Real-Time Water Quality Deployment Report

Lower Churchill River Network

September 21/28 to
October 18/26, 2022

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

Contents

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Newfoundland Labrador

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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 September 21st. Instruments were deployed at Churchill River below Muskrat Falls and at English Point on September 28th.
- The instrument at Churchill River above Grizzle Rapids was removed on October 26th for a deployment period of 35 days.
- The instruments at Churchill River below Muskrat Falls and at English Point were also removed on October 26th, for a deployment period of 28 days.
- The instrument at Churchill River below Metchin River was not deployed on September 21st; however, for the purposes of this report, data from this station will be reported as if it had been. The instrument at this station was deployed continuously from August 26th through October 18th. A deployment period of 27 days will be used for reporting purposes.

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 September 21/28 to October 18/26, 2022 are summarized in Table 2.

Table 2: Comparison rankings for Lower Churchill River stations September 21/28 to October 18/26, 2022

Churchill River Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Below Metchin River	September 21, 2022	Deployment	N/A	N/A	N/A	N/A	N/A
	October 18, 2022	Removal	Good	Good	Excellent	Excellent	Excellent
Above Grizzle Rapids	September 21, 2022	Deployment	Excellent	Good	Excellent	Excellent	Excellent
	October 26, 2022	Removal	Excellent	Fair	Excellent	Good	Good
Below Muskrat Falls	September 28, 2022	Deployment	Good	Excellent	Excellent	Excellent	Good
	October 26, 2022	Removal	Good	Good	Excellent	Excellent	Poor
At English Point	September 28, 2022	Deployment	Excellent	Excellent	Good	Excellent	Poor
	October 26, 2022	Removal	Good	Excellent	Good	Excellent	Excellent

- **Churchill River below Metchin River**
  - Comparison rankings are not available for deployment since this instrument was not physically deployed at the date in question.
  - At removal, all parameters ranked as either ‘excellent’ or ‘good’.

- **Churchill River above Grizzle Rapids**
  - At deployment, all parameters ranked as either ‘excellent’ or ‘good’.
  - At removal, all parameters ranked as either ‘excellent’ or ‘good’ with the exception of pH, which was ‘fair’.

- **Churchill River below Muskrat Falls**
  - At deployment, all parameters ranked as either ‘excellent’ or ‘good’.
  - At removal, all parameters ranked as either ‘excellent’ or ‘good’ with the exception of turbidity, which was ‘poor’. This discrepancy is due to an issue with the sensor, likely caused by sediment build-up.

- **Churchill River at English Point**
    - At deployment, all parameters ranked as either 'excellent' or 'good' with the exception of turbidity, which was 'poor'. This discrepancy could be due to the QA/QC sonde not being given sufficient time to acclimate or not being placed in close enough proximity to the field sonde.
    - At removal, all parameters again ranked as either 'excellent' or 'good'.

Data Interpretation

- The following graphs and discussion illustrate water quality related events occurring from September 21/28 to October 18/26, 2022 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.

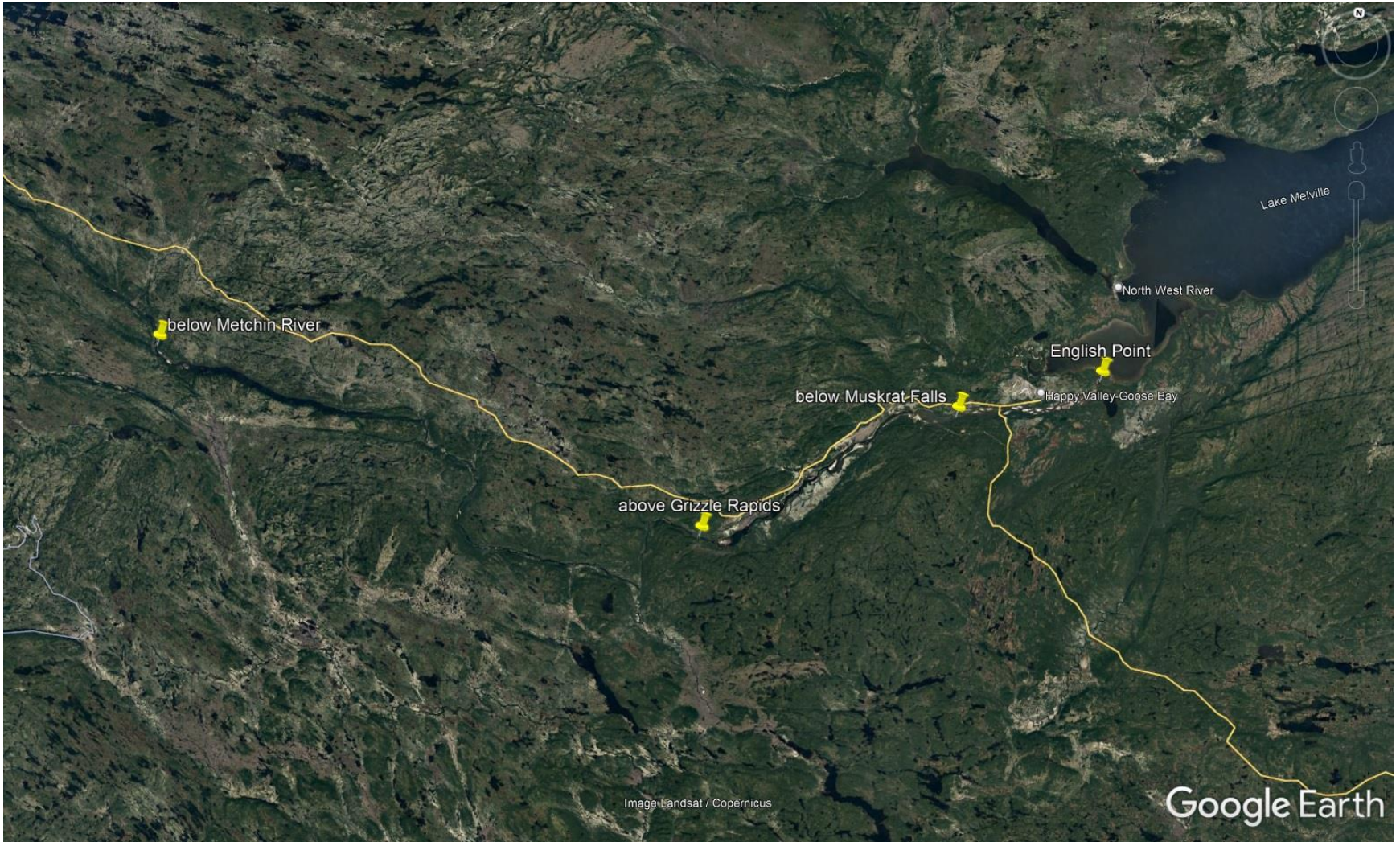

Figure 1: Lower Churchill Network of Real-Time Water Quality Stations

Churchill River below Metchin River

Water Temperature

- Over the deployment period, water temperature ranged from 5.2°C to 12.1°C, with a median value of 7.7°C (Figure 2). Air temperature data was obtained from the Metchin River near TLH Weather Station.
- Water temperature was slowly decreasing over the course of deployment, which is to be expected as air temperatures were also slowly decreasing through the fall 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.

