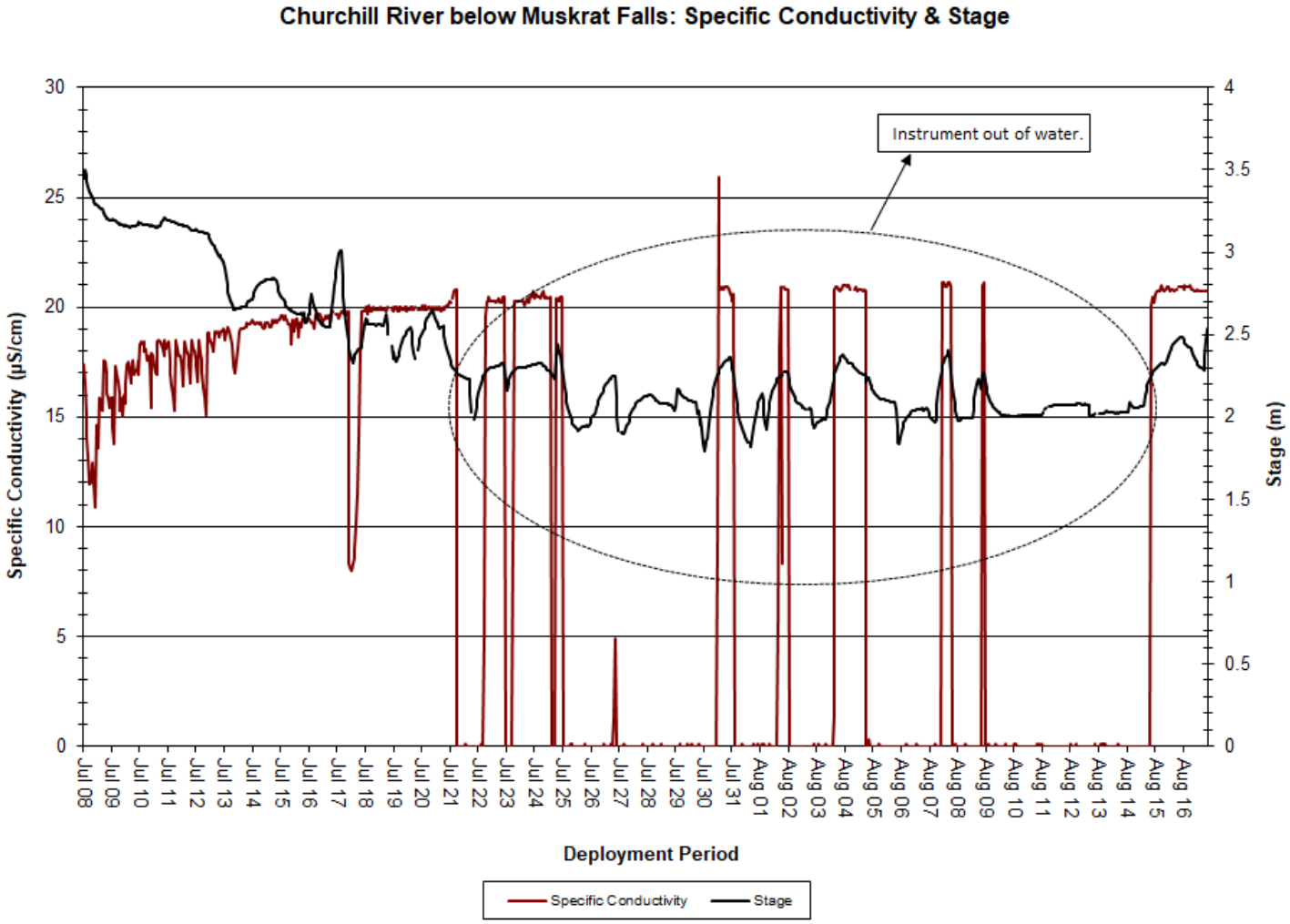

Figure 17: Specific Conductivity & Stage at Churchill River below Muskrat Falls

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 5.26mg/L to 11.57mg/L, with a median value of 9.57mg/L. Saturation of dissolved oxygen ranged from 53.2% to 115.5%, with a median value of 98.1% (Figure 18).
- Dissolved oxygen and water temperature exhibit an inverse relationship: as one parameter increases, the other decreases, and vice versa. Dissolved oxygen levels slowly decreased over the course of deployment. This is to be expected since water temperatures were slowly increasing over the same period. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures.
- The period of greater fluctuation in dissolved oxygen levels observed from July 21 through August 14 is being attributed to the instrument being out of water.
- Dissolved oxygen levels remained above the CCME's Guidelines for the Protection of Early and Other Life Stages for the beginning of deployment until the instrument came out of water.

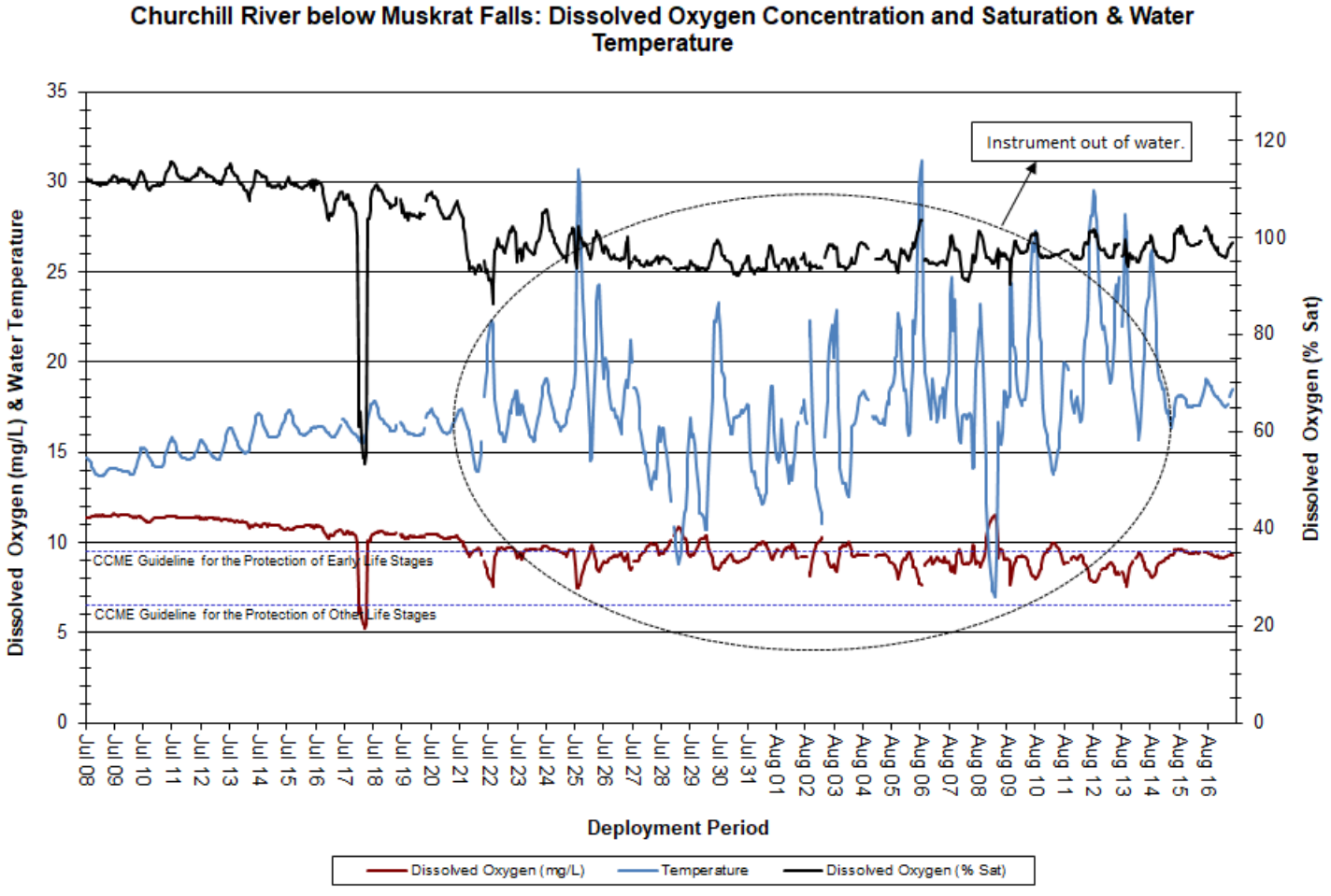

Figure 18: Dissolved Oxygen & Water Temperature at Churchill River below Muskrat Falls

