Real-Time Water Quality Deployment Report

Lower Churchill River Network

July 10/13 to August 17/29, 2018

Newfoundland Labrador

Government of Newfoundland & Labrador
Department of Municipal Affairs & Environment
Water Resources Management Division

Contents

Real Time Water Quality Monitoring 1

Quality Assurance and Quality Control 2

Data Interpretation 4

Churchill River above Grizzle Rapids 6

Churchill River below Muskrat Falls 12

Churchill River at English Point 19

Conclusions 25

References 26

APPENDIX A - Water Parameter Description 27

APPENDIX B - Grab Sample Results 29

Prepared by:
Brenda Congram
Environmental Scientist
Department of Municipal Affairs & Environment
Water Resources Management Division
brendacongram@gov.nl.ca

Newfoundland Labrador

Real-Time Water Quality Deployment Report

Lower Churchill River Network

July 10/13 to August 17/29, 2018

Real Time Water Quality Monitoring

- Staff with the Department of Municipal Affairs & Environment monitor real-time water quality data on a regular basis.
- This deployment report discusses water quality related events occurring at three stations on the Lower Churchill River: Churchill River above Grizzle Rapids, Churchill River below Muskrat Falls and Churchill River at English Point.
- Real-time water quality monitoring instruments were deployed at Churchill River below Muskrat Falls and Churchill River at English Point on July 10th, and at Churchill River above Grizzle Rapids on July 13th. The instrument at Churchill River above Grizzle Rapids was removed on August 17th for a deployment period of 38 days. The instruments at Churchill River below Muskrat Falls and Churchill River at English Point were removed on August 29th for a deployment period of 50 days.
- The station at 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 (as was planned in the fall of 2016). However, due to unforeseen issues, water levels were raised and decreased again. As a result, the newly located above Muskrat Falls station is now situated approximately 650 feet from the edge of the reservoir (i.e. at current water levels) 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 alongside 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 10/13 to August 17/29, 2018 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations July 10/13 to August 17/29, 2018

Churchill River Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Above Grizzle Rapids	July 13, 2018	Deployment	Good	Excellent	Excellent	Excellent	Excellent
	August 17, 2018	Removal	Excellent	Excellent	Excellent	Excellent	Fair
Below Muskrat Falls	July 10, 2018	Deployment	Excellent	Good	Excellent	Good	Excellent
	August 29, 2018	Removal	Excellent	Excellent	Excellent	Excellent	Excellent
At English Point	July 10, 2018	Deployment	Excellent	Good	Excellent	Excellent	Good
	August 29, 2018	Removal	Good	Good	Good	Excellent	Poor
Below Metchin River	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
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 above Grizzle Rapids**
  - At deployment, temperature was ‘good’, while all other parameters were ‘excellent’.
  - At removal, turbidity was ‘fair’, while all other parameters were ‘excellent’.
- **Churchill River below Muskrat Falls**
  - At deployment, pH and dissolved oxygen were ‘good’, while all other parameters were ‘excellent’.
  - At removal, all parameters ranked as ‘excellent’.
- **Churchill River at English Point**
  - At deployment, pH and turbidity were ‘good’, while all other parameters were ‘excellent’.
  - At removal, dissolved oxygen was ‘excellent’, temperature, pH and conductivity were all ‘good’, while turbidity ranked as ‘poor’. This discrepancy may be attributable to the QA/QC sonde not being placed in close enough proximity to the field sonde.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring from July 10/13 to August 17/29, 2018 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 above Grizzle Rapids

Water Temperature

- Over the deployment period, water temperature ranged from 12.40°C to 19.60°C, with a median value of 17.20°C (Figure 2). Air temperature data was obtained from the Muskrat Falls MET Station.
- Water temperature slowly increased at the start of deployment and then remained stable throughout August. This trend is to be expected as air temperatures also warmed through the summer months. 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.

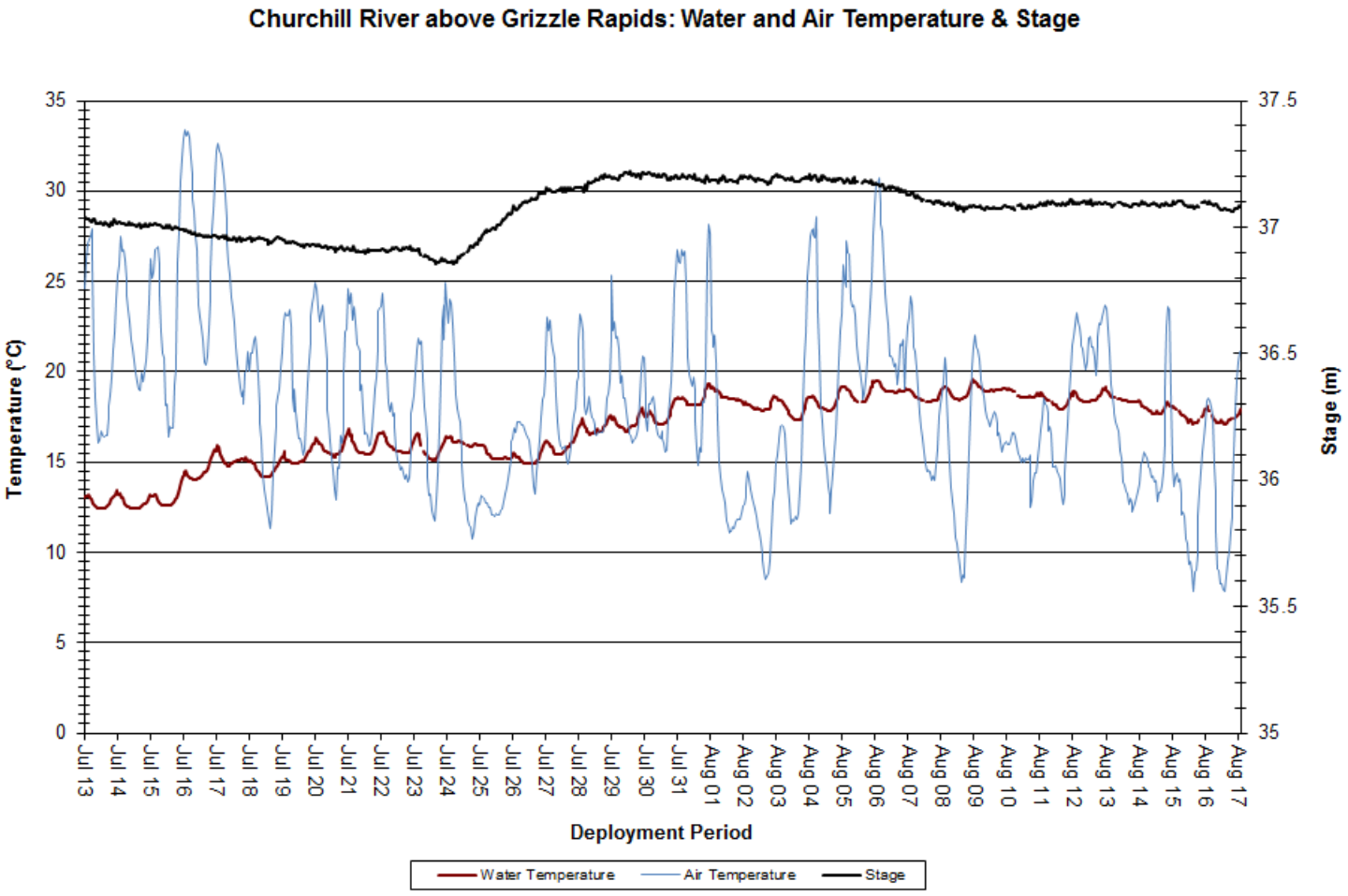


Figure 2: Water and Air Temperature & Stage at Churchill River above Grizzle Rapids

pH

- Over the deployment period, pH values ranged from 6.64 pH units to 6.92 pH units, with a median value of 6.76 (Figure 3).
- pH values were very stable and fell 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.

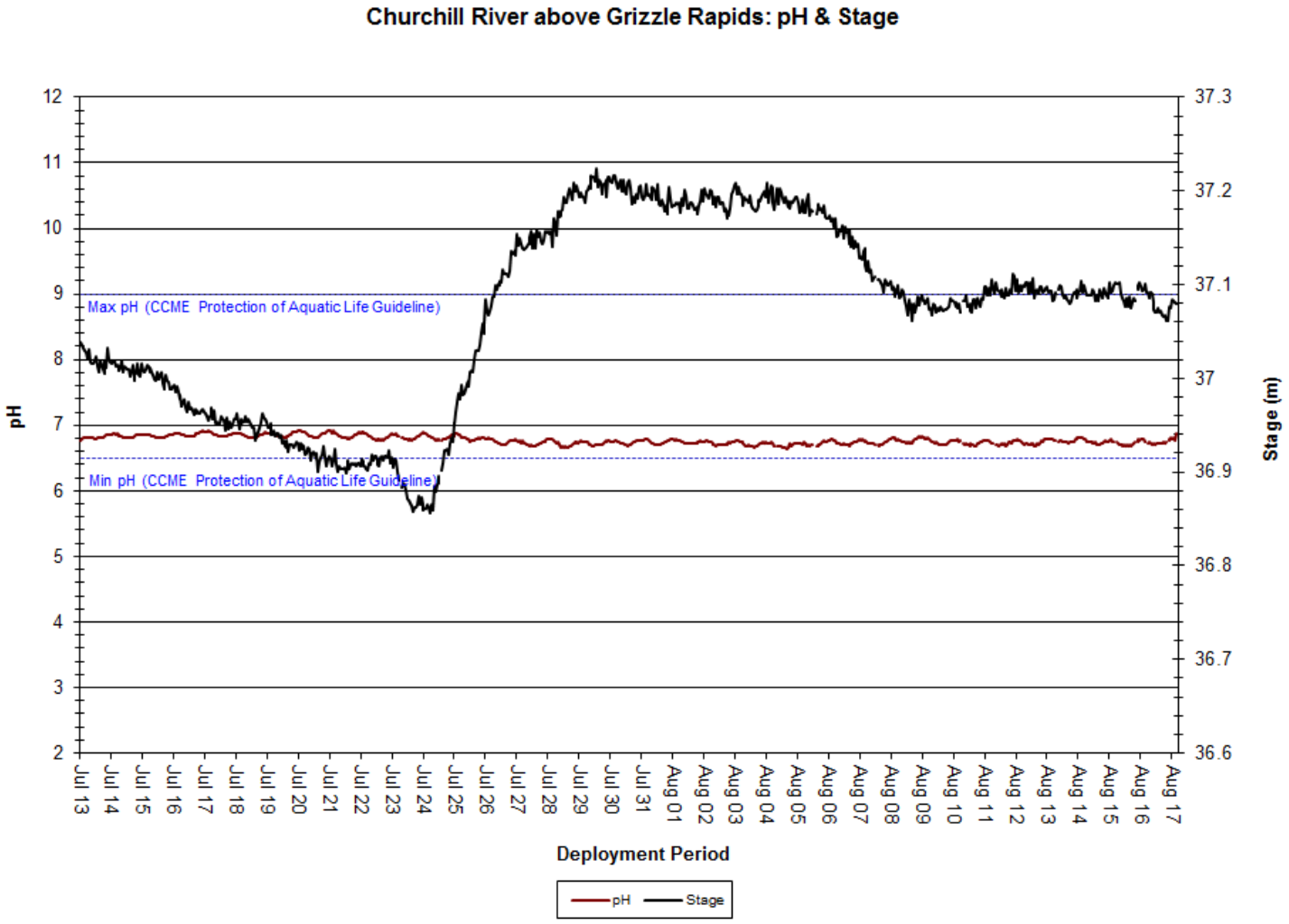


Figure 3: pH & Stage at Churchill River above Grizzle Rapids

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 15.6µS/cm to 20.1µS/cm, with a median of 17.9µS/cm (Figure 4).
- The relationship between conductivity and stage is generally inversed. When stage levels increase, specific conductance levels decrease as the increased amount of water in the river system dilutes solids that are present.
- 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.