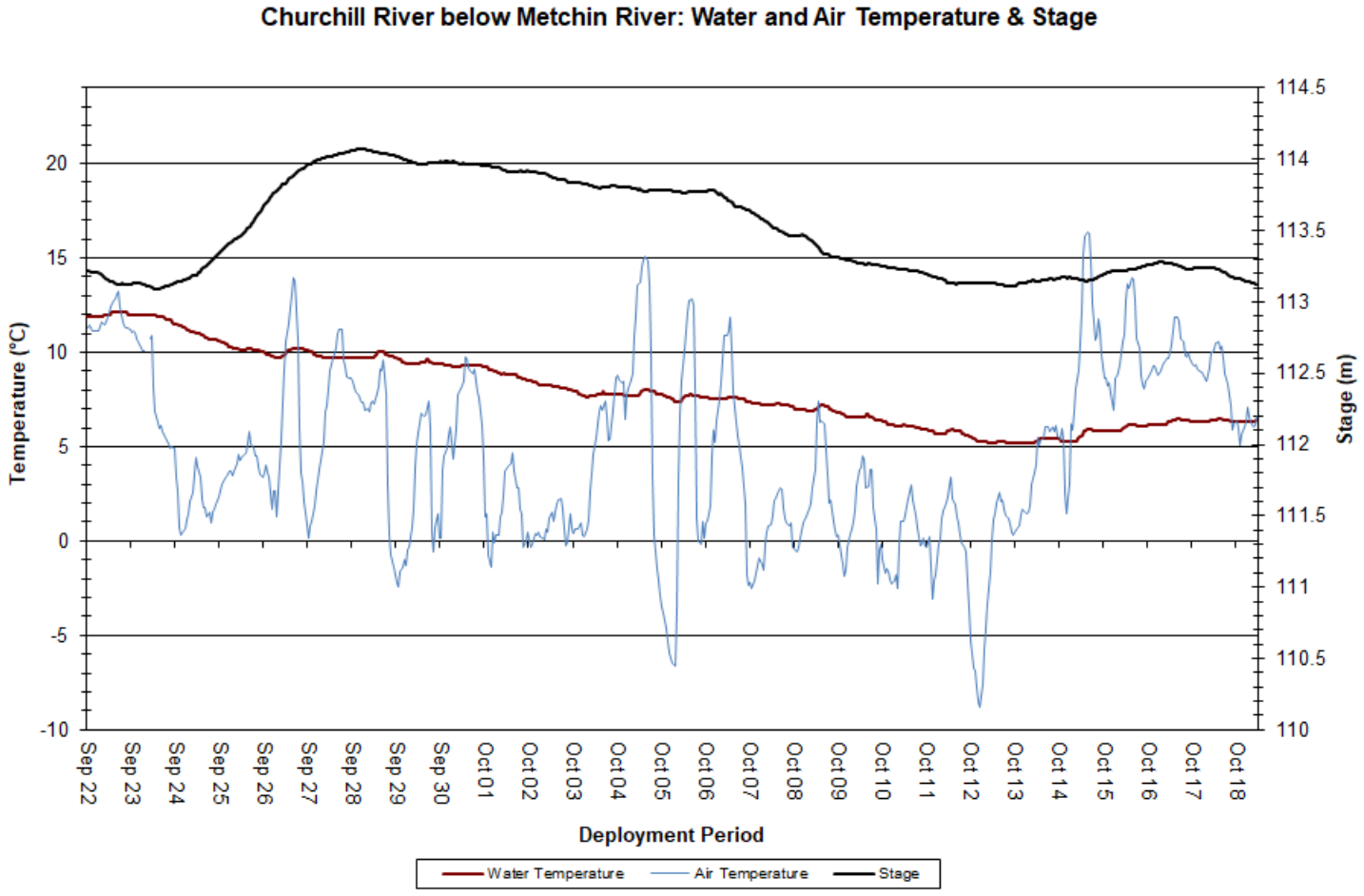

Figure 2: Water and Air Temperature & Stage at Churchill River below Metchin River

pH

- Over the deployment period, pH values ranged from 6.74 to 8.06 pH units, with a median value of 7.02 (Figure 3).
- pH values were relatively stable over the deployment period, 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.

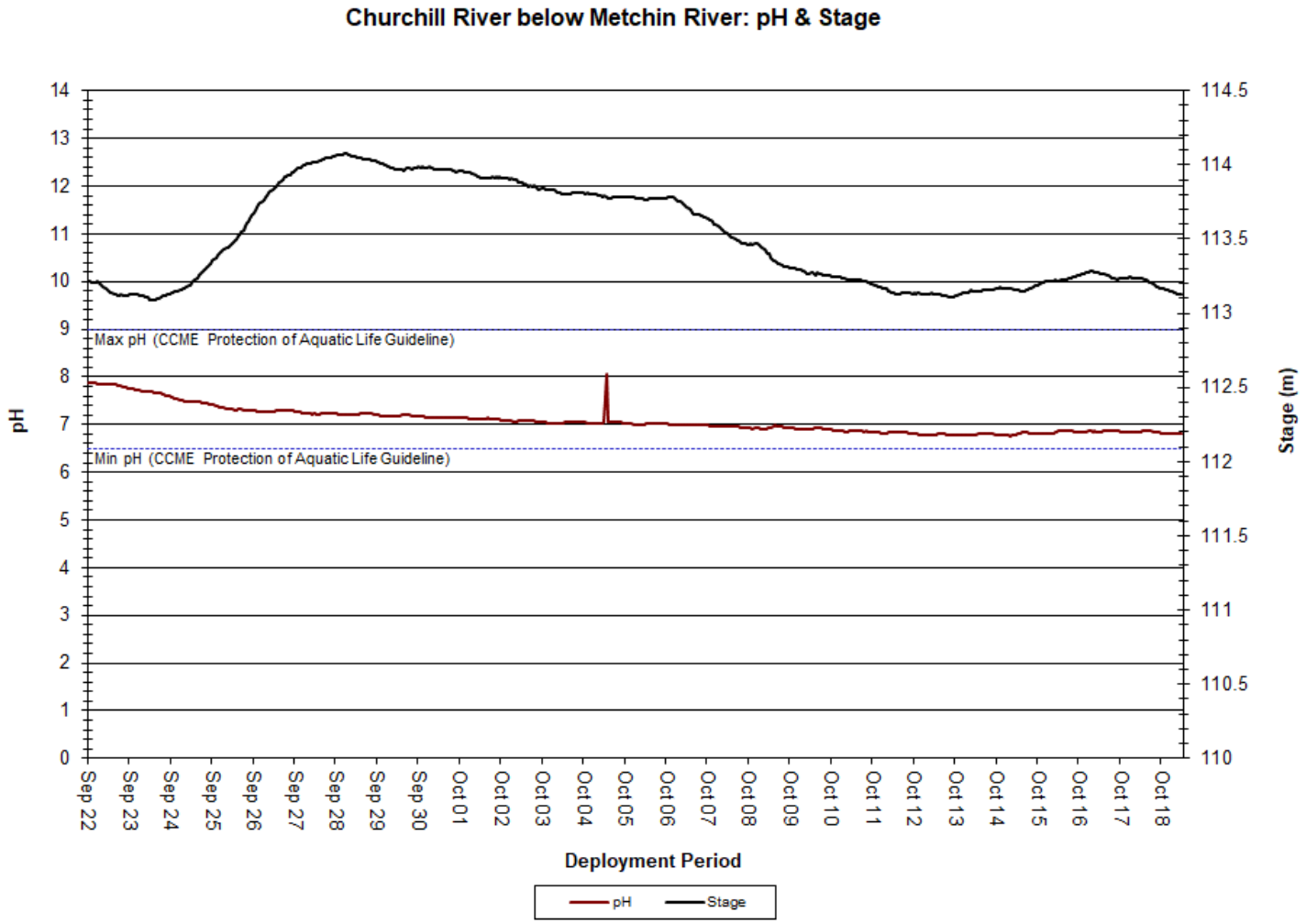

Figure 3: pH & Stage at Churchill River below Metchin River

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 17.4µS/cm to 19.4µS/cm, with a median value of 18.7µS/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.