Turbidity

- Over the deployment period, turbidity ranged from 0 NTU to 2346 NTU, with a median value of 0.9 NTU. A median value of 0.9 NTU indicates a small amount of natural background turbidity in the waterbody, which is typical of this station. Precipitation data was obtained from the Muskrat Falls MET Station.
- There was some correlation between turbidity events and precipitation events across the deployment period (Figure 19). Turbidity levels are often quite variable at this station, and do not always correlate with precipitation events given that this station is located on a wide and deep section of the Churchill River. In addition, the instrument was out of water from July 21 through August 14, which would have affected the observed turbidity levels during that period.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

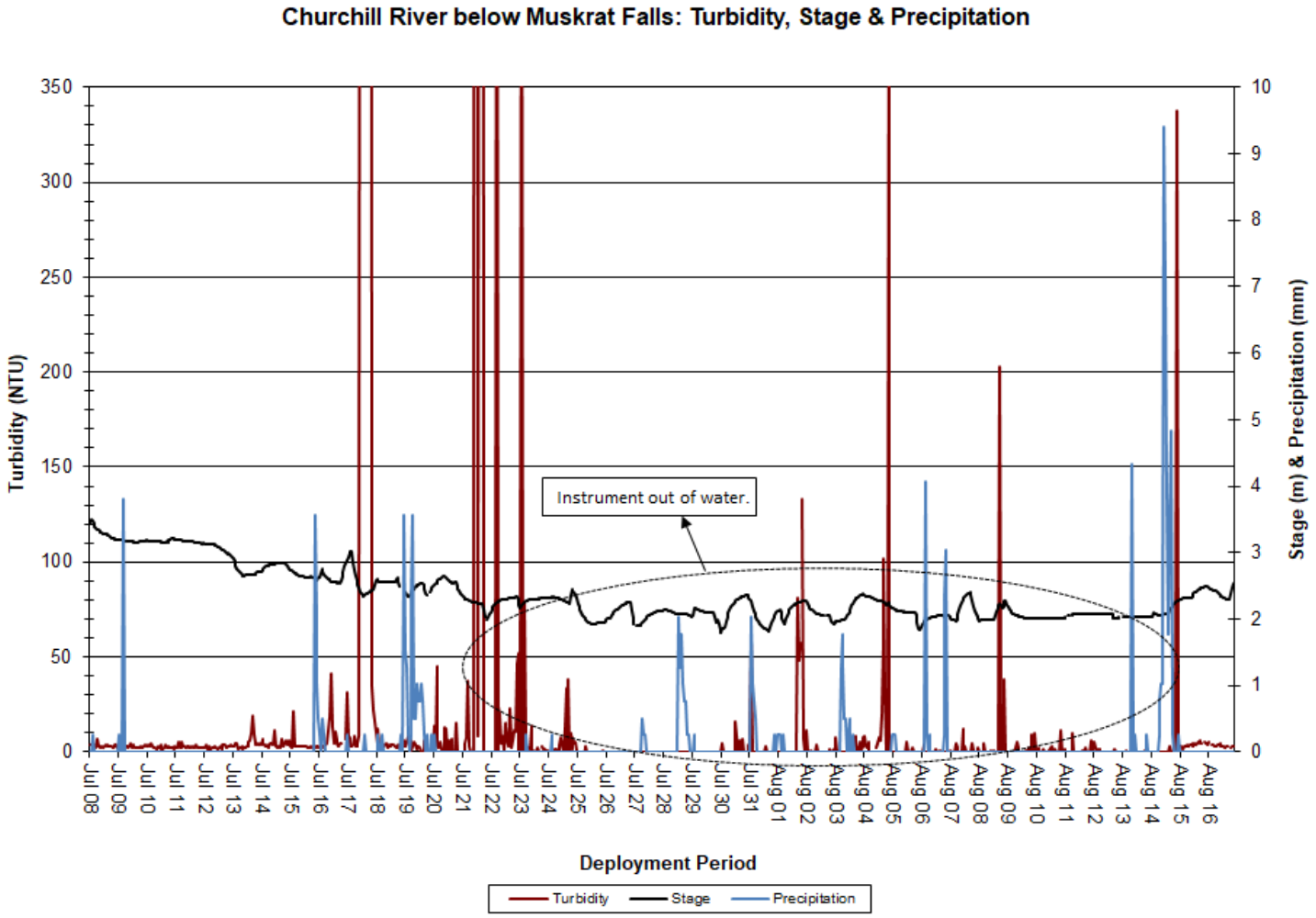

Figure 19: Turbidity, Precipitation & Stage at Churchill River below Muskrat Falls

Stage & Flow

- Over the deployment period, stage ranged from 1.793m to 3.498m, with a median value of 2.262m. Flow ranged from 910.749m^3/s to 2608.476m^3/s, with a median value of 1290.377m^3/s (Figure 20). Precipitation data was obtained from the Muskrat Falls MET Station.
- Stage and flow were variable and slightly decreasing over the course of deployment, and did not generally correlate closely with precipitation events. This is partly related to the fact that this station is located on a very wide section of the Churchill River and therefore not as easily influenced by smaller precipitation events. Stage and flow at this station are also influenced by upstream activities at the Muskrat Falls hydroelectric project.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