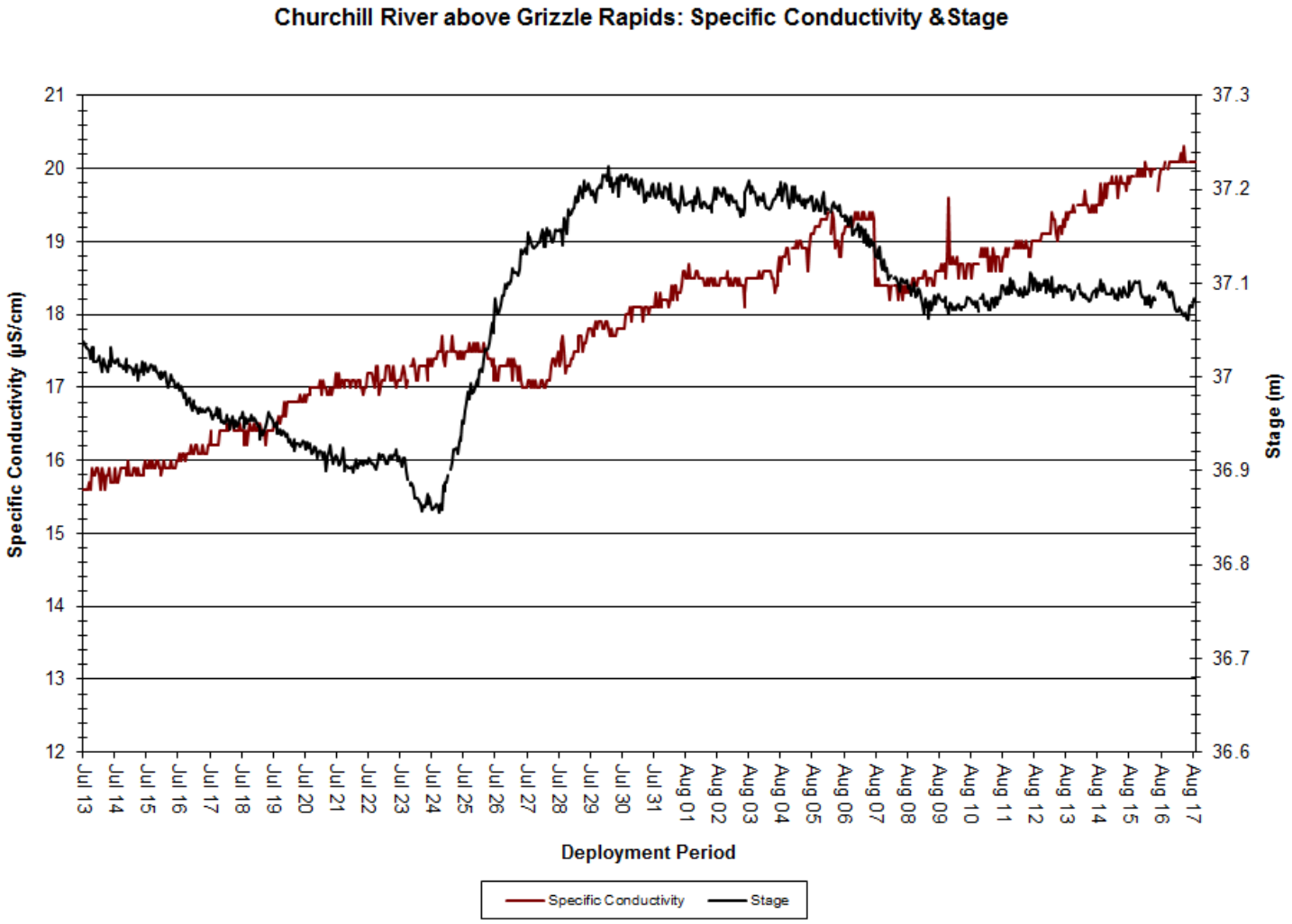


Figure 4: Specific Conductivity & Stage at Churchill River above Grizzle Rapids

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 8.82mg/L to 10.70mg/L, with a median value of 9.33mg/L. Saturation of dissolved oxygen ranged from 93.8% saturation to 101.7% saturation, with a median value of 96.8% (Figure 5).
- 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 months. 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 above the CCME's Guideline for the Protection of Early Life Stages until the end of July, after which levels fell below the guideline for the remainder of deployment. This is to be expected given the higher water temperatures observed during the latter half of the deployment period.

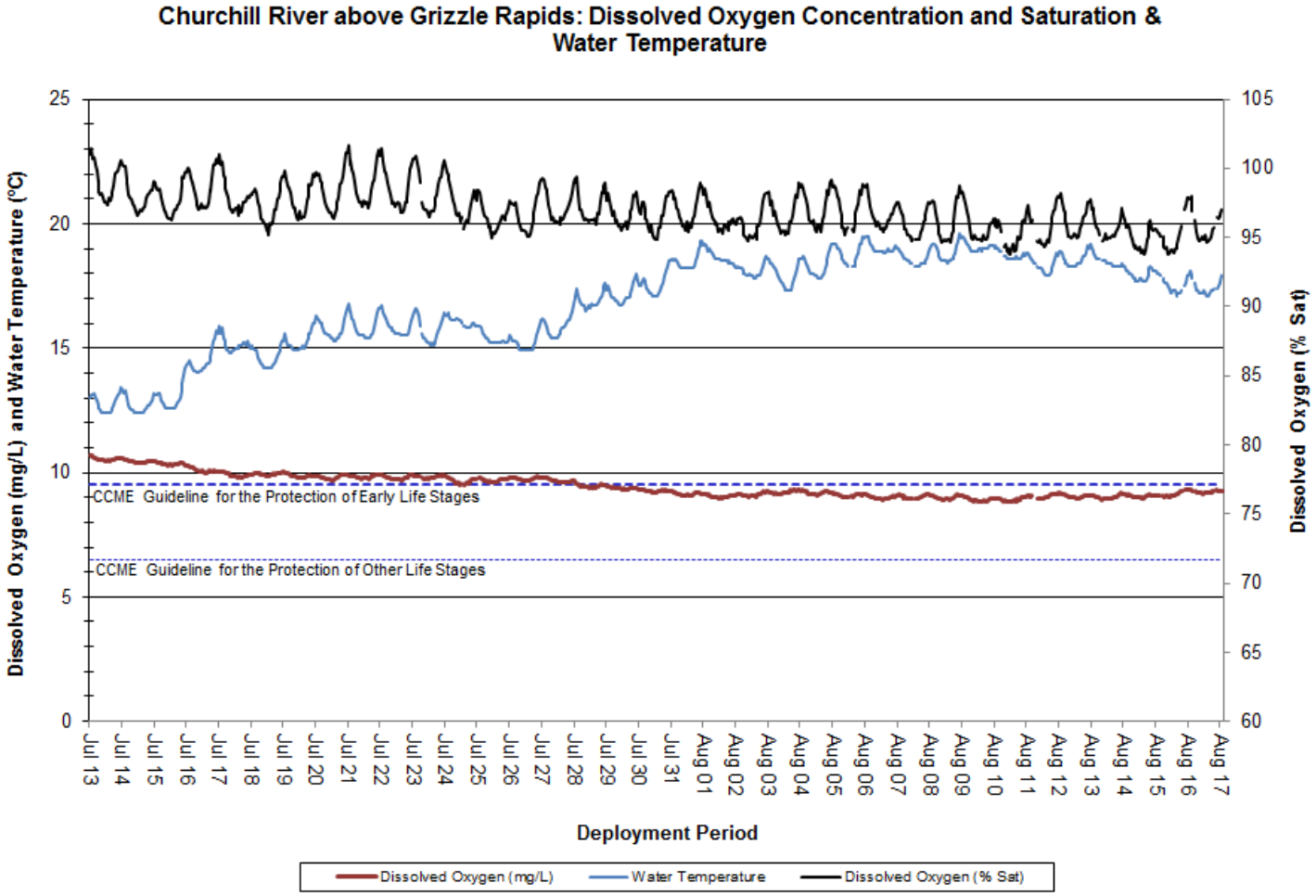


Figure 5: Dissolved Oxygen & Water Temperature at Churchill River above Grizzle Rapids

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 36.5NTU, with a median value of 0.0NTU (Figure 6). A median value of 0.0NTU indicates a very low level of natural background turbidity in the waterbody.
- Many of the larger turbidity spikes observed over the deployment period correlate with increases in stage, which further correlate with precipitation events (Figure 6). 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.

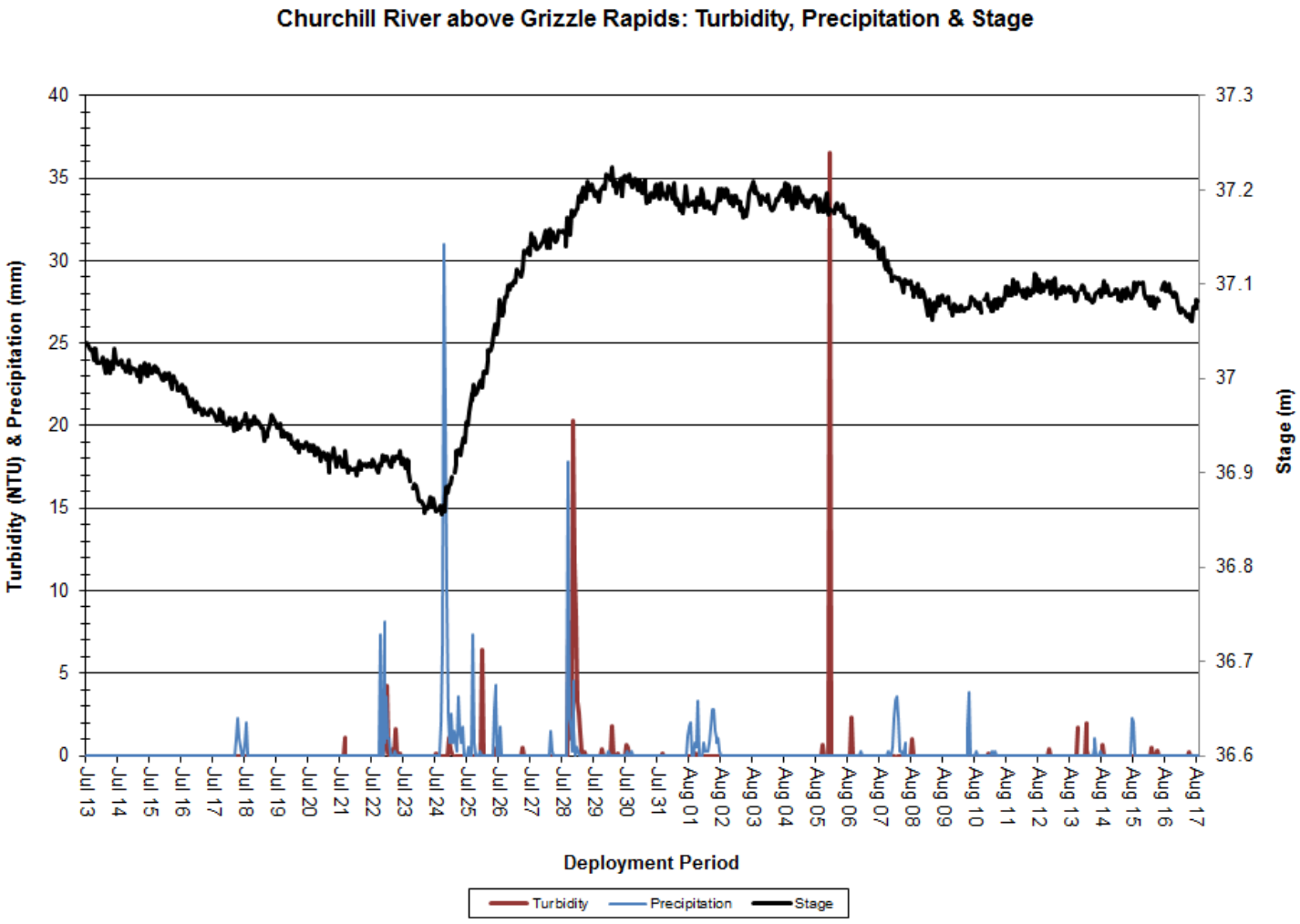


Figure 6: Turbidity, Precipitation & Stage at Churchill River above Grizzle Rapids

Stage & Flow

- Over the deployment period, stage levels ranged from 36.86m to 37.22m, with a median value of 37.09m (Figure 7).
- Over the deployment period, flow ranged from 1282.74m^3/s to 1750.74m^3/s, with a median value of 1571.12m^3/s (Figure 7).
- Precipitation data was obtained from the Muskrat Falls MET Station.
- Stage and flow were variable across the course of deployment, with precipitation events often correlating with temporary increases in both stage and flow. Changes in stage are not evident in the graph below because of the scale used, but follow a similar trend as flow.
- 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.