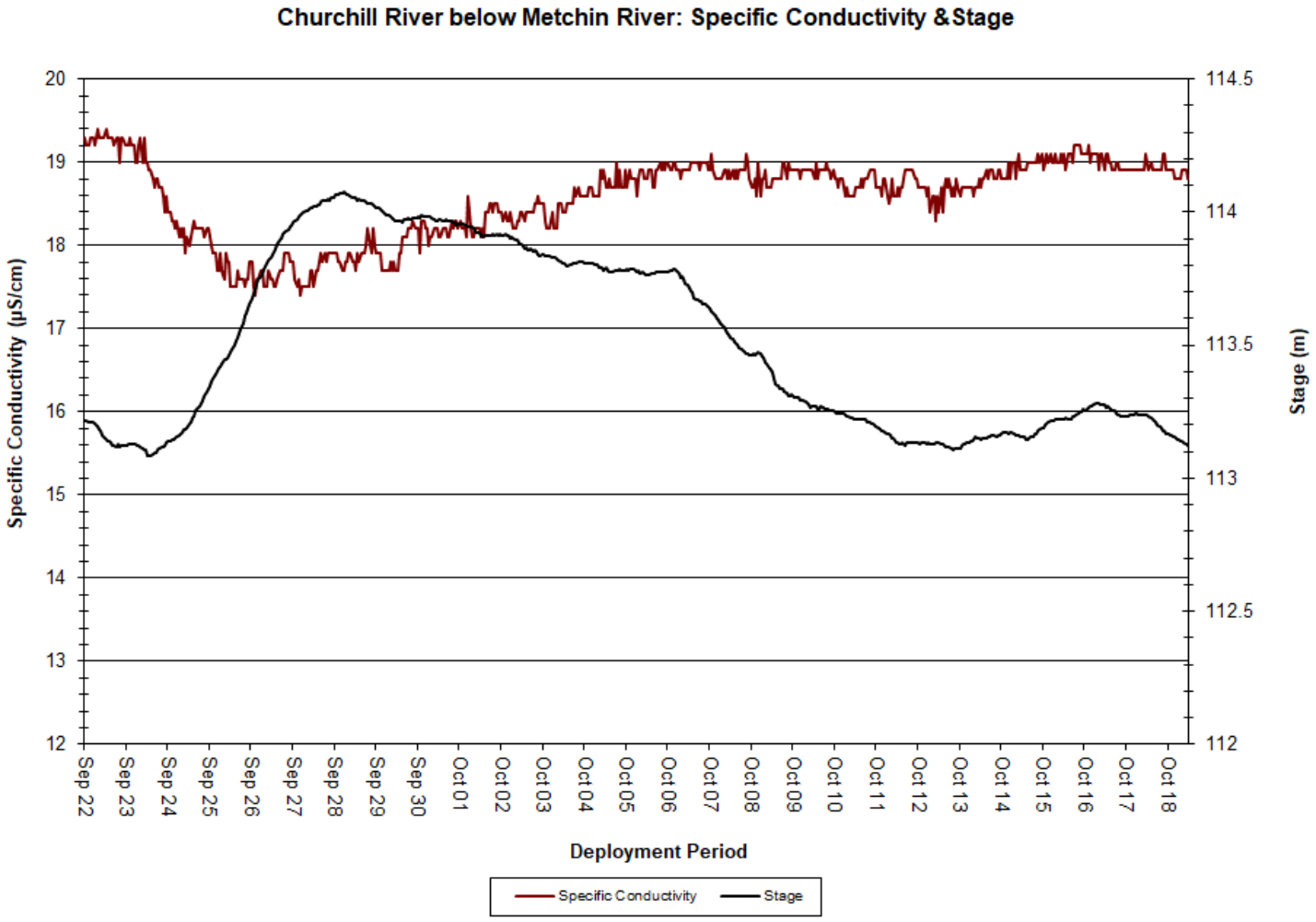

Figure 4: Specific Conductivity & Stage at Churchill River below Metchin River

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 9.97mg/L to 11.95mg/L, with a median value of 11.27mg/L. Saturation of dissolved oxygen ranged from 92.4% to 96.7%, with a median value of 94.3% (Figure 5).
- There is an evident relationship between water temperature and dissolved oxygen. Over the deployment period, dissolved oxygen levels were steadily increasing, as water temperatures were steadily decreasing. 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 Guidelines for the Protection of Early and Other Life Stages for the duration of deployment.