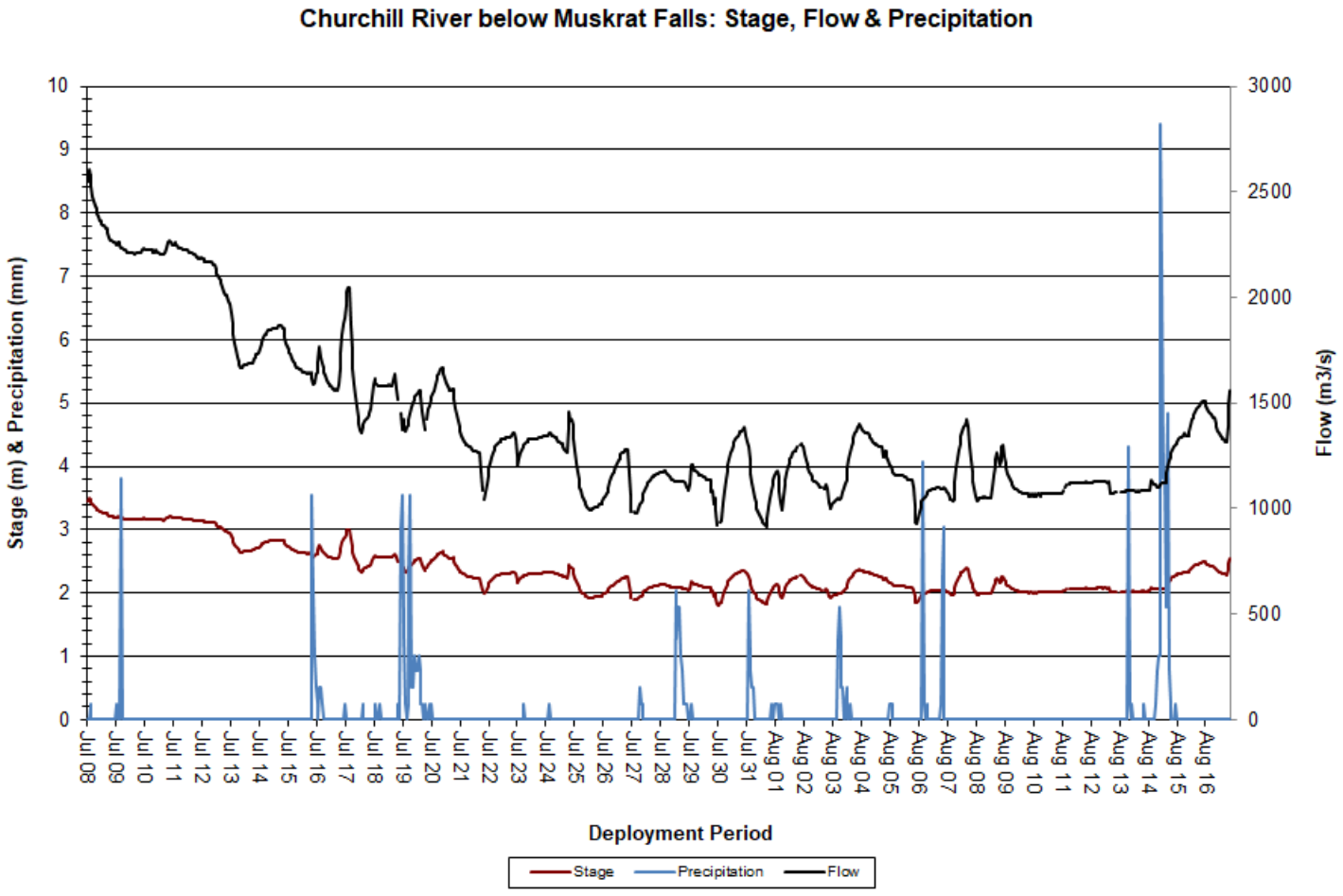

Figure 20: Stage, Flow & Precipitation at Churchill River below Muskrat Falls

Chlorophyll

- Over the deployment period, chlorophyll ranged from 0ug/L to 8.04ug/L, with a median value of 1.25ug/L (Figure 21).
- Chlorophyll is found within living cells of photosynthetic organisms like phytoplankton and cyanobacteria. The amount of chlorophyll found in water can be used to understand the general biological health of an ecosystem. Chlorophyll can also be used to identify algal bloom events and is an indicator of nutrient loading in ecosystems.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

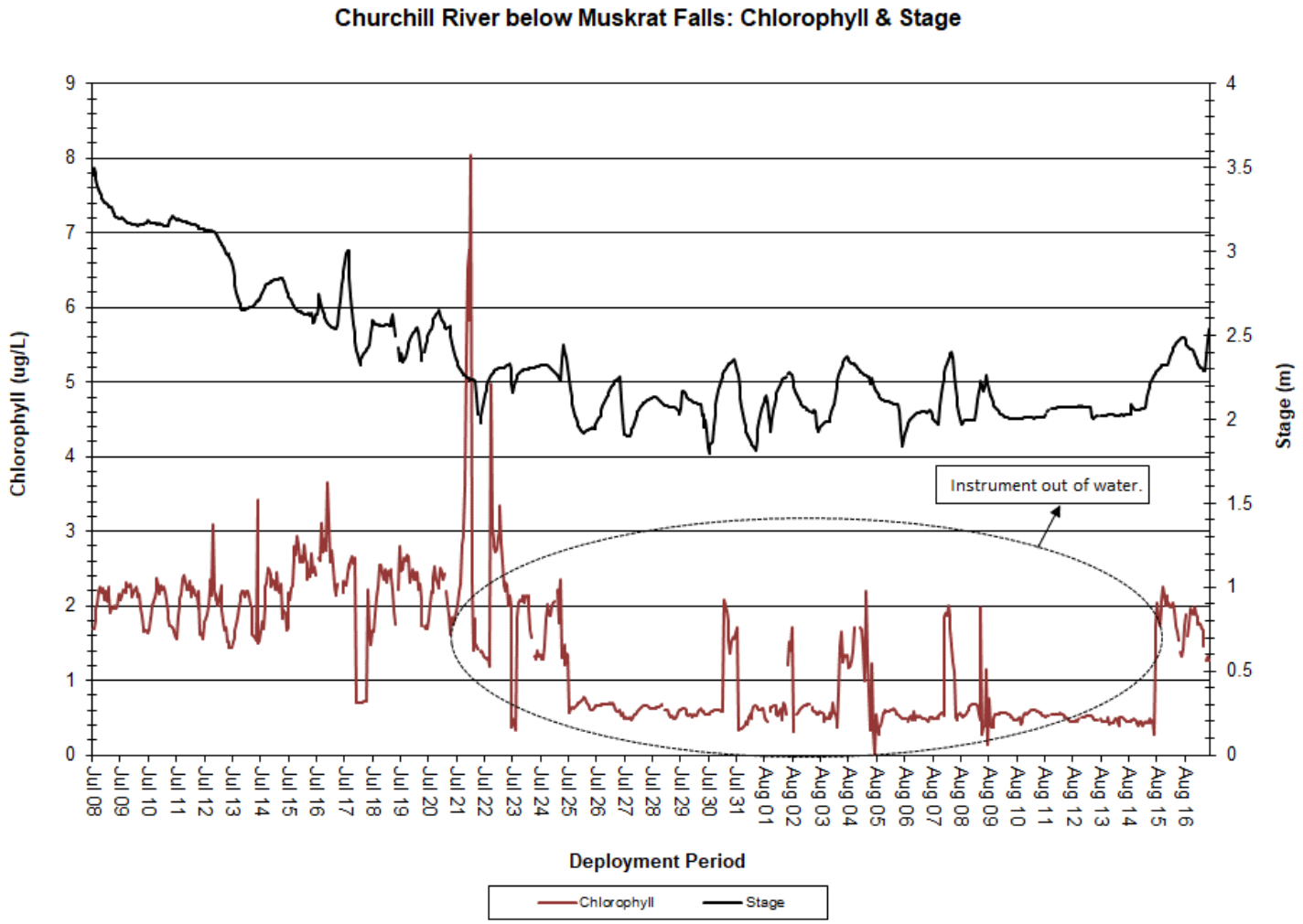

Figure 21: Chlorophyll & Stage at Churchill River below Muskrat Falls

Churchill River at English Point

Water Temperature

- Water temperature ranged from 13.3°C to 22.4°C, with a median value of 17.9°C (Figure 22). Air temperature data was obtained from the End of Mud Lake Road Weather Station.
- Water temperature increased slowly across the deployment period. Water temperatures closely correlated with ambient air temperatures, which followed a similar trend across the same period.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