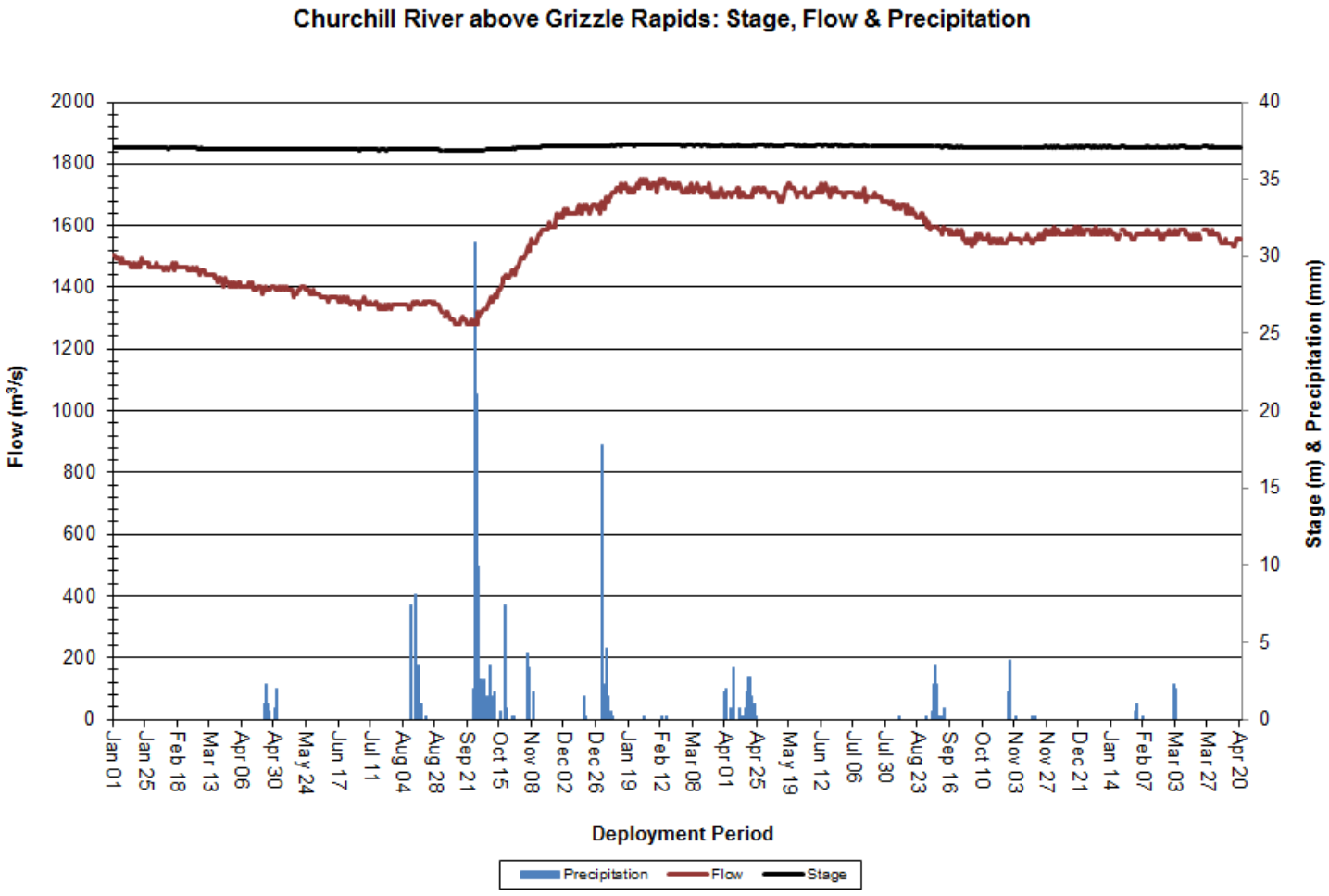


Figure 7: Stage, Flow & Precipitation at Churchill River above Grizzle Rapids

Churchill River below Muskrat Falls

Water Temperature

- Over the deployment period, water temperature ranged from 11.70°C to 20.20°C, with a median value of 17.40°C (Figure 8). Air temperature data was obtained from the Muskrat Falls MET Station.
- Water temperature gradually increased through the middle of August, after which it started to decrease again. This is to be expected as ambient air temperatures showed a similar trend through July and August. Water temperatures closely correlate 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.

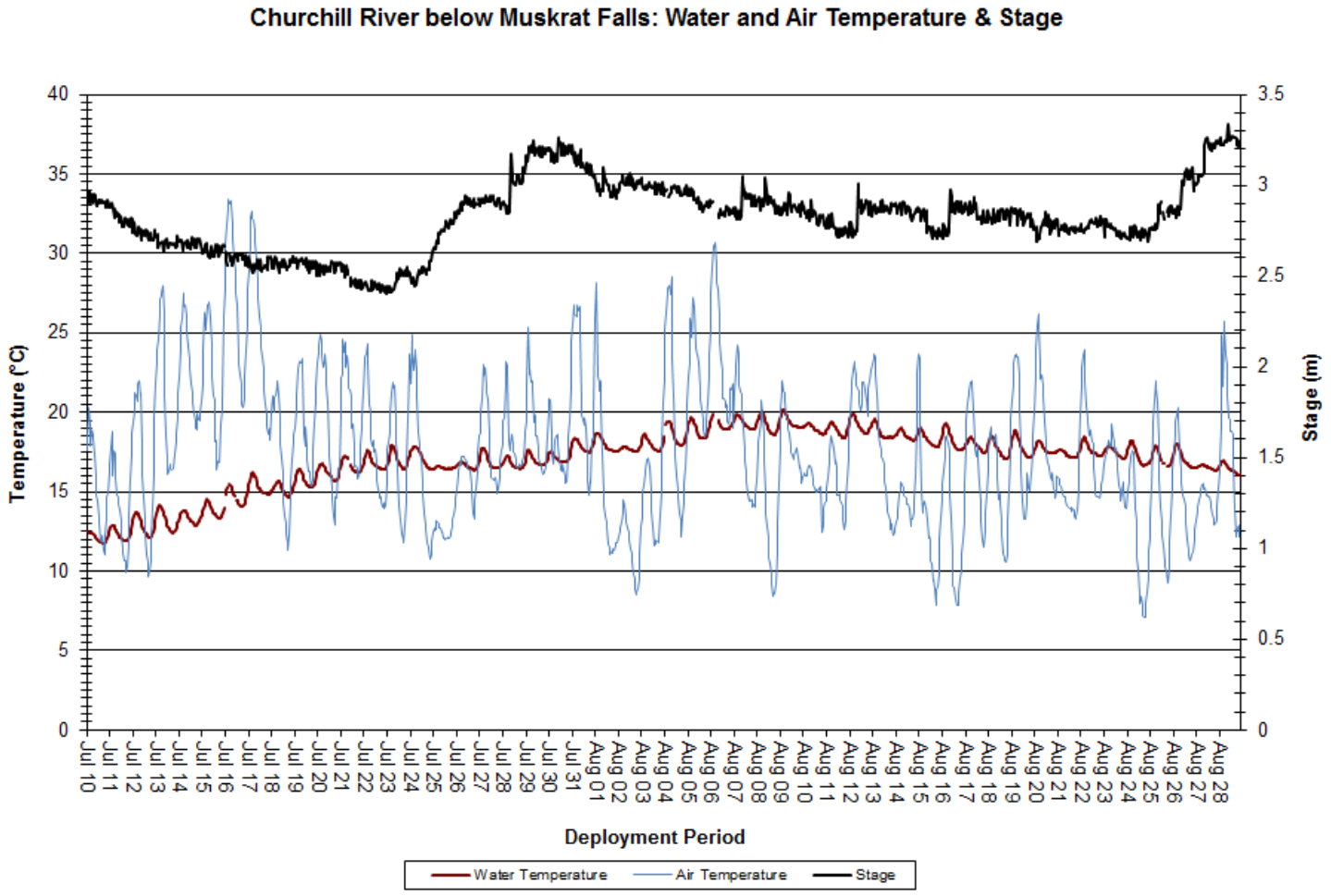


Figure 8: Water and Air Temperature & Stage at Churchill River below Muskrat Falls

pH

- Over the deployment period, pH ranged from 5.51 pH units to 6.24 pH units, with a median value of 5.72 (Figure 9).
- pH values fluctuated slightly and were below the CCME's Minimum Guidelines for the Protection of Aquatic Life for the duration 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.