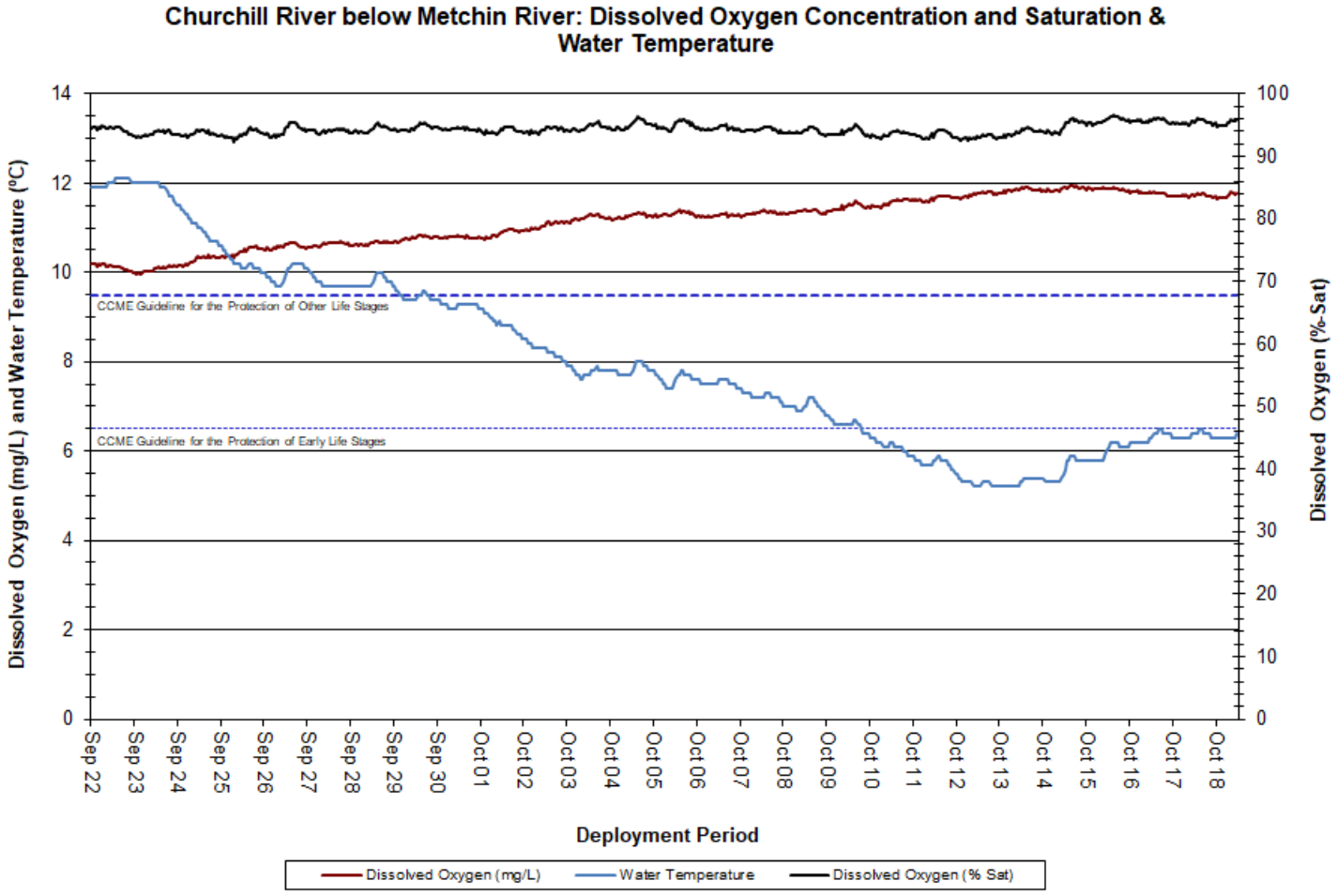

Figure 5: Dissolved Oxygen & Water Temperature at Churchill River below Metchin River

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 12.6NTU, with a median value of 1.7NTU (Figure 6). A median value of 1.7NTU indicates a very 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. The steady increase in turbidity levels from October 5th onwards may be attributed to sediment build-up around the sensor.
- 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.

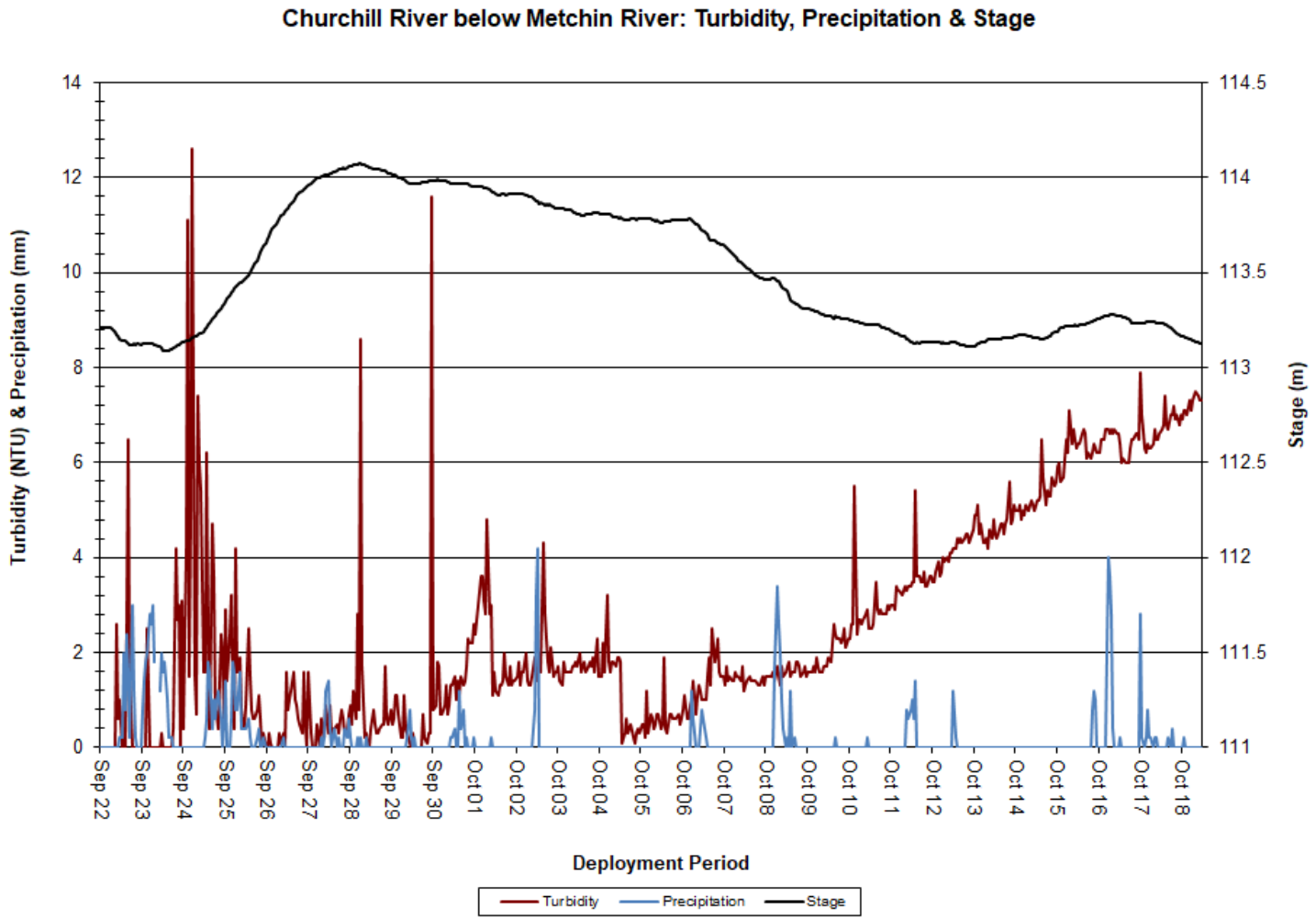

Figure 6: Turbidity, Precipitation & Stage at Churchill River below Metchin River

Stage and Flow

- Over the deployment period, stage levels ranged from 113.085m to 114.074m, with a median value of 113.410m. Flow ranged from 1290.228m^3/s to 1526.319m^3/s, with a median value of 1375.108m^3/s (Figure 7). Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Stage and flow were relatively stable over the course of deployment. Precipitation events across the same period somewhat 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.