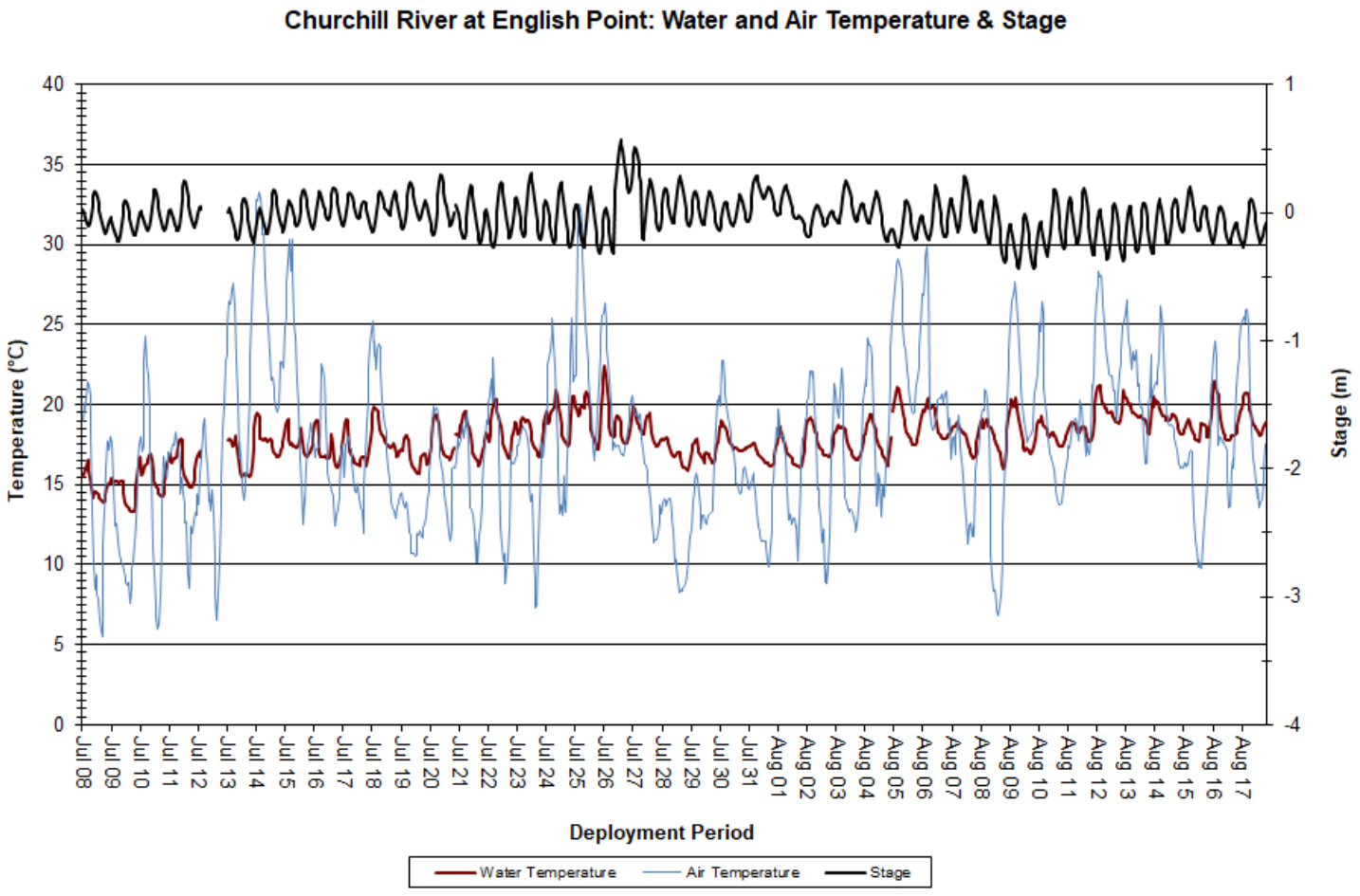

Figure 22: Water and Air Temperature & Stage at Churchill River at English Point

pH

- Over the deployment period, pH ranged from 6.11 pH units to 7.17 pH units, with a median value of 6.61 (Figure 23).
- pH values were relatively stable over the course of deployment. pH values were within the CCME's Guidelines for the Protection of Aquatic Life for the beginning of deployment, after which they hovered around the Minimum Guideline for the remainder of deployment.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

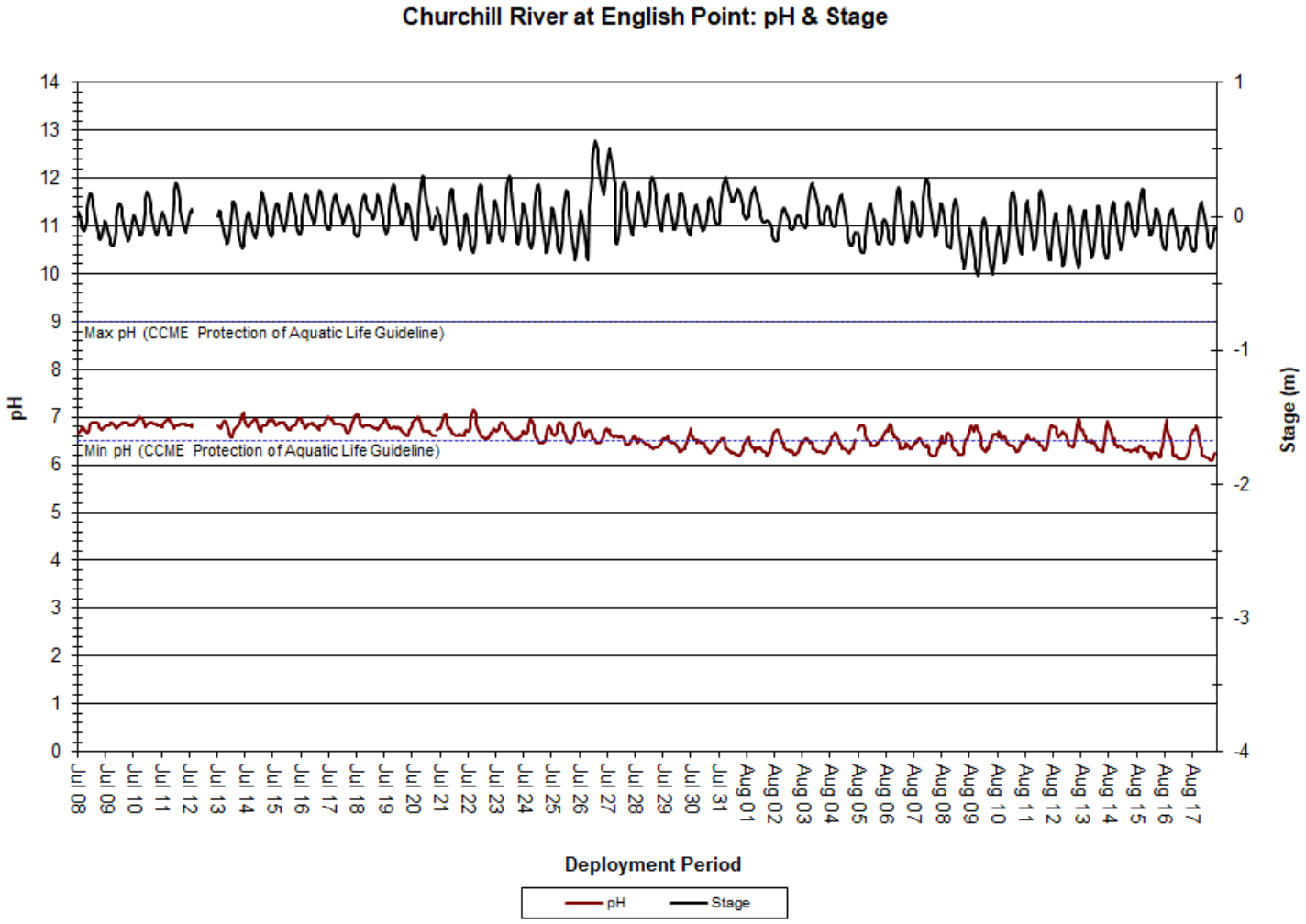

Figure 23: pH & Stage at Churchill River at English Point

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 20.8µS/cm to 60.8µs/cm, with a median value of 33.4µS/cm (Figure 24).
- Specific conductivity fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean on Lake Melville. As the tide comes in, specific conductivity increases as dissolved solids and salinity increase, and vice versa as the tide goes out. This increase and decrease in specific conductivity and stage occurs twice daily. This pattern is generally consistent throughout the deployment period (Figure 24).
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