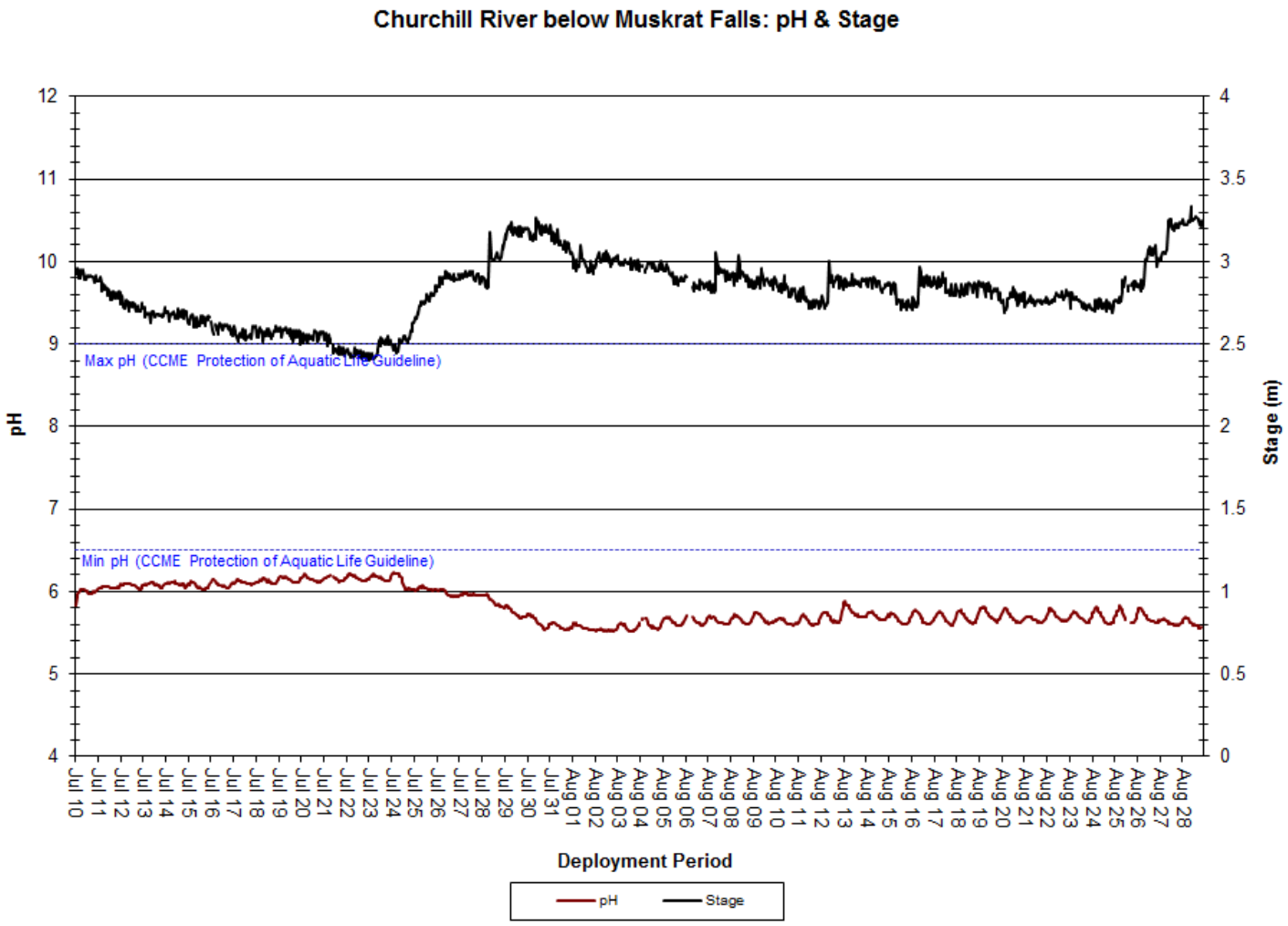


Figure 9: pH & Stage at Churchill River below Muskrat Falls

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 13.2µS/cm to 19.7µS/cm, with a median value of 17.8µS/cm (Figure 10).
- 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 apparent in the graph below.
- 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.

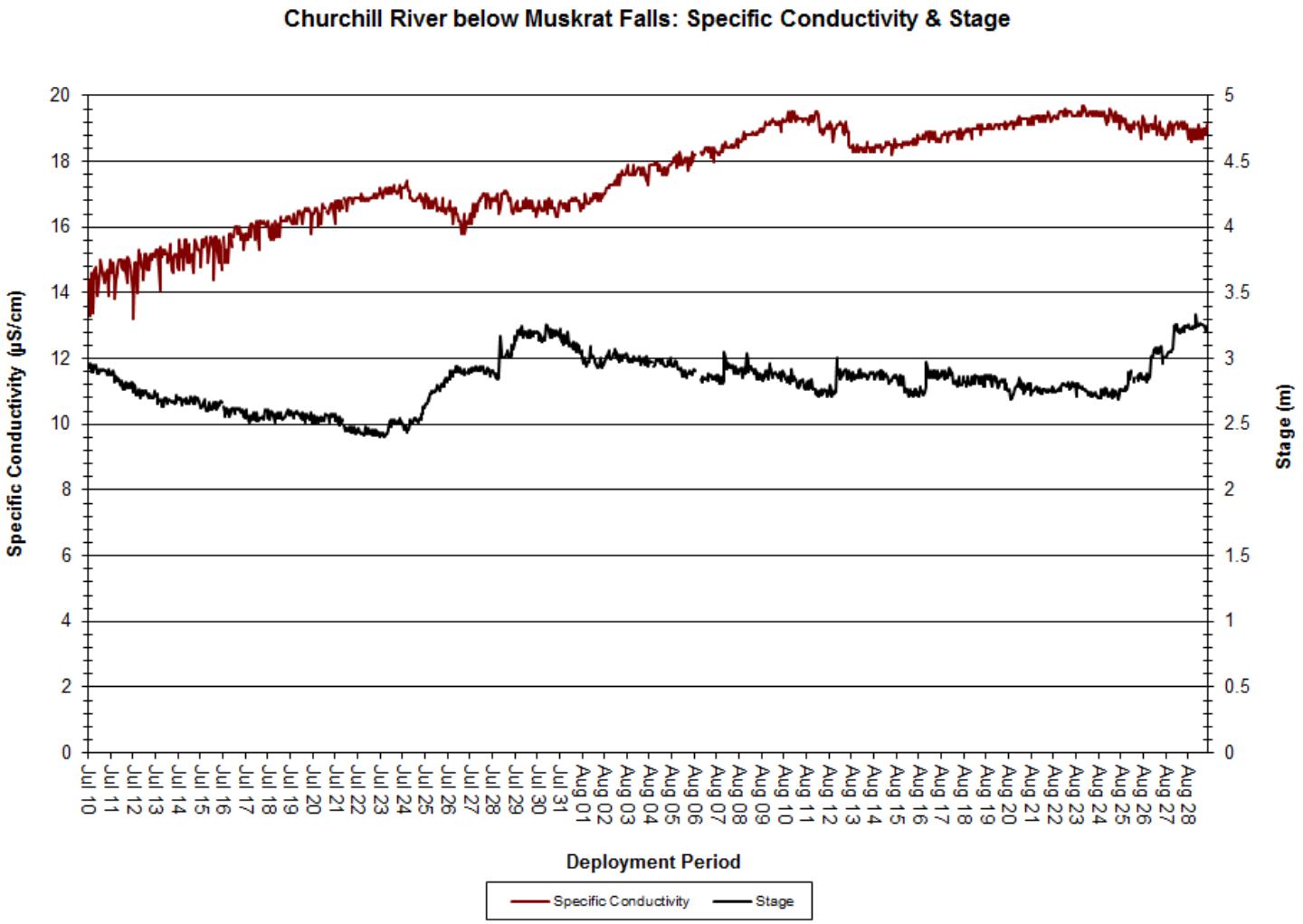


Figure 10: Specific Conductivity & Stage at Churchill River below Muskrat Falls

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 9.74mg/L to 12.38mg/L, with a median value of 10.86mg/L. Saturation of dissolved oxygen ranged from 106.2% to 120.8%, with a median value of 112.9% (Figure 11).
- Dissolved oxygen and water temperature exhibit an inverse relationship: as one parameter increases, the other decreases, and vice versa. Dissolved oxygen levels decreased slightly at the start of deployment, after which they remained relatively consistent. This is to be expected since water temperatures increased slightly at the start of deployment, after which they remained relatively consistent. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures.
- Dissolved oxygen levels remained above the CCME's Guideline for the Protection of Other and Early Life Stages for the duration of deployment.

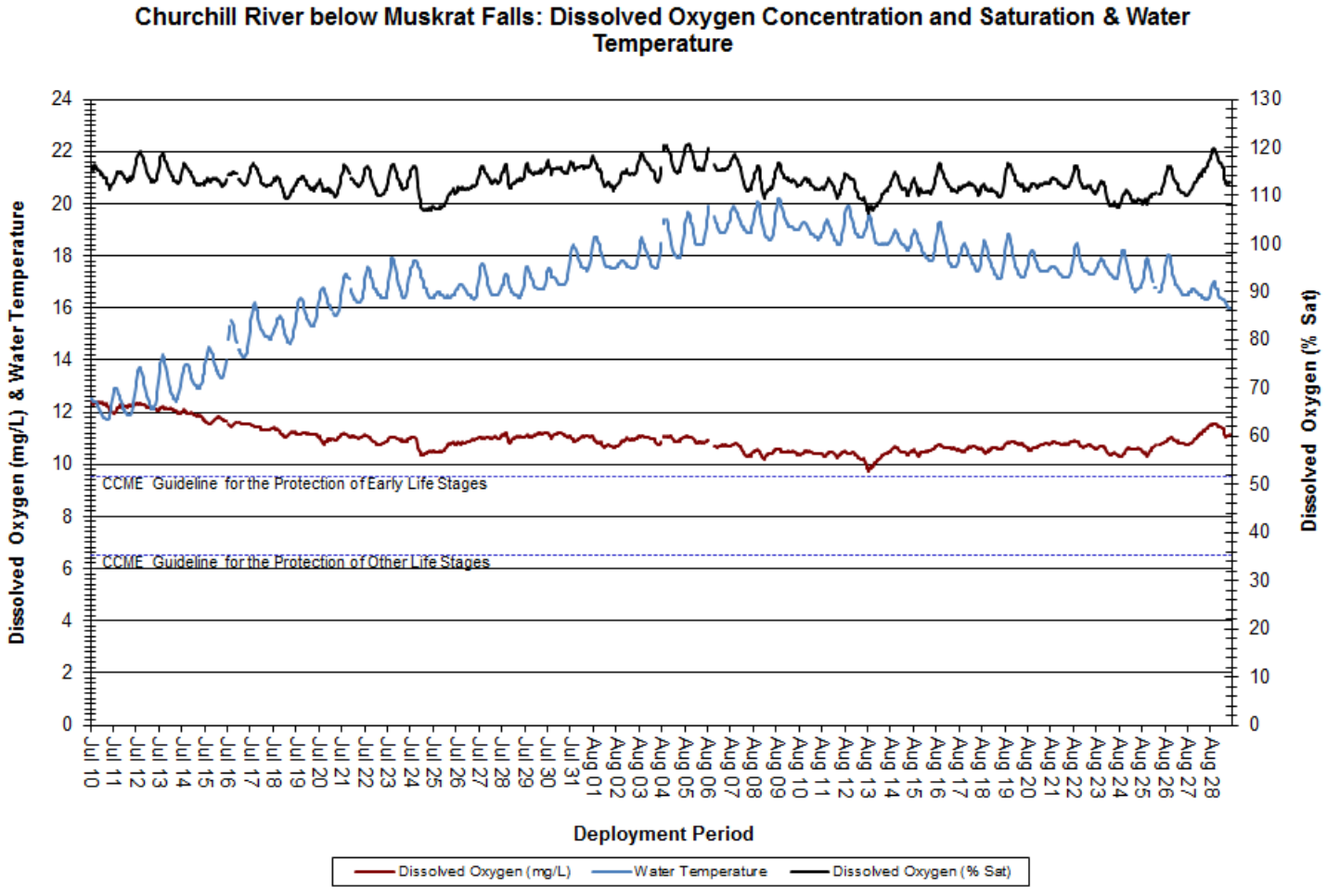


Figure 11: Dissolved Oxygen & Water Temperature at Churchill River below Muskrat Falls

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 21.5NTU, with a median value of 0.0NTU. A median value of 0.0NTU indicates a very low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Muskrat Falls MET Station.
- Larger turbidity spikes observed over the deployment period correlated closely with increases in stage, which further correlated with precipitation events (Figure 12). 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.