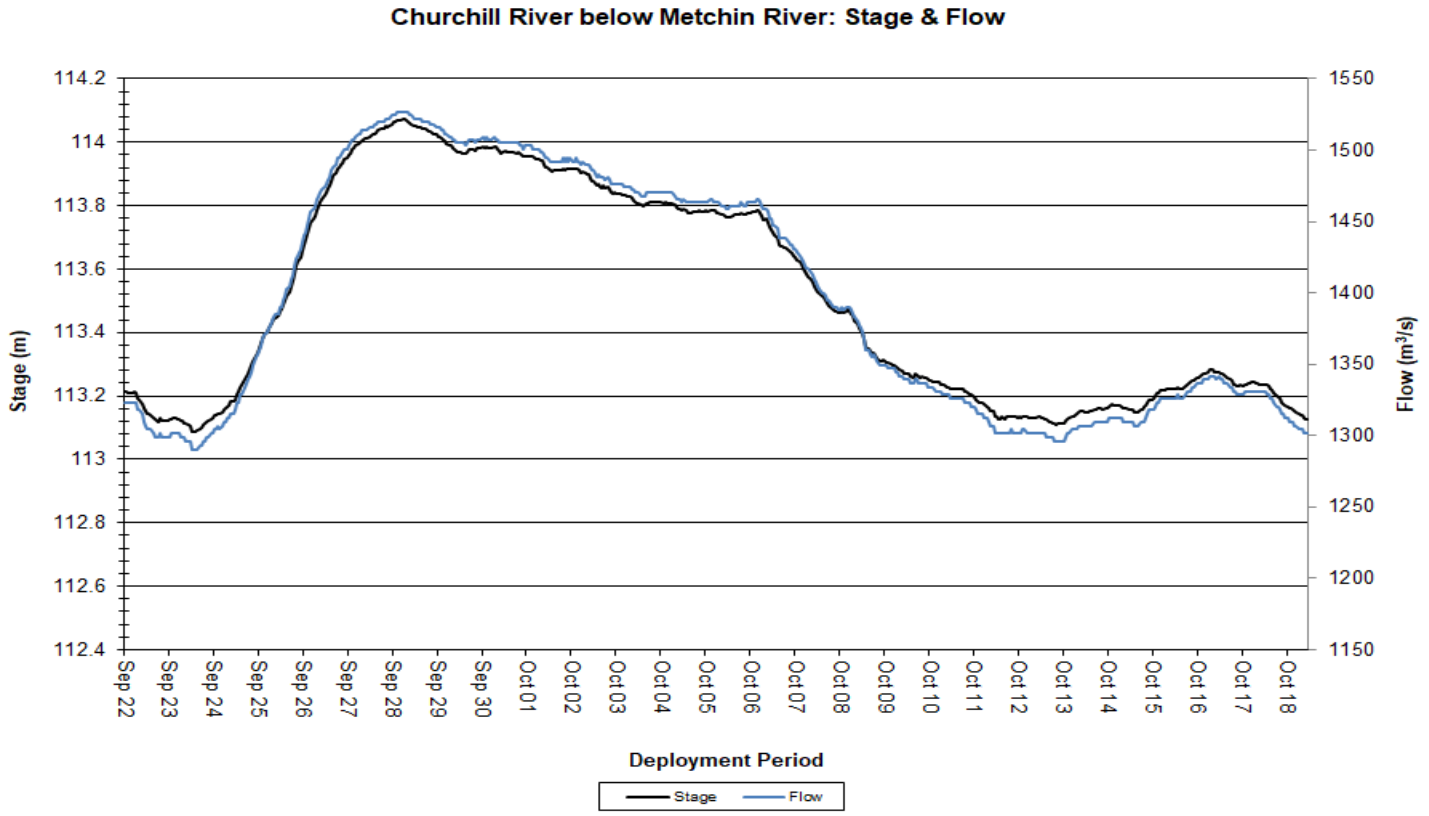

Figure 7: Stage & Flow at Churchill River below Metchin River

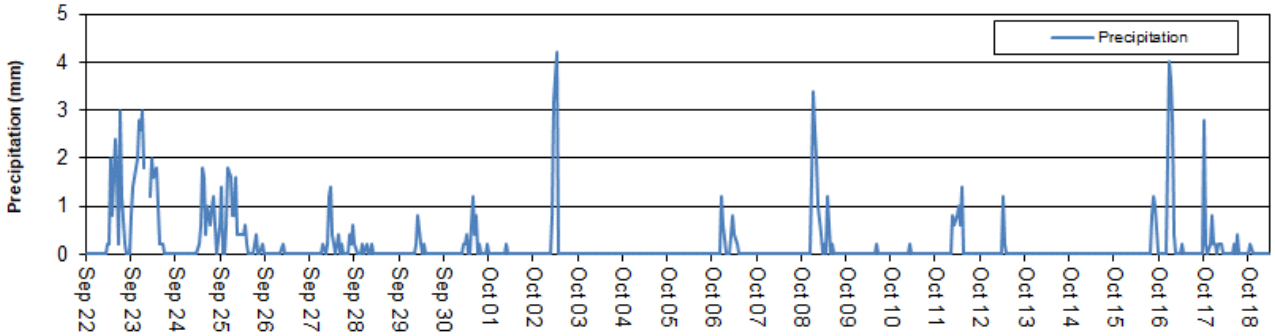

Figure 8: Precipitation at Churchill River below Metchin River

Churchill River above Grizzle Rapids

Water Temperature

- Over the deployment period, water temperature ranged from 6.8°C to 15.1°C, with a median value of 8.9°C (Figure 9). Air temperature data was obtained from the Metchin River near TLH Weather Station.
- Water temperature steadily decreased across the deployment period. This trend is to be expected as air temperatures also decreased through October. 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.

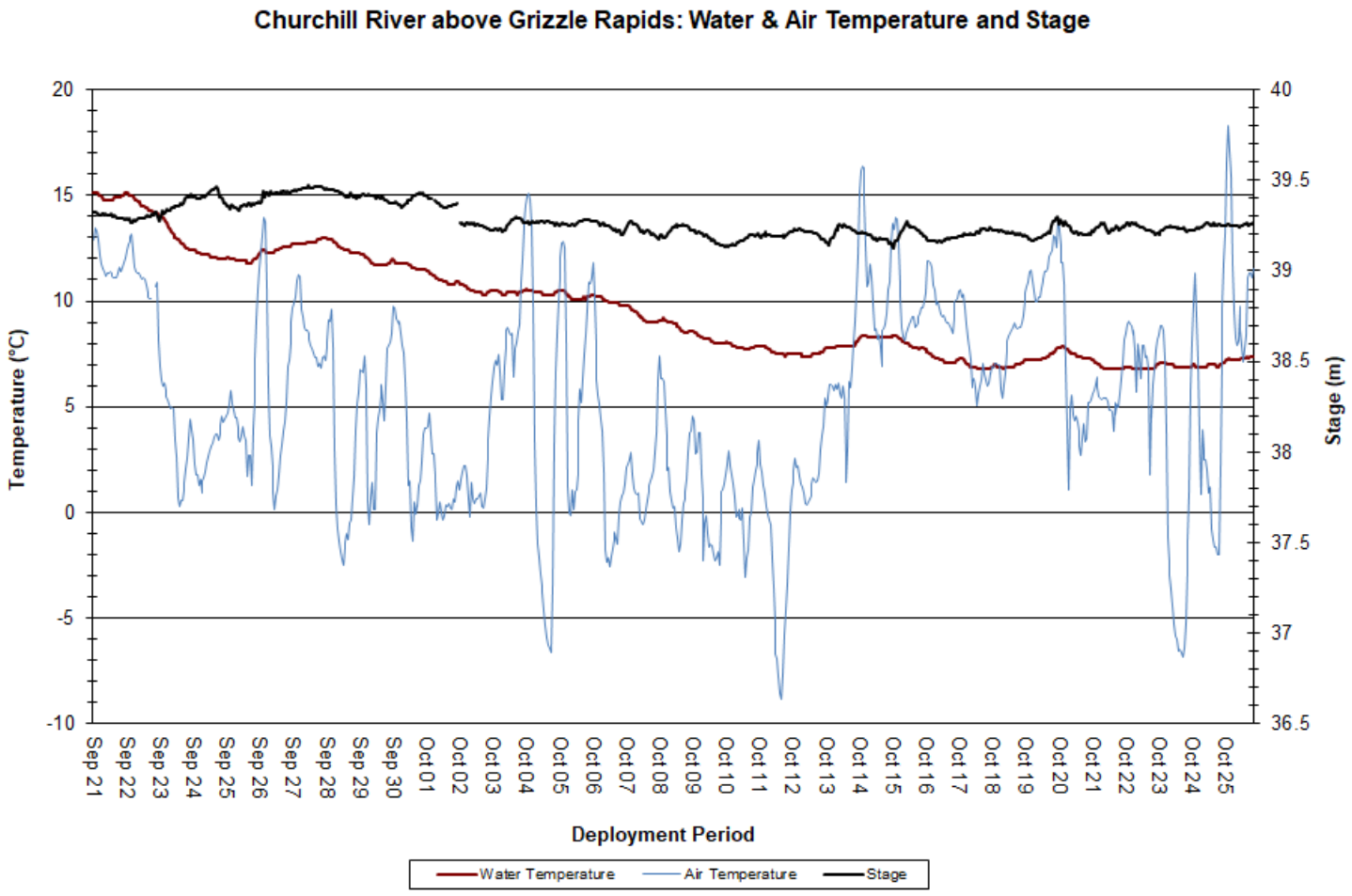

Figure 9: Water and Air Temperature & Stage at Churchill River above Grizzle Rapids

pH

- Over the deployment period, pH values ranged from 6.80 pH units to 7.29 pH units, with a median value of 7.03 (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.