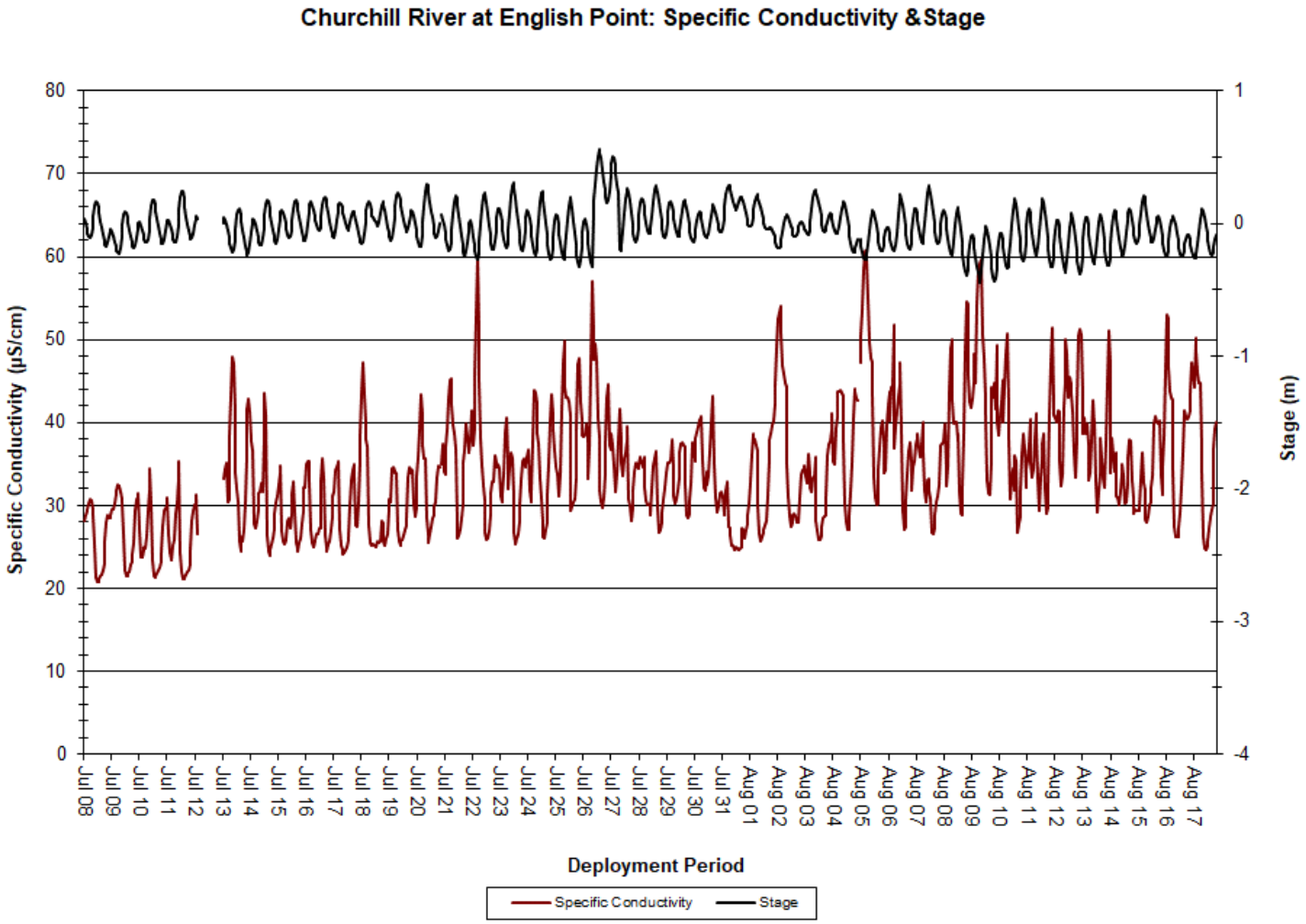

Figure 24: Specific Conductivity & Stage at Churchill River at English Point

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 8.34mg/L to 11.13mg/L, with a median value of 9.22mg/L. Saturation of dissolved oxygen ranged from 88.6% to 113.5% saturation, with a median value of 98.3% (Figure 25).
- There is an evident relationship between water temperature and dissolved oxygen. As water temperatures increased over the deployment period, dissolved oxygen levels decreased. Dissolved oxygen levels also follow a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures. Generally, dissolved oxygen levels are higher in a waterbody during cooler temperatures.
- Dissolved oxygen levels were above the CCME's Guideline for the Protection of Early Life Stages for the very beginning of deployment, after which they hovered around and then fell below that Guideline. Dissolved oxygen levels were above the CCME's Guidelines for the Protection of Other Life Stages for the duration of deployment (Figure 25).

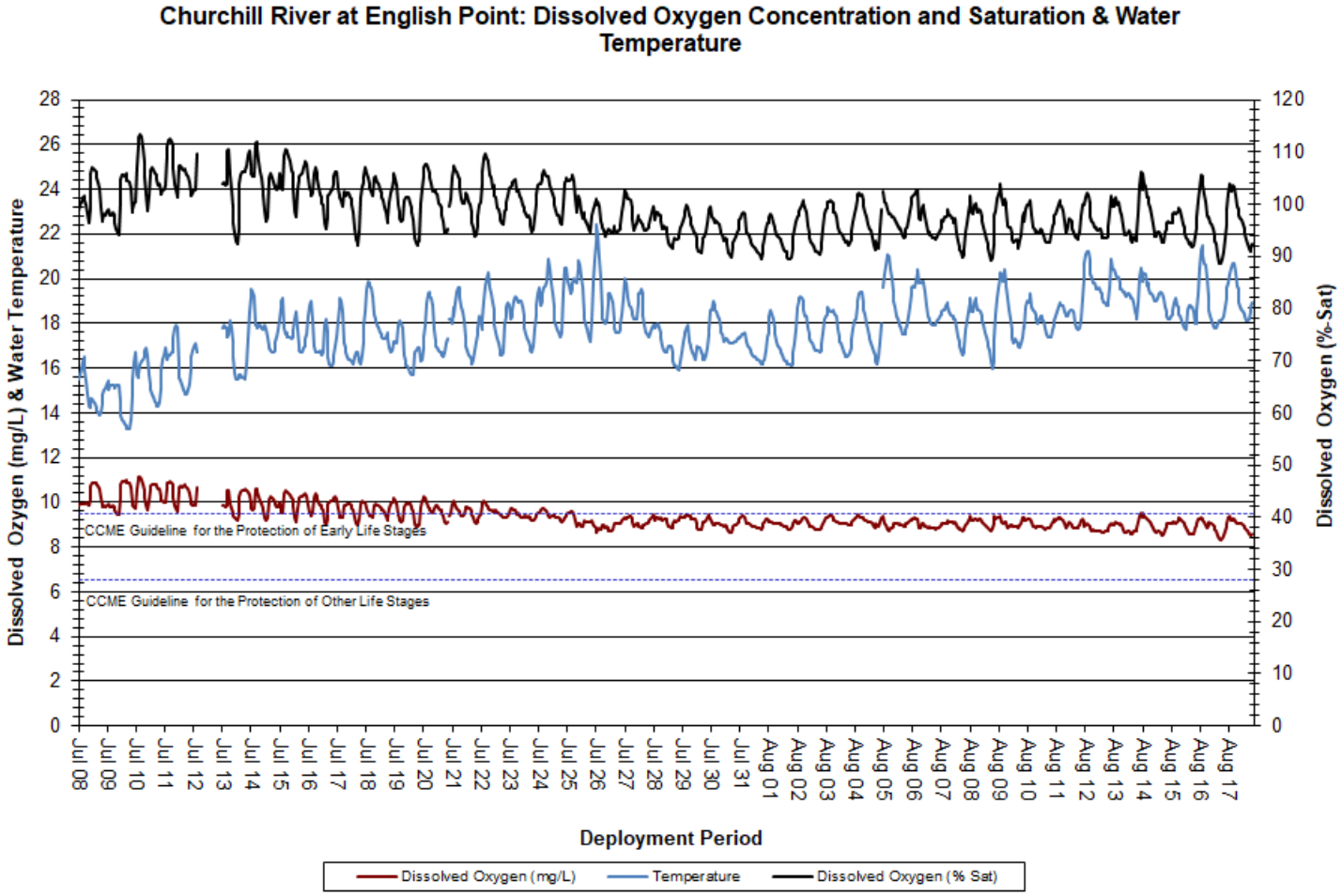

Figure 25: Dissolved Oxygen & Water Temperature at Churchill River at English Point