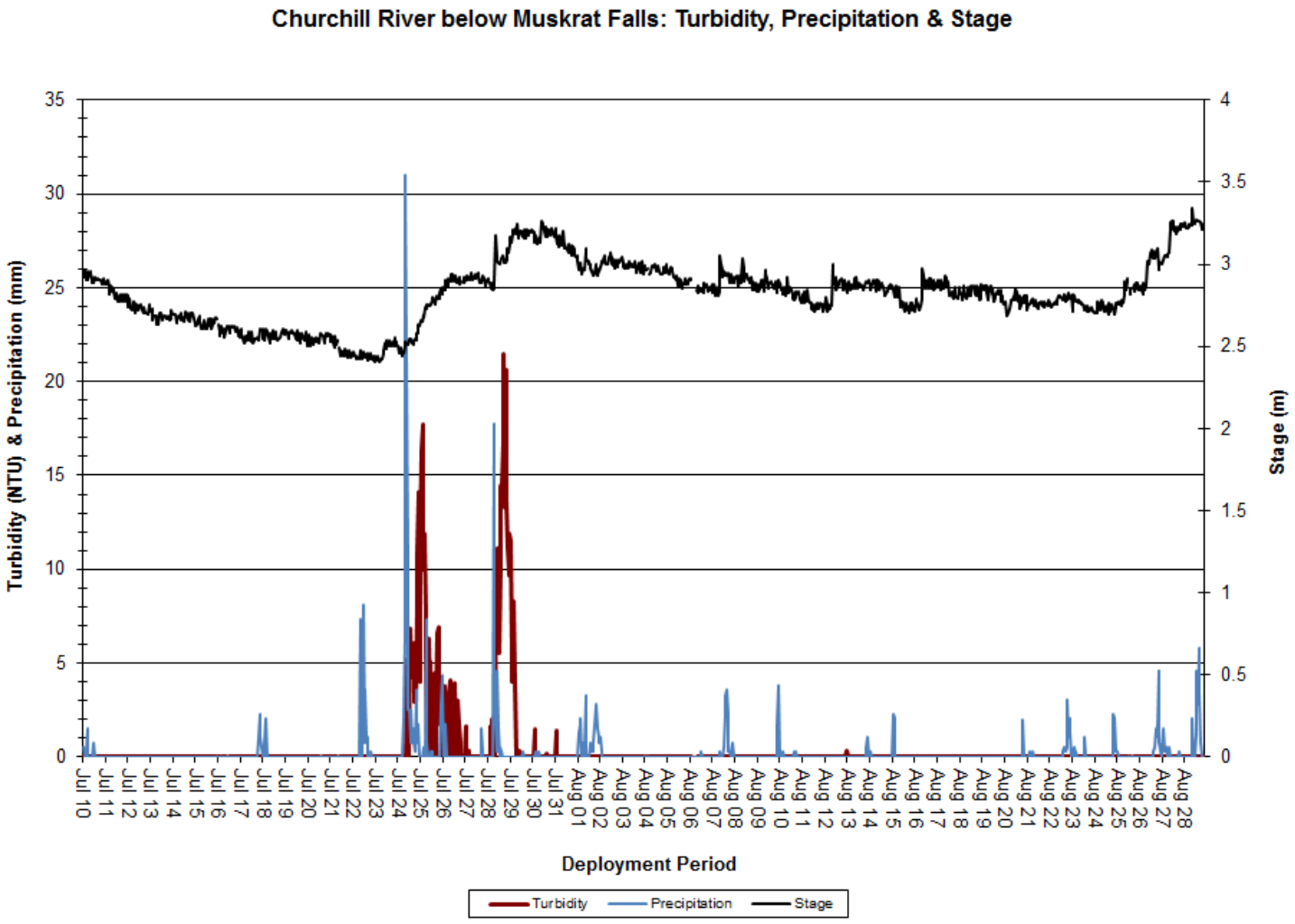


Figure 12: Turbidity, Precipitation & Stage at Churchill River below Muskrat Falls

Stage

- Over the deployment period, stage ranged from 2.41m to 3.34m, with a median value of 2.83m (Figure 13). Precipitation data was obtained from the Muskrat Falls MET Station.
- Stage remained relatively consistent over the course of deployment, with precipitation events often correlating with increases in stage. This is particularly evident from July 24th through July 29th.
- 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.

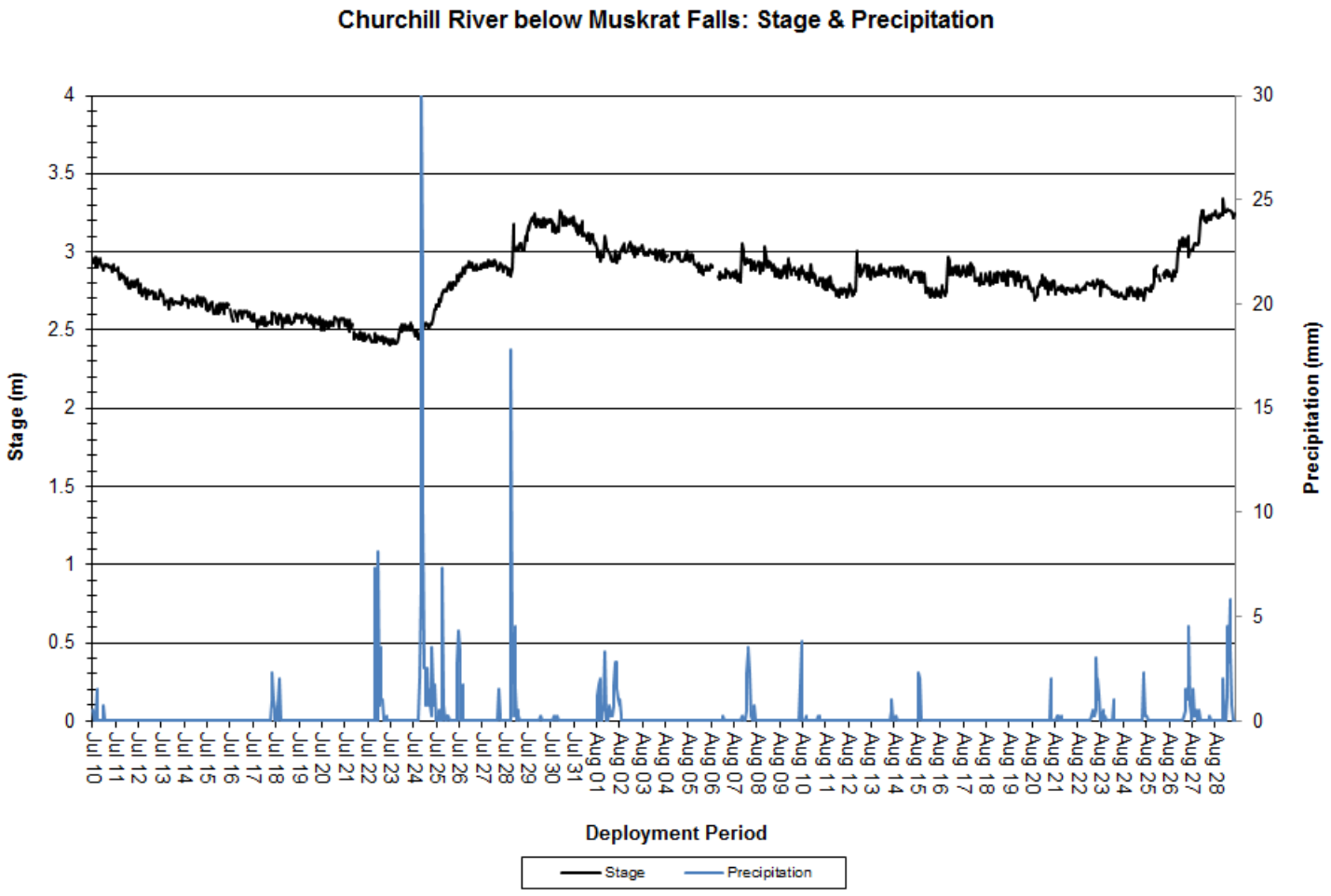


Figure 13: Stage & Precipitation at Churchill River below Muskrat Falls

Chlorophyll

- Over the deployment period, chlorophyll ranged from 1.70ug/L to 7.11ug/L, with a median value of 2.68ug/L (Figure 14).
- 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.

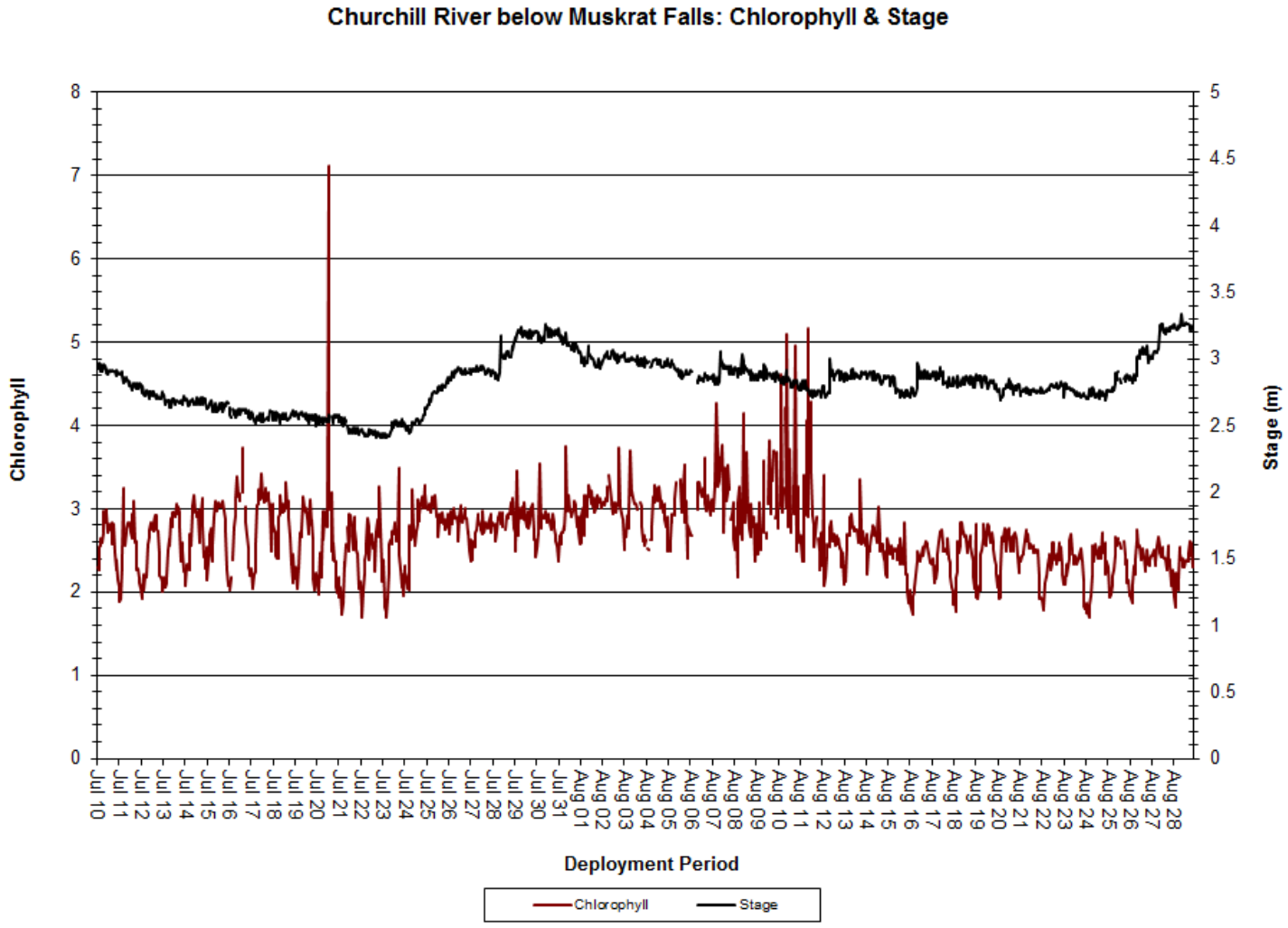


Figure 14: Chlorophyll & Stage at Churchill River below Muskrat Falls

Churchill River at English Point

Water Temperature

- Water temperature ranged from 12.40°C to 21.80°C, with a median value of 17.50°C (Figure 15). Air temperature data was obtained from the Muskrat Falls MET Station.
- Water temperature increased slightly at the start of deployment, after which it remained relatively stable for the remainder of the deployment period. Water temperatures closely correlate 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.