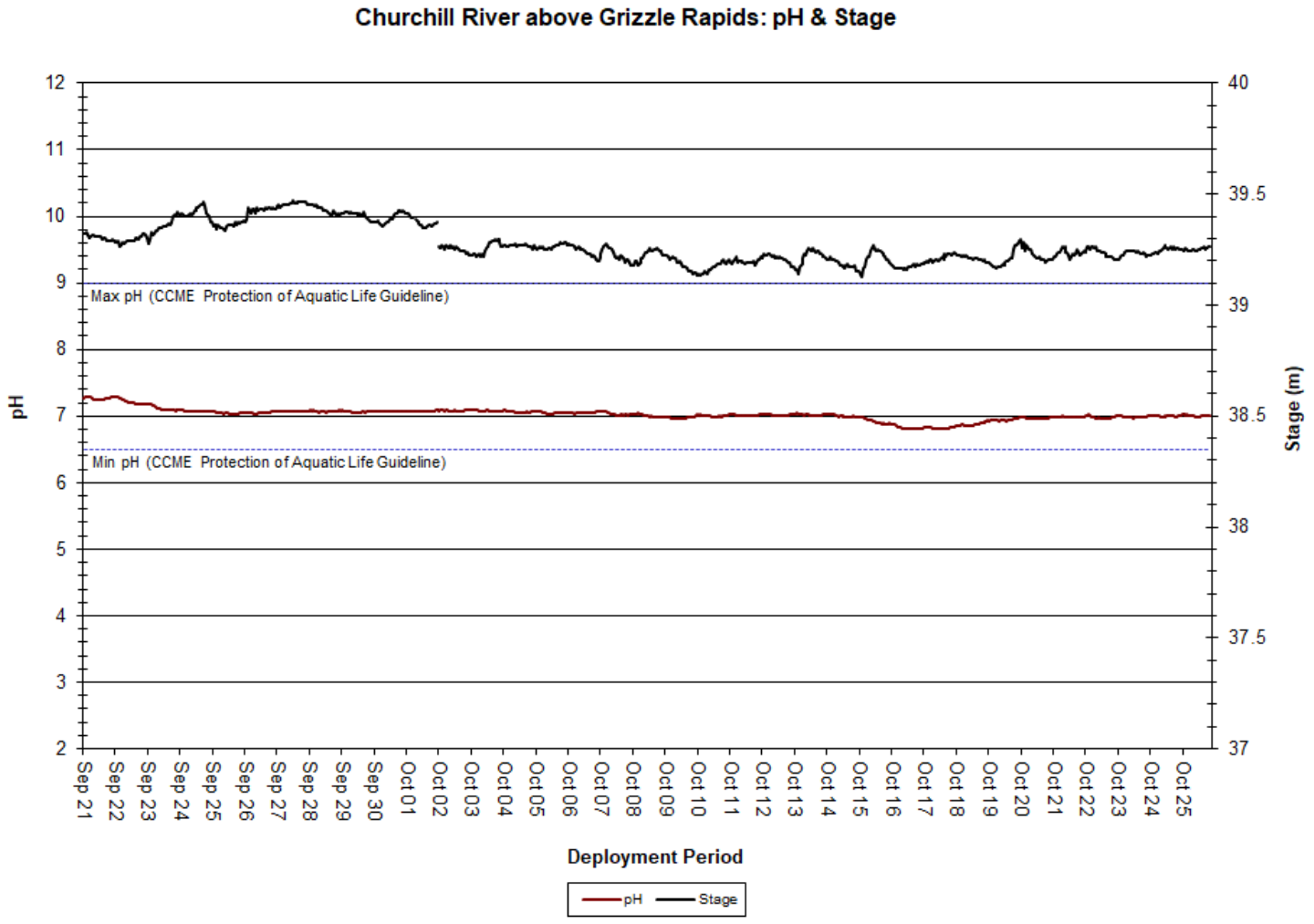

Figure 10: pH & Stage at Churchill River above Grizzle Rapids

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 15.9µS/cm to 19.5µS/cm, with a median of 17.0µS/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.