Turbidity

- Over the deployment period, turbidity ranged from 0.9 NTU to 469 NTU, with a median value of 5.8 NTU (Figure 26). A median value of 5.8NTU indicates a low level of background turbidity; this is to be expected considering the sandy river bed and tidal influences present at this station. Precipitation data was obtained from the End of Mud Lake Road Weather Station.
- Turbidity events generally correlate with precipitation events, as these can increase the presence of suspended material in water. High winds and tidal influences can also contribute to turbidity events at this station by disturbing sediment from the river bed (Figure 26). Wind speed data was also obtained from the End of Mud Lake Road Weather Station.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

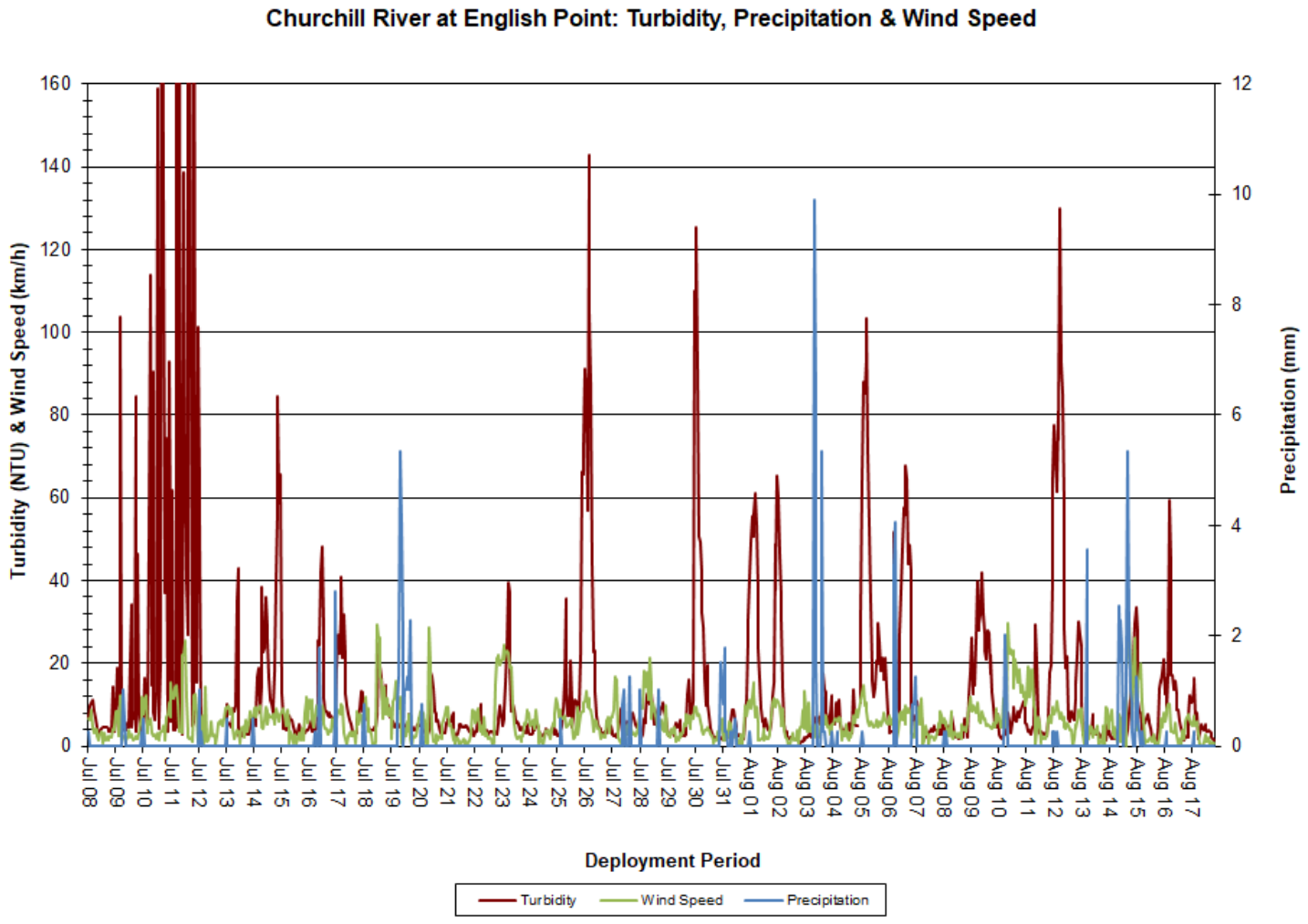

Figure 26: Turbidity, Precipitation & Wind Speed at Churchill River at English Point

Stage

- Over the deployment period, stage ranged from -0.442m to 0.566m, with a median value of -0.031m (Figure 27). Precipitation data was obtained from the End of Mud Lake Road Weather Station.
- Stage fluctuates considerably at this location due to the tidal influences of the Atlantic Ocean. This pattern is consistent over the deployment period. Increases in stage often correlate with precipitation events.
- Water Survey of Canada (Environment and Climate Change Canada) is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request.