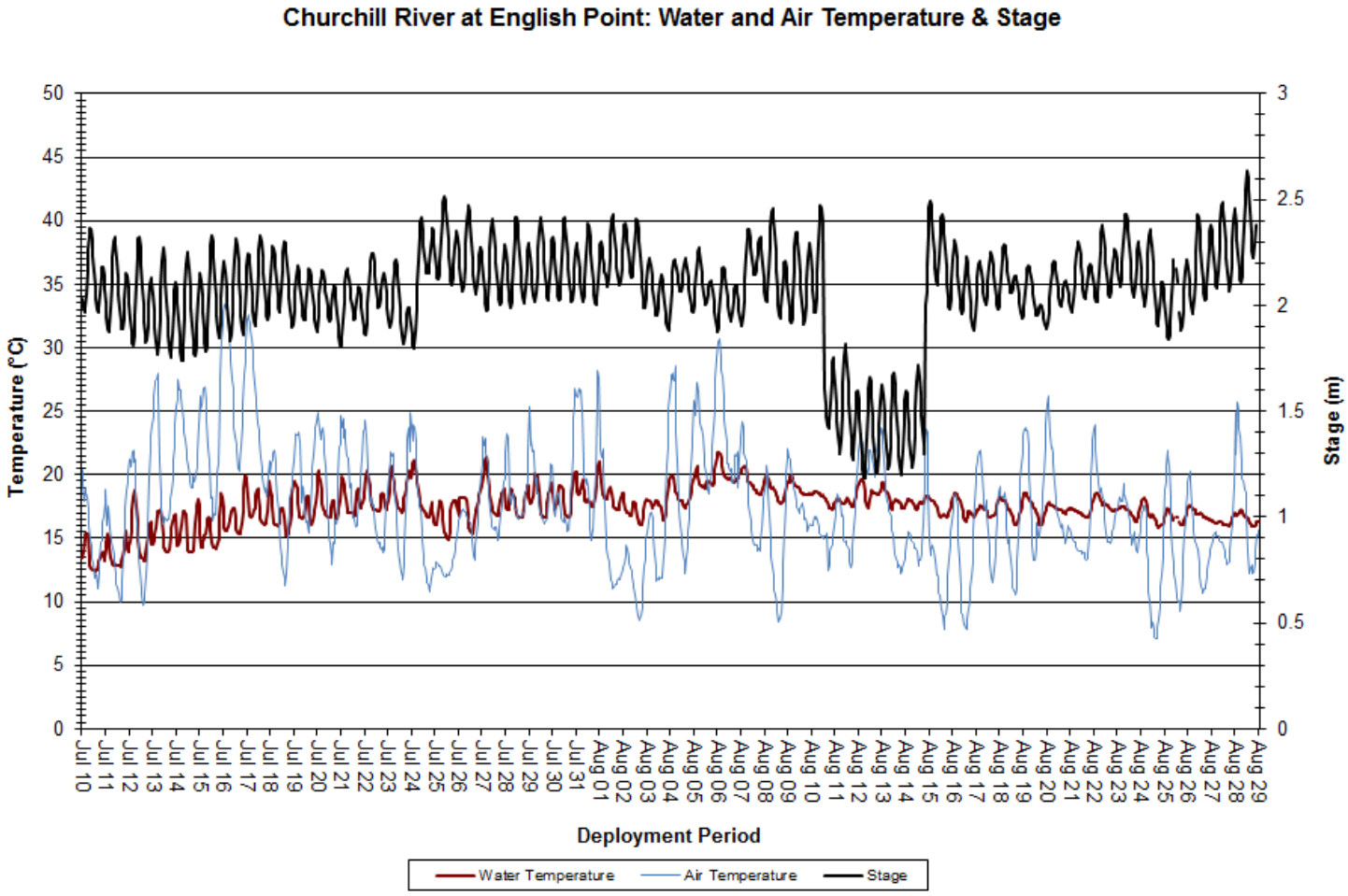


Figure 15: Water and Air Temperature & Stage at Churchill River at English Point

pH

- Over the deployment period, pH ranged from 6.04 pH units to 6.89 pH units, with a median value of 6.40 (Figure 16).
- pH values fell below the CCME's Minimum Guideline for the Protection of Aquatic Life for the majority 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.

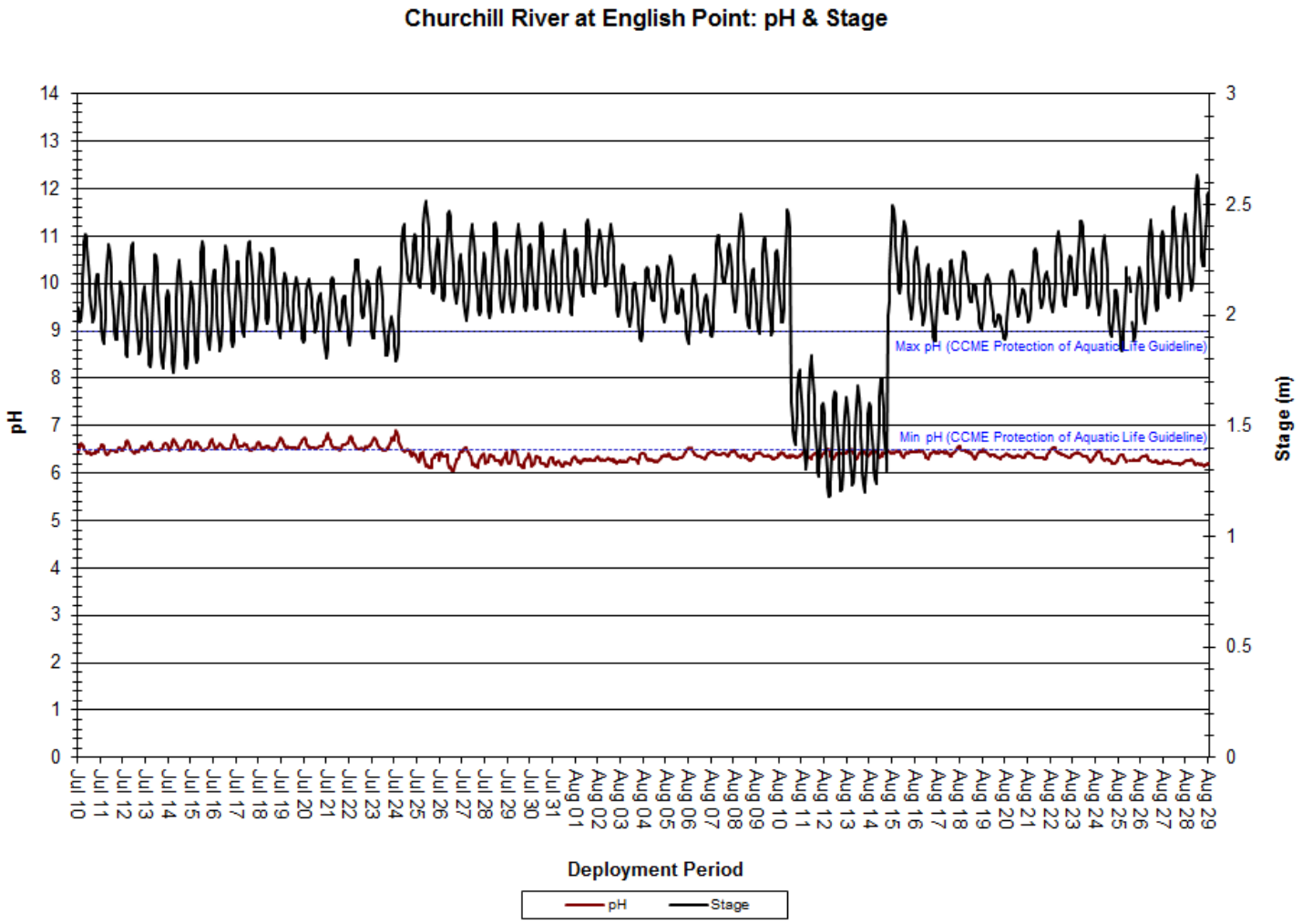


Figure 16: pH & Stage at Churchill River at English Point

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 17.5µS/cm to 47.4µs/cm, with a median value of 27.3µS/cm (Figure 17).
- 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 17).
- 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.

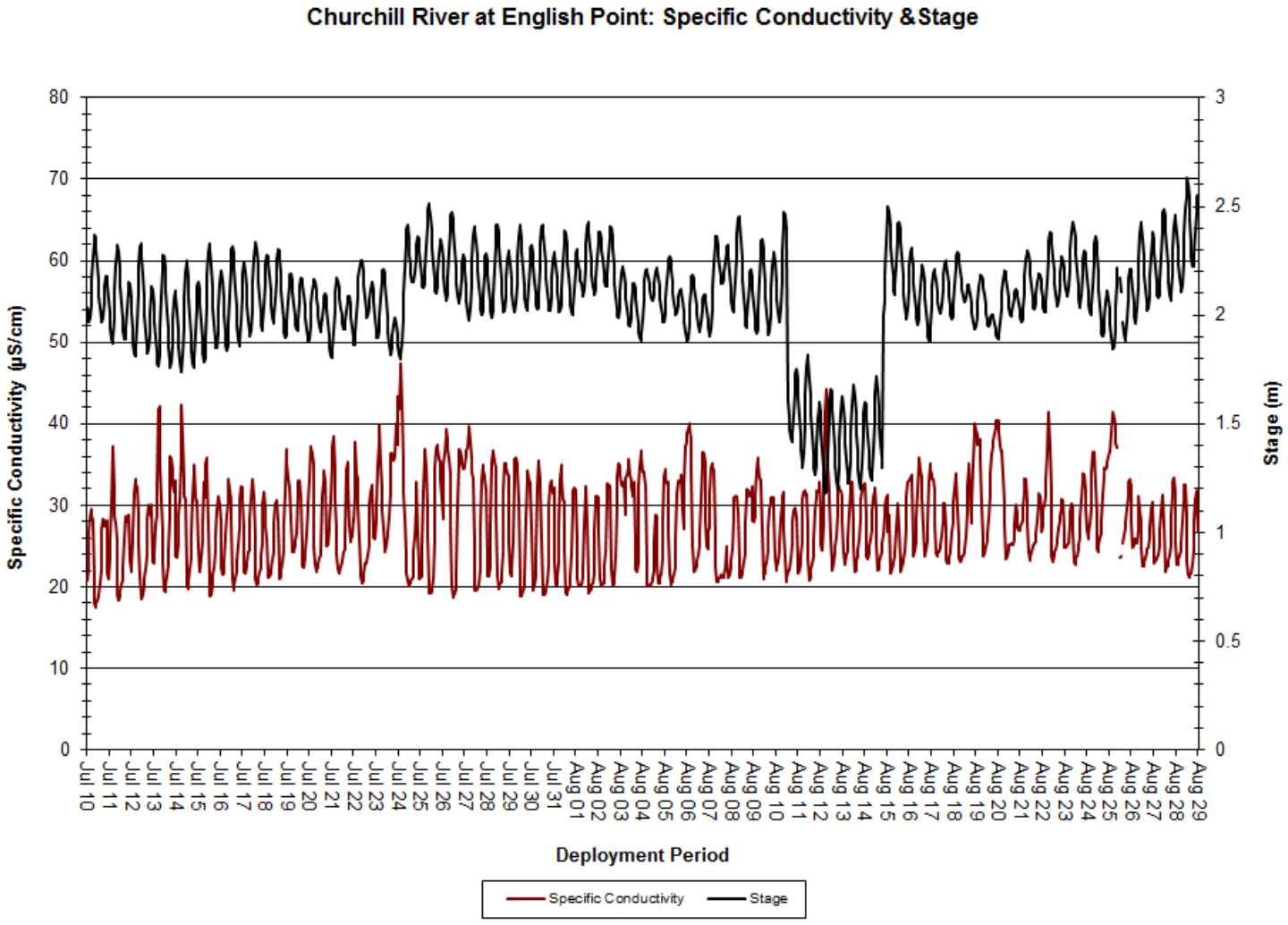


Figure 17: Specific Conductivity & Stage at Churchill River at English Point

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 8.39mg/L to 11.50mg/L, with a median value of 9.64mg/L. Saturation of dissolved oxygen ranged from 88.3% to 113.9% saturation, with a median value of 101.1% (Figure 18).
- There is an evident relationship between water temperature and dissolved oxygen. As water temperatures increased over the deployment period, dissolved oxygen levels slowly 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 hovered above and below the CCME's Guideline for the Protection of Early Life Stages for the duration of deployment (Figure 18). This is not surprising considering the warmer water temperatures during the summer months.