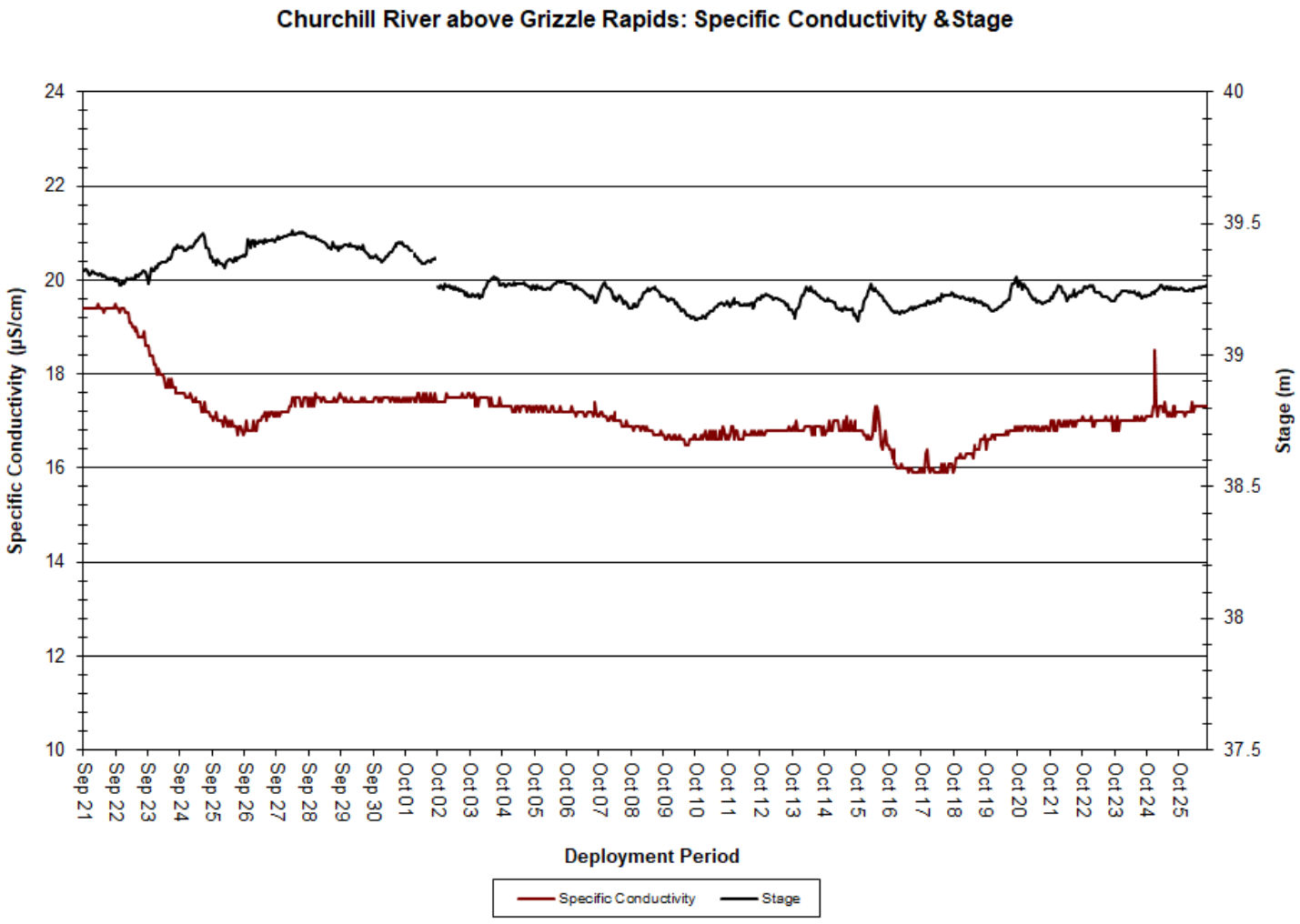

Figure 11: Specific Conductivity & Stage at Churchill River above Grizzle Rapids

Dissolved Oxygen

- Over the deployment period, dissolved oxygen content ranged from 9.45mg/L to 11.45mg/L, with a median value of 10.67mg/L. Saturation of dissolved oxygen ranged from 91.4% saturation to 97.4% saturation, with a median value of 93.3% (Figure 12).
- There is an evident relationship between water temperature and dissolved oxygen. Over the deployment period, dissolved oxygen levels gradually increased as water temperatures decreased through October. 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 duration of deployment, with the exception of a brief period at the very beginning 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.

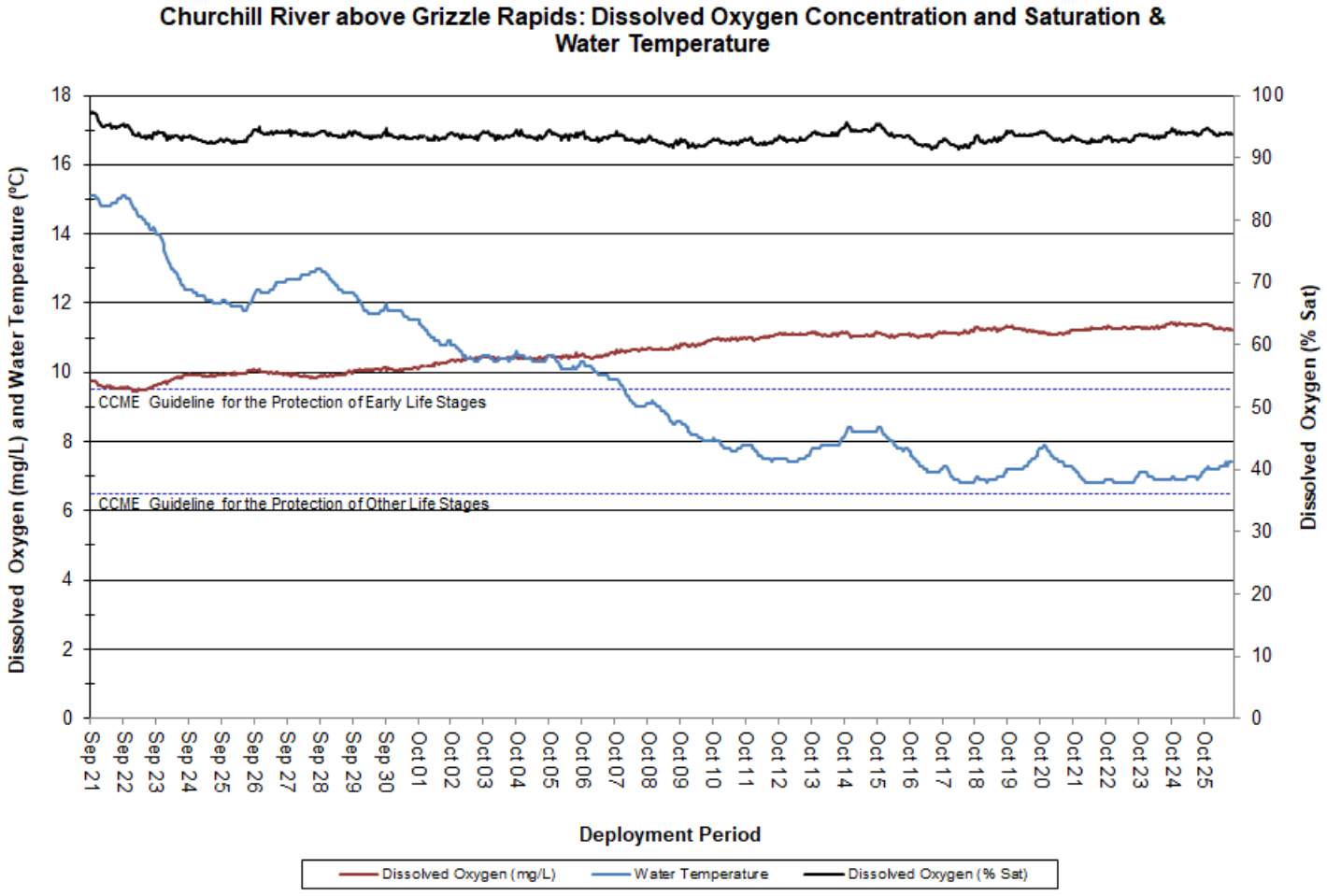

Figure 12: Dissolved Oxygen & Water Temperature at Churchill River above Grizzle Rapids

Turbidity

- Over the deployment period, turbidity ranged from 0.0NTU to 8.9NTU, with a median value of 2.9NTU (Figure 13). A median value of 2.9NTU indicates a low level of natural background turbidity in the waterbody. Precipitation data was obtained from the Metchin River near TLH Weather 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.