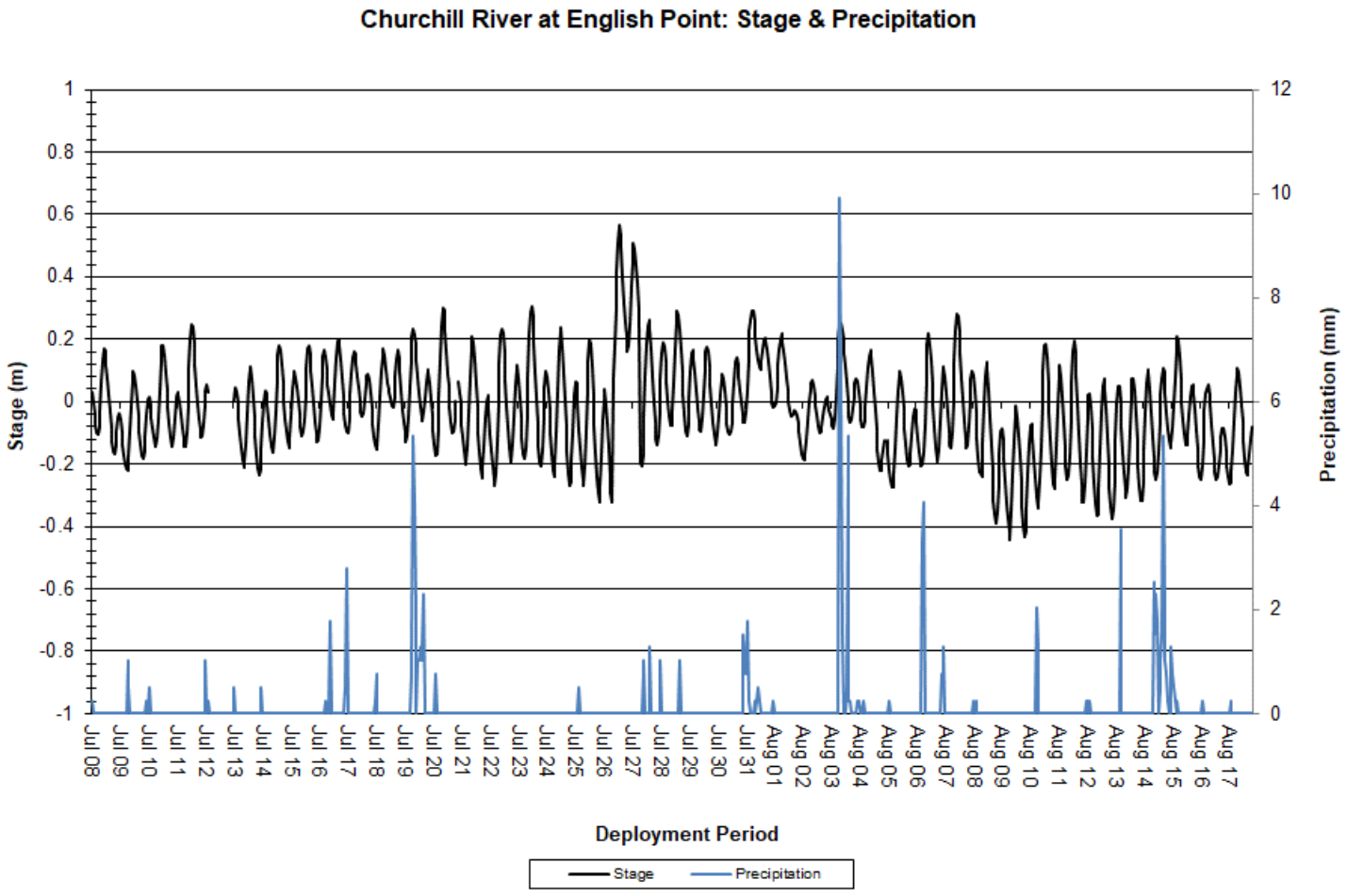

Figure 27: Stage & Precipitation at Churchill River at English Point

Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from July 7/8/27 through August 17/18, 2021.
- Water temperature increased steadily at all stations over the course of deployment. This is to be expected based on ambient air temperature trends during the same period through July and August.
- pH was relatively stable at all stations over the course of deployment. pH was within the CCME's Guidelines for the Protection of Aquatic Life for the duration of deployment at Churchill River below Metchin River, above Grizzle Rapids and below Muskrat Falls (except while the instrument was out of water), while pH hovered around the minimum Guideline at English Point.
- Specific conductivity generally increased over the course of deployment at all stations. Since English Point is influenced by tides in Lake Melville, specific conductivity values at the Churchill River at English Point station had a much wider range, which is comparable to other deployments at this location.
- Dissolved oxygen levels slowly decreased over the course of deployment at all stations as water temperatures increased through the summer. Dissolved oxygen levels are generally higher in water at cooler temperatures. Dissolved oxygen levels eventually fell below the CCME's Guideline for the Protection of Early Life Stages at some point during deployment at all stations. Dissolved oxygen levels were above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment at all stations.
- Turbidity events occurred at all stations and were generally related to precipitation, wind or tidal events. In most cases, turbidity values returned to background levels following each observed event.

References

Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated December, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. Available at: http://st-ts.ccme.ca/en/index.html?chems=154,162&chapters=1 [Accessed December 12, 2017].

Fondriest Environmental Inc. (2016a). Fundamentals of Environmental Measurements [Online]. Available at: http://www.fondriest.com/environmental-measurements/parameters/water-quality/conductivity-salinity-tds/#cond15 [Accessed December 12, 2017].

Fondriest Environmental Inc. (2016b). Fundamentals of Environmental Measurements [Online]. Available at: http://www.fondriest.com/environmental-measurements/parameters/water-quality/water-temperature/#watertemp1 [Accessed December 12, 2017].

Swenson, H.A., and Baldwin, H.L. (1965). A Primer on Water Quality, U.S. Geological Survey. Available at: https://pubs.usgs.gov/gip/7000057/report.pdf [Accessed December 12, 2017].

United States Geological Survey. (2017). Water properties: Dissolved oxygen [Online]. Available at: https://water.usgs.gov/edu/dissolvedoxygen.html [Accessed December 12, 2017].

APPENDIX A

Water Parameter Description

Water Parameter Description

Dissolved Oxygen - The amount of Dissolved Oxygen (DO) (mg/l or % saturation) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (USGS, 2017).

Flow - Flow (m3/s) is a measure of how quickly a volume of water is displaced in streams, rivers, and other channels.

pH - pH is a measure of the relative amount of free hydrogen and hydroxyl ions in water. pH is an important indicator of chemically changing water, and determines the solubility and biological availability of nutrients and heavy metals in the water (USGS, 2017).

Specific conductivity - Specific conductivity (µs/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25°C. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Fondriest Environmental Inc, 2016).

Stage - Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature - Essential to the measurement of most water quality parameters, temperature (°C) controls most aquatic processes. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth. In turn, water temperature has an influence on the metabolic rates and biological activity of aquatic organisms (Fondriest Environmental Inc, 2016b).

Total Dissolved Solids - Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Swenson and Baldwin, 1965).

Turbidity - Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Swenson and Baldwin 1965).

APPENDIX B

Grab Sample Results

BV Labs Job #: C1J3250
Report Date: 2021/07/22

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

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QBQ156 CR ABOVE GR								
Sampling Date 2021/07/07 12:40								
Matrix W								
Sample # 2021-6313-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	9.6	1.0	mg/L	N/A	2021/07/15		7458782
Nitrate (N)	-	0.085	0.050	mg/L	N/A	2021/07/20		7458785
Total dissolved solids (calc., EC)	-	11	1.0	mg/L	N/A	2021/07/15		7459157
Inorganics								
Conductivity	-	21	1.0	uS/cm	N/A	2021/07/15	SHW	7463852
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2021/07/15	FD	7462652
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/07/15	FD	7462652
Sulphate (SO4)	-	1.8	1.0	mg/L	N/A	2021/07/15	FD	7462652
Total Alkalinity (Total as CaCO3)	-	11	5.0	mg/L	N/A	2021/07/19	MCN	7467033
Colour	-	26	5.0	TCU	N/A	2021/07/19	MCN	7467053
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/07/15	SHW	7463854
Total Kjeldahl Nitrogen (TKN)	-	0.11	0.10	mg/L	2021/07/15	2021/07/15	MJ1	7464114
Nitrate + Nitrite (N)	-	0.085	0.050	mg/L	N/A	2021/07/19	MCN	7467058
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/07/19	MCN	7467060
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/07/16	MCN	7464859
Dissolved Organic Carbon (C)	-	4.0	0.50	mg/L	N/A	2021/07/16	NGI	7466389
Total Organic Carbon (C)	-	3.8	0.50	mg/L	N/A	2021/07/19	NGI	7466428
pH	-	7.02		pH	N/A	2021/07/15	SHW	7463853
Total Phosphorus	-	0.009	0.004	mg/L	2021/07/15	2021/07/16	SSV	7464667
Total Suspended Solids	-	28	2.2	mg/L	2021/07/14	2021/07/19	BBD	7461331
Turbidity	-	1.3	0.10	NTU	N/A	2021/07/15	SHW	7463889
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/07/16	2021/07/16	NHU	7462030
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.11	0.0050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Barium (Ba)	-	0.0085	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Boron (B)	-	ND	0.050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Calcium (Ca)	-	2.5	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Copper (Cu)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Iron (Fe)	-	0.24	0.050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Magnesium (Mg)	-	0.83	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Manganese (Mn)	-	0.013	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

BV Labs Job #: C1J3250
Report Date: 2021/07/22

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

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QBQ156 CR ABOVE GR								
Sampling Date 2021/07/07 12:40								
Matrix W								
Sample # 2021-6313-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Sodium (Na)	-	0.77	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Strontium (Sr)	-	0.011	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Uranium (U)	-	ND	0.00010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/07/13	2021/07/14	BAN	7459710