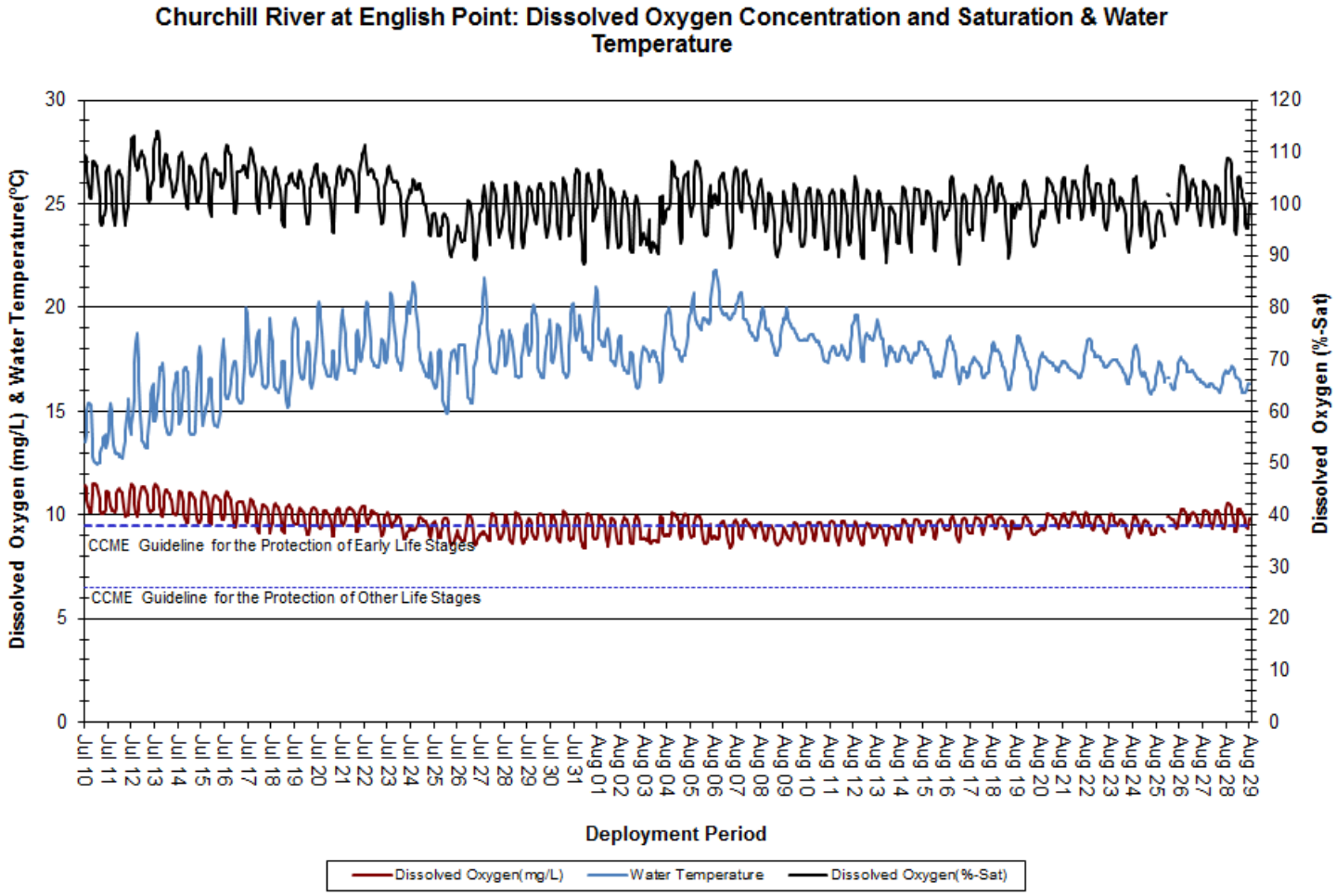


Figure 18: Dissolved Oxygen & Water Temperature at Churchill River at English Point

Turbidity

- Over the deployment period, turbidity ranged from 0.8NTU to 601.0NTU, with a median value of 4.2NTU (Figure 19). A median value of 4.2NTU 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 Muskrat Falls MET Station.
- Turbidity events generally correlate with increases in stage and precipitation events, as these can increase the presence of suspended material in water (Figure 19). High winds can also contribute to turbidity events at this station by disturbing sediment from the river bed.
- 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.

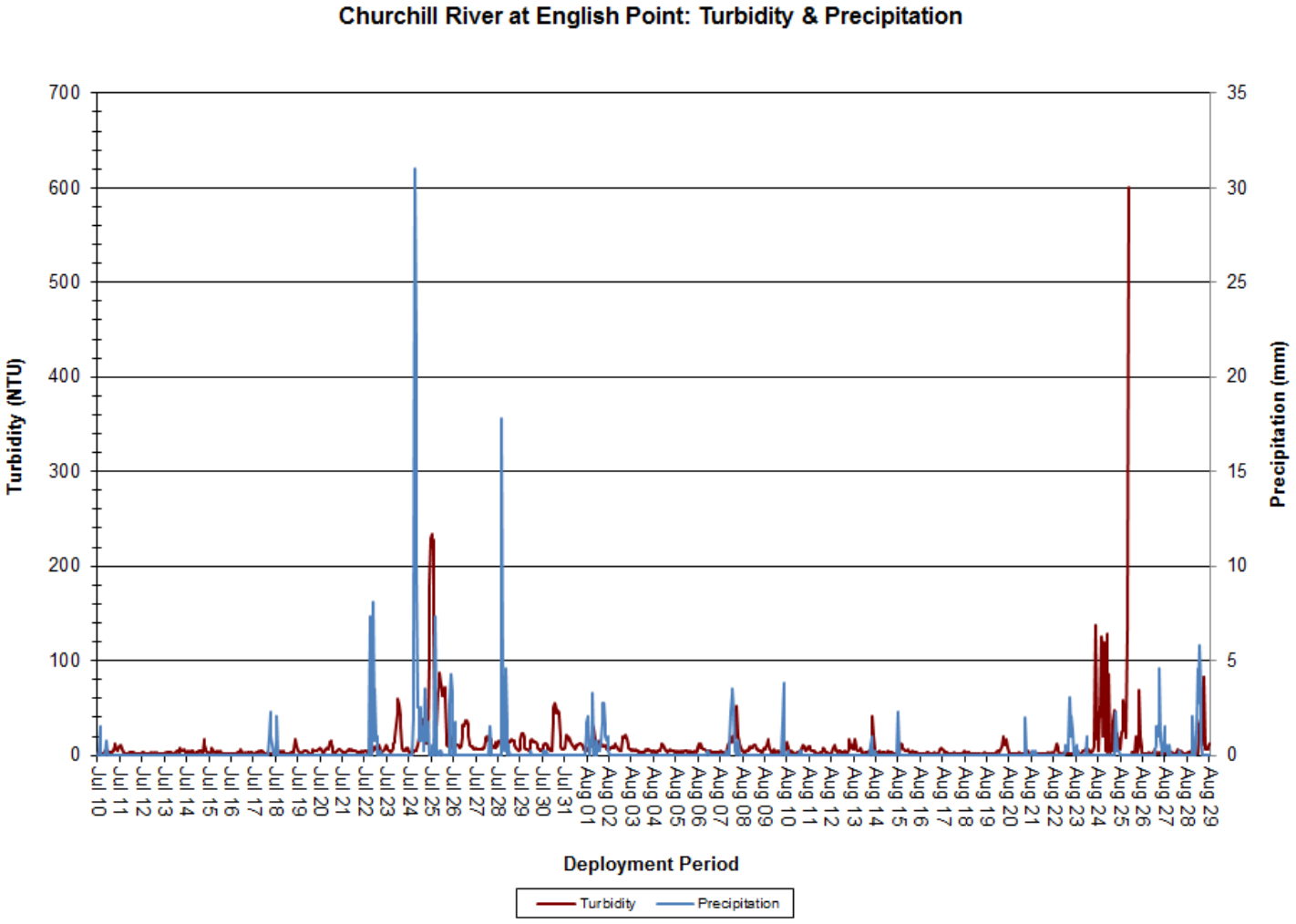


Figure 19: Turbidity & Precipitation at Churchill River at English Point

Stage

- Over the deployment period, stage ranged from 1.18m to 2.63m, with a median value of 2.10m (Figure 20). Precipitation data was obtained from the Muskrat Falls MET 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; this is particularly evident on July 24th (Figure 20).
- 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.