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QBQ158 CR AT EP								
Sampling Date 2021/07/08 13:35								
Matrix W								
Sample # 2021-6315-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	7.5	1.0	mg/L	N/A	2021/07/15		7458782
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/07/22		7458785
Total dissolved solids (calc., EC)	-	16	1.0	mg/L	N/A	2021/07/16		7459157
Inorganics								
Conductivity	-	28	1.0	uS/cm	N/A	2021/07/16	SHW	7466278
Chloride (Cl-)	-	5.4	1.0	mg/L	N/A	2021/07/15	FD	7462652
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/07/15	FD	7462652
Sulphate (SO4)	-	1.2	1.0	mg/L	N/A	2021/07/15	FD	7462652
Total Alkalinity (Total as CaCO3)	-	8.8	5.0	mg/L	N/A	2021/07/21	EMT	7474286
Colour	-	46	10	TCU	N/A	2021/07/21	EMT	7474274
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/07/16	SHW	7466280
Total Kjeldahl Nitrogen (TKN)	-	0.15	0.10	mg/L	2021/07/14	2021/07/15	MJ1	7462699
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2021/07/21	EMT	7474270
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/07/21	EMT	7472846
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/07/20	EMT	7471985
Dissolved Organic Carbon (C)	-	6.0	0.50	mg/L	N/A	2021/07/20	NGI	7471896
Total Organic Carbon (C)	-	6.2	0.50	mg/L	N/A	2021/07/21	NGI	7474332
pH	-	6.84		pH	N/A	2021/07/16	SHW	7466279
Total Phosphorus	-	0.019	0.004	mg/L	2021/07/15	2021/07/16	SSV	7464667
Total Suspended Solids	-	9.2	1.0	mg/L	2021/07/15	2021/07/16	MKX	7464001
Turbidity	-	12	0.10	NTU	N/A	2021/07/15	SHW	7463888
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/07/16	2021/07/16	NHU	7462030
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.43	0.0050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Barium (Ba)	-	0.0093	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Boron (B)	-	ND	0.050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Calcium (Ca)	-	1.5	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Copper (Cu)	-	0.0012	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Iron (Fe)	-	0.69	0.050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Magnesium (Mg)	-	0.89	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Manganese (Mn)	-	0.019	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

BV Labs Job #: C1J3250
Report Date: 2021/07/22

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

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QBQ158 CR AT EP Sampling Date 2021/07/08 13:35 Matrix W Sample # 2021-6315-00-SI-SP Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Sodium (Na)	-	3.4	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Strontium (Sr)	-	0.013	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Uranium (U)	-	ND	0.00010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/07/13	2021/07/14	BAN	7459710

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QBQ160 CR BELOW MF								
Sampling Date 2021/07/08 15:00								
Matrix W								
Sample # 2021-6317-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	8.6	1.0	mg/L	N/A	2021/07/15		7458782
Nitrate (N)	-	0.095	0.050	mg/L	N/A	2021/07/20		7458785
Total dissolved solids (calc., EC)	-	10	1.0	mg/L	N/A	2021/07/15		7459157
Inorganics								
Conductivity	-	19	1.0	uS/cm	N/A	2021/07/15	SHW	7463852
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2021/07/15	FD	7462652
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/07/15	FD	7462652
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2021/07/15	FD	7462652
Total Alkalinity (Total as CaCO3)	-	12	5.0	mg/L	N/A	2021/07/19	MCN	7467033
Colour	-	33	5.0	TCU	N/A	2021/07/19	MCN	7467053
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/07/15	SHW	7463854
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2021/07/15	2021/07/15	MJ1	7464114
Nitrate + Nitrite (N)	-	0.095	0.050	mg/L	N/A	2021/07/19	MCN	7467058
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/07/19	MCN	7467060
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2021/07/16	MCN	7464859
Dissolved Organic Carbon (C)	-	4.2	0.50	mg/L	N/A	2021/07/17	NGI	7466389
Total Organic Carbon (C)	-	4.5	0.50	mg/L	N/A	2021/07/19	NGI	7466428
pH	-	7.03		pH	N/A	2021/07/15	SHW	7463853
Total Phosphorus	-	0.012	0.004	mg/L	2021/07/15	2021/07/16	SSV	7464667
Total Suspended Solids	-	16	1.0	mg/L	2021/07/14	2021/07/16	MKX	7461654
Turbidity	-	9.6	0.10	NTU	N/A	2021/07/15	SHW	7463889
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/07/16	2021/07/16	NHU	7462030
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.24	0.0050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Barium (Ba)	-	0.0091	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Boron (B)	-	ND	0.050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Calcium (Ca)	-	2.2	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Copper (Cu)	-	0.00067	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Iron (Fe)	-	0.27	0.050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Magnesium (Mg)	-	0.76	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Manganese (Mn)	-	0.011	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QBQ160 CR BELOW MF								
Sampling Date 2021/07/08 15:00								
Matrix W								
Sample # 2021-6317-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Sodium (Na)	-	0.66	0.10	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Strontium (Sr)	-	0.011	0.0020	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Uranium (U)	-	ND	0.00010	mg/L	2021/07/13	2021/07/14	BAN	7459710
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/07/13	2021/07/14	BAN	7459710

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

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
QGW723 CR ABOVE MR								
Sampling Date 2021/07/27 12:40								
Matrix W								
Sample # 2021-6318-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	11	1.0	mg/L	N/A	2021/08/09		7499108
Nitrate (N)	-	ND	0.050	mg/L	N/A	2021/08/11		7499111
Total dissolved solids (calc., EC)	-	12	1.0	mg/L	N/A	2021/08/09		7499578
Inorganics								
Conductivity	-	22	1.0	uS/cm	N/A	2021/08/09	SHW	7507793
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2021/08/11	FD	7509771
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/08/11	FD	7509771
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2021/08/11	FD	7509771
Total Alkalinity (Total as CaCO3)	-	11	5.0	mg/L	N/A	2021/08/10	EMT	7508188
Colour	-	17	5.0	TCU	N/A	2021/08/10	EMT	7508213
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/08/09	SHW	7507797
Total Kjeldahl Nitrogen (TKN)	-	0.11	0.10	mg/L	2021/08/09	2021/08/10	MJ1	7508170
Nitrate + Nitrite (N)	-	ND	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	7507893
Dissolved Organic Carbon (C)	-	3.2	0.50	mg/L	N/A	2021/08/07	NGI	7504348
Total Organic Carbon (C)	-	3.5	0.50	mg/L	N/A	2021/08/09	NGI	7504414
pH	-	7.11		pH	N/A	2021/08/09	SHW	7507795
Total Phosphorus	-	0.056	0.004	mg/L	2021/08/11	2021/08/12	SSV	7512775
Total Suspended Solids	-	53	1.0	mg/L	2021/08/04	2021/08/11	MKX	7499981
Turbidity	-	9.6	0.10	NTU	N/A	2021/08/06	SHW	7504524
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)	-	0.44	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)	-	0.013	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)	-	2.7	0.10	mg/L	2021/08/06	2021/08/06	BAN	7504243
Total Chromium (Cr)	-	0.0012	0.0010	mg/L	2021/08/06	2021/08/06	BAN	7504243
Total Copper (Cu)	-	0.0013	0.00050	mg/L	2021/08/06	2021/08/06	BAN	7504243
Total Iron (Fe)	-	0.99	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)	-	1.1	0.10	mg/L	2021/08/06	2021/08/06	BAN	7504243
Total Manganese (Mn)	-	0.037	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 Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

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
QGW723 CR ABOVE MR Sampling Date 2021/07/27 12:40 Matrix W Sample # 2021-6318-00-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)	-	0.60	0.10	mg/L	2021/08/06	2021/08/06	BAN	7504243
Total Strontium (Sr)	-	0.012	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

Bureau Veritas Laboratories 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com