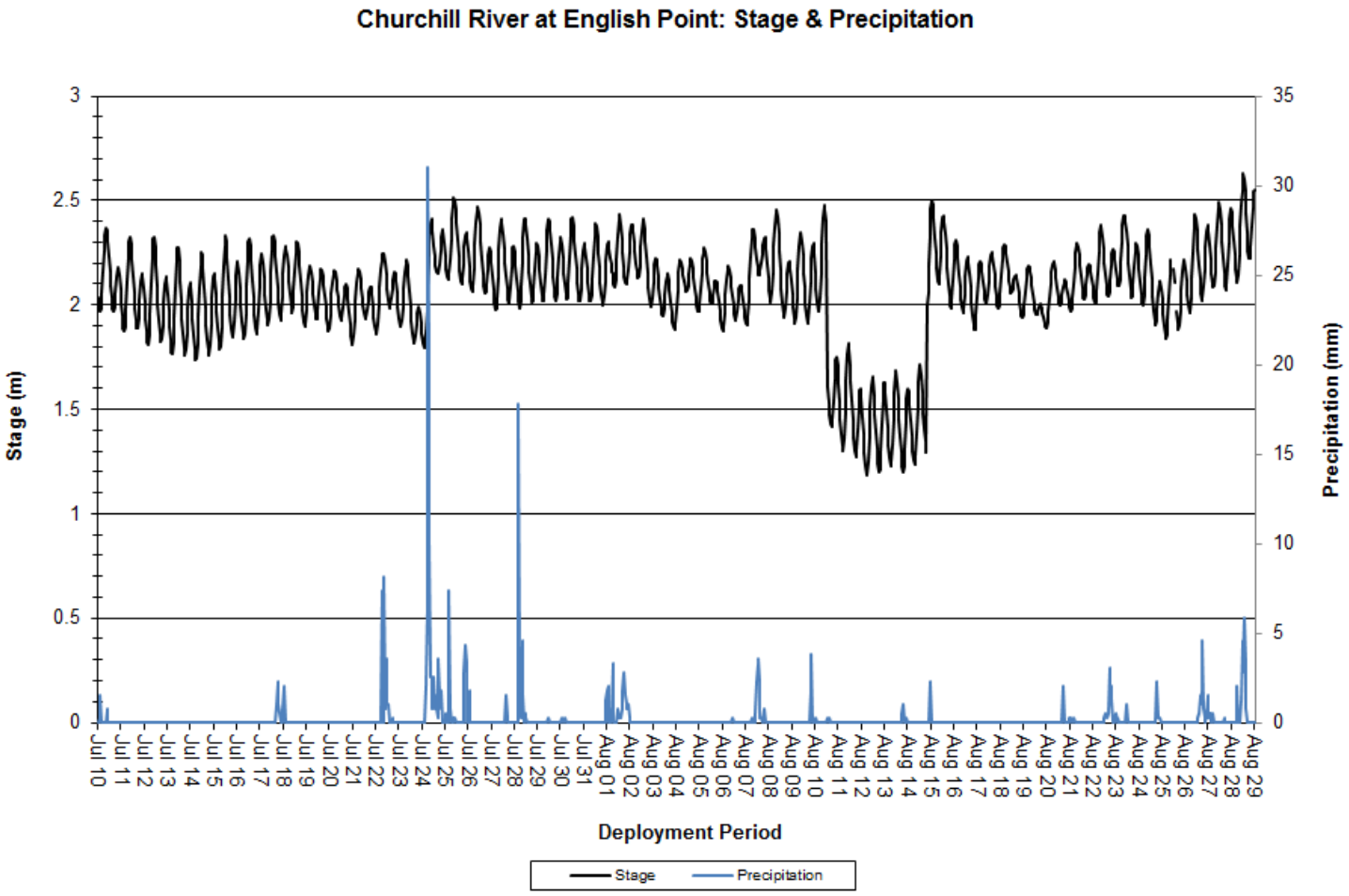


Figure 20: Stage & Precipitation at Churchill River at English Point

Conclusions

- Instruments at three water quality monitoring stations on the Lower Churchill River were deployed from July 10/13 to August 17/29, 2018.
- Water temperature increased slowly at all stations for the first half of deployment, after which it remained relatively stable or decreased slightly. This is to be expected based on ambient air temperature trends during the same period.
- pH was relatively stable at all stations over the course of deployment, and generally fell below the CCME's Minimum Guideline for the Protection of Aquatic Life.
- Specific conductivity slowly increased over the course of deployment at the above Grizzle Rapids and below Muskrat Falls 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 months. Dissolved oxygen levels are generally higher in water at cooler temperatures. Dissolved oxygen levels remained above the CCME's Guideline for the Protection of Early Life Stages for the duration of deployment at Churchill River below Muskrat Falls. Dissolved oxygen levels at the other two stations remained above the CCME's Guideline for the Protection of Other Life Stages for the duration of deployment, but were only above the CCME's Guideline for the Protection of Early Life Stages for the first part of the deployment period.
- Turbidity events occurred at all stations and were generally related to precipitation events. In all 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

REPORT OF ANALYSIS

Lab Report Number: **1812569**

Cient:	Department of Environment	**COC Number:**	833916
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-30
Client Project:		**Date Submitted:**	2018-07-18
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1374643	WS-S-0000 CR Above GR	2018-6311-00-SI-SP	2018-07-13

Sample comment:

Holding time for turbidity analysis was exceeded for entire report.

Report comment:

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	6
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	<1
Colour	TCU	2	38
Conductivity	uS/cm	5	18
Dissolved Organic Carbon	mg/L	0.5	4.4
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	5
N-NH3 (Ammonia)	mg/L	0.05	<0.05
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.96
Sulphate	mg/L	1	1
Total Dissolved Solids (COND - CALC)	mg/L	1	12
Total Kjeldahl Nitrogen	mg/L	0.10	<0.10
Total Organic Carbon	mg/L	0.5	4.8
Turbidity	NTU	0.1	0.8
Aluminum	mg/L	0.01	0.05

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: 

Sarah Horner

REPORT OF ANALYSIS

Lab Report Number: **1812569**

Cient:	Department of Environment	**COC Number:**	833916
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-30
Client Project:		**Date Submitted:**	2018-07-18
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374643	WS-S-0000 CR Above GR	2018-6311-00-SI-SP	2018-07-13	Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001
				Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.11
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.010

Sample comment:

Holding time for turbidity analysis was exceeded for entire report.

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: Sarah Horner

REPORT OF ANALYSIS

Lab Report Number: **1812569**

Cient:	Department of Environment	**COC Number:**	833916
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-30
Client Project:		**Date Submitted:**	2018-07-18
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374643	WS-S-0000	2018-6311-00-SI-SP	2018-07-13	Uranium	mg/L	0.001	<0.001
	CR Above GR			Zinc	mg/L	0.01	<0.01
				Phosphorus	mg/L	0.002	0.003
				Total Suspended Solids	mg/L	2	3

Sample comment:

Holding time for turbidity analysis was exceeded for entire report.

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: 

Sarah Horner

REPORT OF ANALYSIS

Lab Report Number: **1812381**

Cient:	Department of Environment	**COC Number:**	833826
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-23
Client Project:		**Date Submitted:**	2018-07-16
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date
1374192	WS-S-0000 CR Below MF	2018-6307-00-SI-SP	2018-07-10

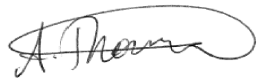
Sample comment:

Holding time for turbidity analysis was exceeded for entire report.

Report comment:

ANALYTE	UNIT	MRL	RESULT
Alkalinity as CaCO3	mg/L	5	6
Bromide	mg/L	0.25	<0.25
Chloride	mg/L	1	<1
Colour	TCU	2	40
Conductivity	uS/cm	5	17
Dissolved Organic Carbon	mg/L	0.5	5.3
Fluoride	mg/L	0.10	<0.10
Hardness as CaCO3	mg/L	1	5
N-NH3 (Ammonia)	mg/L	0.05	<0.05
N-NO2 (Nitrite)	mg/L	0.10	<0.10
N-NO3 (Nitrate)	mg/L	0.10	<0.10
pH		1.00	6.92
Sulphate	mg/L	1	6
Total Dissolved Solids (COND - CALC)	mg/L	1	11
Total Kjeldahl Nitrogen	mg/L	0.1	0.1
Total Organic Carbon	mg/L	0.5	4.6
Turbidity	NTU	0.1	3.2
Aluminum	mg/L	0.01	0.14

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: 

Addrine Thomas

REPORT OF ANALYSIS

Lab Report Number: 1812381

Cient:	Department of Environment	**COC Number:**	833826
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-23
Client Project:		**Date Submitted:**	2018-07-16
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374192	WS-S-0000 CR Below MF	2018-6307-00-SI-SP	2018-07-10	Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001
				Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.17
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.011

Sample comment:

Holding time for turbidity analysis was exceeded for entire report.

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: Addrine Thomas

REPORT OF ANALYSIS

Lab Report Number: **1812381**

Cient:	Department of Environment	**COC Number:**	833826
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-23
Client Project:		**Date Submitted:**	2018-07-16
Purchase Order:	2180014302	**Sample Matrix:**	Water

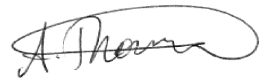
LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374192	WS-S-0000	2018-6307-00-SI-SP	2018-07-10	Uranium	mg/L	0.001	<0.001
	CR Below MF			Zinc	mg/L	0.01	<0.01
				Phosphorus	mg/L	0.002	0.006
				Total Suspended Solids	mg/L	2	<2

Sample comment:

Holding time for turbidity analysis was exceeded for entire report.

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: 

Addrine Thomas

REPORT OF ANALYSIS

Lab Report Number: 1812381

Cient:	Department of Environment	**COC Number:**	
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-23
Client Project:		**Date Submitted:**	2018-07-16
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374194	WS-S-0000 CR @ EP	2018-6309-00-SI-SP	2018-07-10	Alkalinity as CaCO3	mg/L	5	6
				Bromide	mg/L	0.25	<0.25
				Chloride	mg/L	1	2
				Colour	TCU	2	47
				Conductivity	uS/cm	5	21
				Dissolved Organic Carbon	mg/L	0.5	5.7
				Fluoride	mg/L	0.10	<0.10
				Hardness as CaCO3	mg/L	1	5
				N-NH3 (Ammonia)	mg/L	0.05	<0.05
				N-NO2 (Nitrite)	mg/L	0.10	<0.10
				N-NO3 (Nitrate)	mg/L	0.10	<0.10
				pH		1.00	6.90
				Sulphate	mg/L	1	<1
				Total Dissolved Solids (COND - CALC)	mg/L	1	14
				Total Kjeldahl Nitrogen	mg/L	0.1	0.1
				Total Organic Carbon	mg/L	0.5	5.1
				Turbidity	NTU	0.1	4.5
				Aluminum	mg/L	0.01	0.19

Sample comment:

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: Addrine Thomas

REPORT OF ANALYSIS

Lab Report Number: 1812381

Cient:	Department of Environment	**COC Number:**	
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-23
Client Project:		**Date Submitted:**	2018-07-16
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374194	WS-S-0000 CR @ EP	2018-6309-00-SI-SP	2018-07-10	Antimony	mg/L	0.0005	<0.0005
				Arsenic	mg/L	0.001	<0.001
				Barium	mg/L	0.01	<0.01
				Boron	mg/L	0.01	<0.01
				Calcium	mg/L	1	2
				Cadmium	mg/L	0.0001	<0.0001
				Chromium	mg/L	0.001	<0.001
				Copper	mg/L	0.001	<0.001
				Iron	mg/L	0.03	0.24
				Lead	mg/L	0.001	<0.001
				Magnesium	mg/L	1	<1
				Manganese	mg/L	0.01	<0.01
				Mercury	mg/L	0.0001	<0.0001
				Nickel	mg/L	0.005	<0.005
				Potassium	mg/L	1	<1
				Selenium	mg/L	0.001	<0.001
				Sodium	mg/L	2	<2
				Strontium	mg/L	0.001	0.013

Sample comment:

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: A. Thomas

Addrine Thomas

REPORT OF ANALYSIS

Lab Report Number: 1812381

Cient:	Department of Environment	**COC Number:**	
Attention:	Ms. Tara Clinton	**Date Reported:**	2018-07-23
Client Project:		**Date Submitted:**	2018-07-16
Purchase Order:	2180014302	**Sample Matrix:**	Water

LAB ID	Supply / Description	Client Sample ID	Sample Date	ANALYTE	UNIT	MRL	RESULT
1374194	WS-S-0000	2018-6309-00-SI-SP	2018-07-10	Uranium	mg/L	0.001	<0.001
	CR @ EP			Zinc	mg/L	0.01	<0.01
				Phosphorus	mg/L	0.002	0.007
Sample comment:				Total Suspended Solids	mg/L	2	3

Report comment:

Eurofins (Ottawa) is accredited for specific parameters by CALA. The scope can be viewed at http://www.cala.ca/scopes/2602.pdf.
Results relate only to the parameters tested on the samples submitted.
Methods references and/or additional QA/QC information available on request.

APPROVAL: A. Thomas

Addrine Thomas