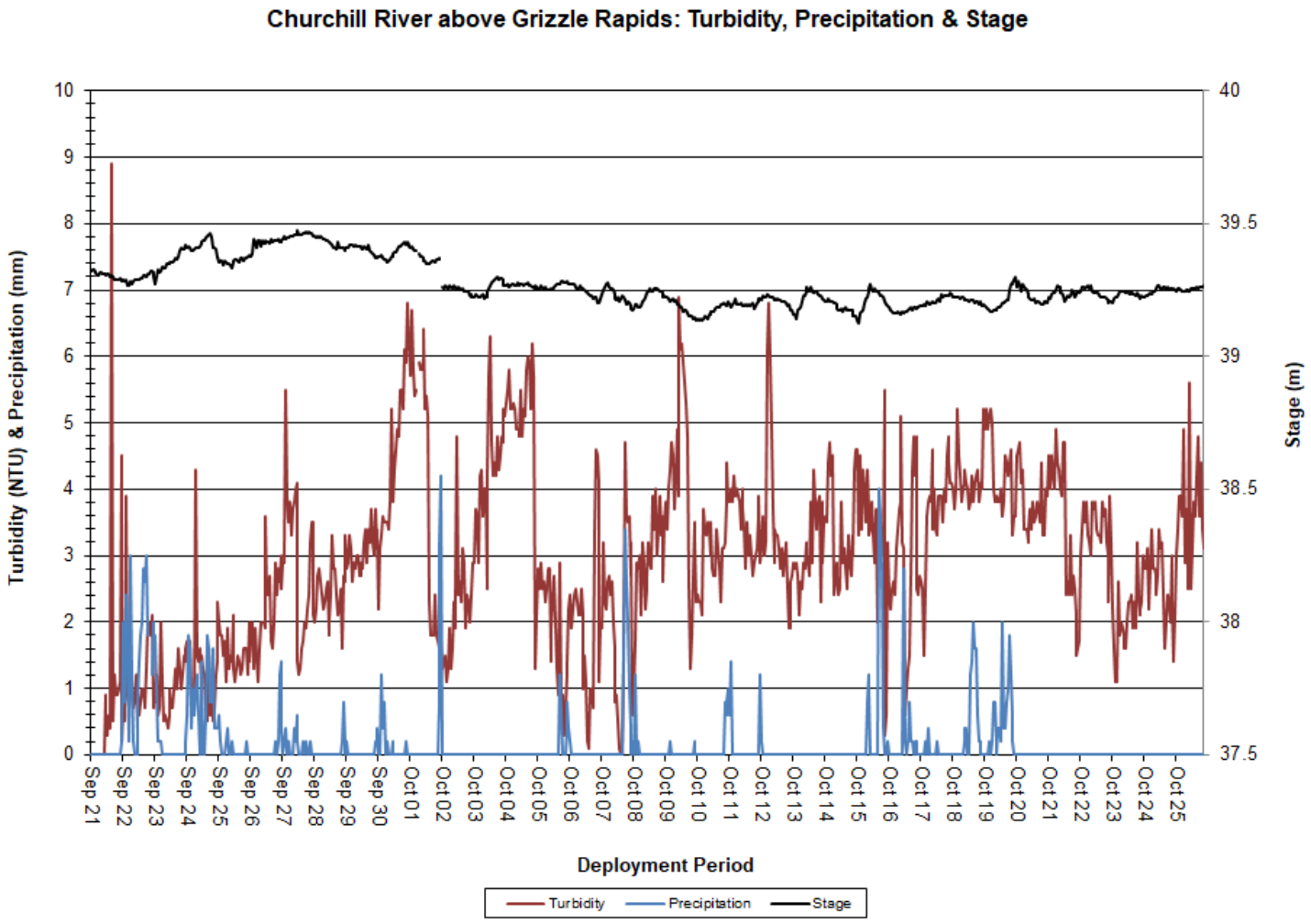

Figure 13: Turbidity, Precipitation & Stage at Churchill River above Grizzle Rapids

Stage

- Over the deployment period, stage ranged from 39.127m to 39.473m, with a median value of 39.25m (Figure 14). Precipitation data was obtained from the Metchin River near TLH Weather Station.
- Stage was quite stable across the deployment period, with precipitation events often correlating with slight 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.

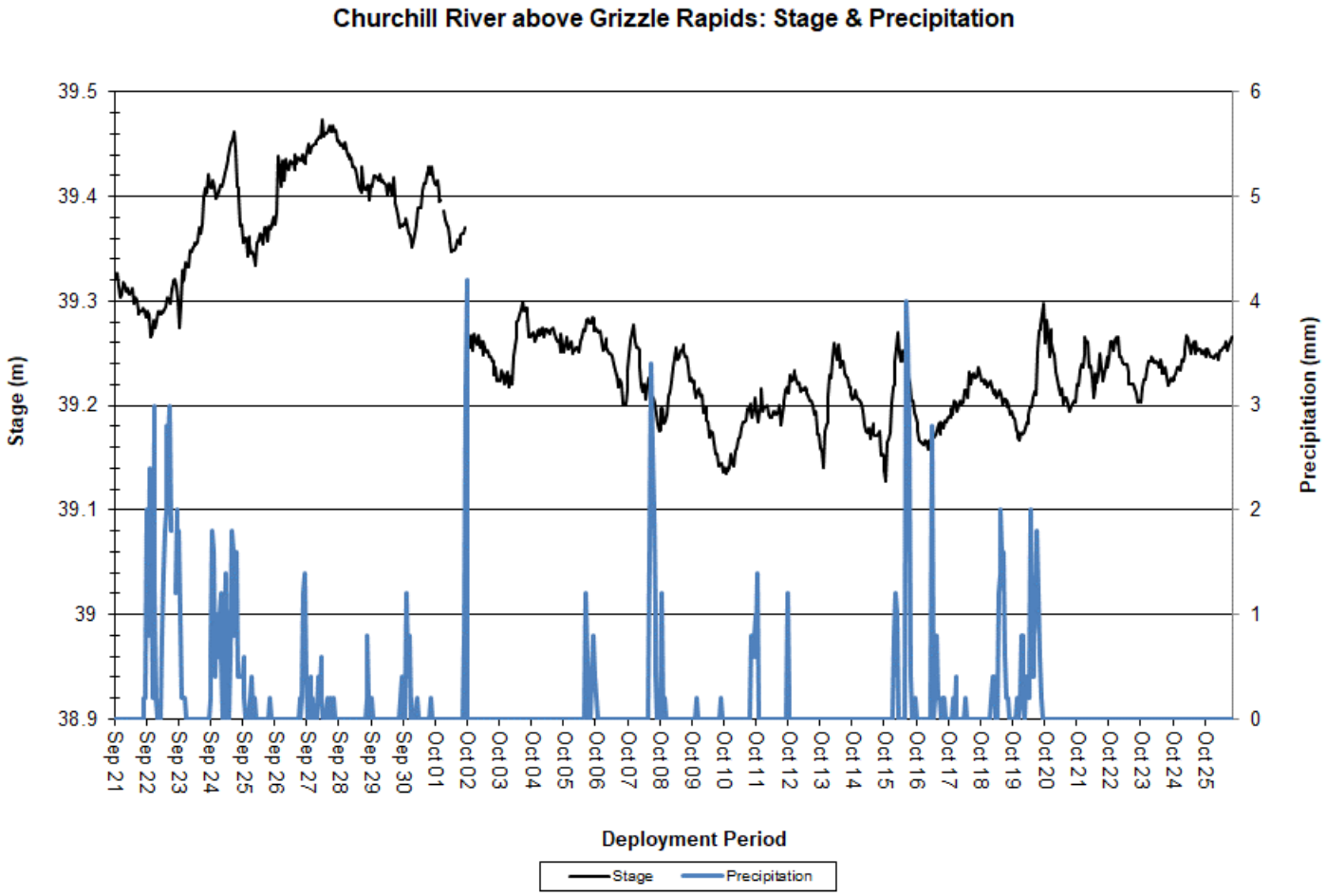

Figure 14: Stage & Precipitation at Churchill River above Grizzle Rapids

Churchill River below Muskrat Falls

Water Temperature

- Over the deployment period, water temperature ranged from 7.2°C to 13.8°C, with a median value of 9.4°C (Figure 15). Air temperature data was obtained from the Churchill River at End of Mud Lake Road Weather Station.
- Water temperature slowly decreased over the course of the deployment period. This is to be expected as ambient air temperatures also decreased through September.
- 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.

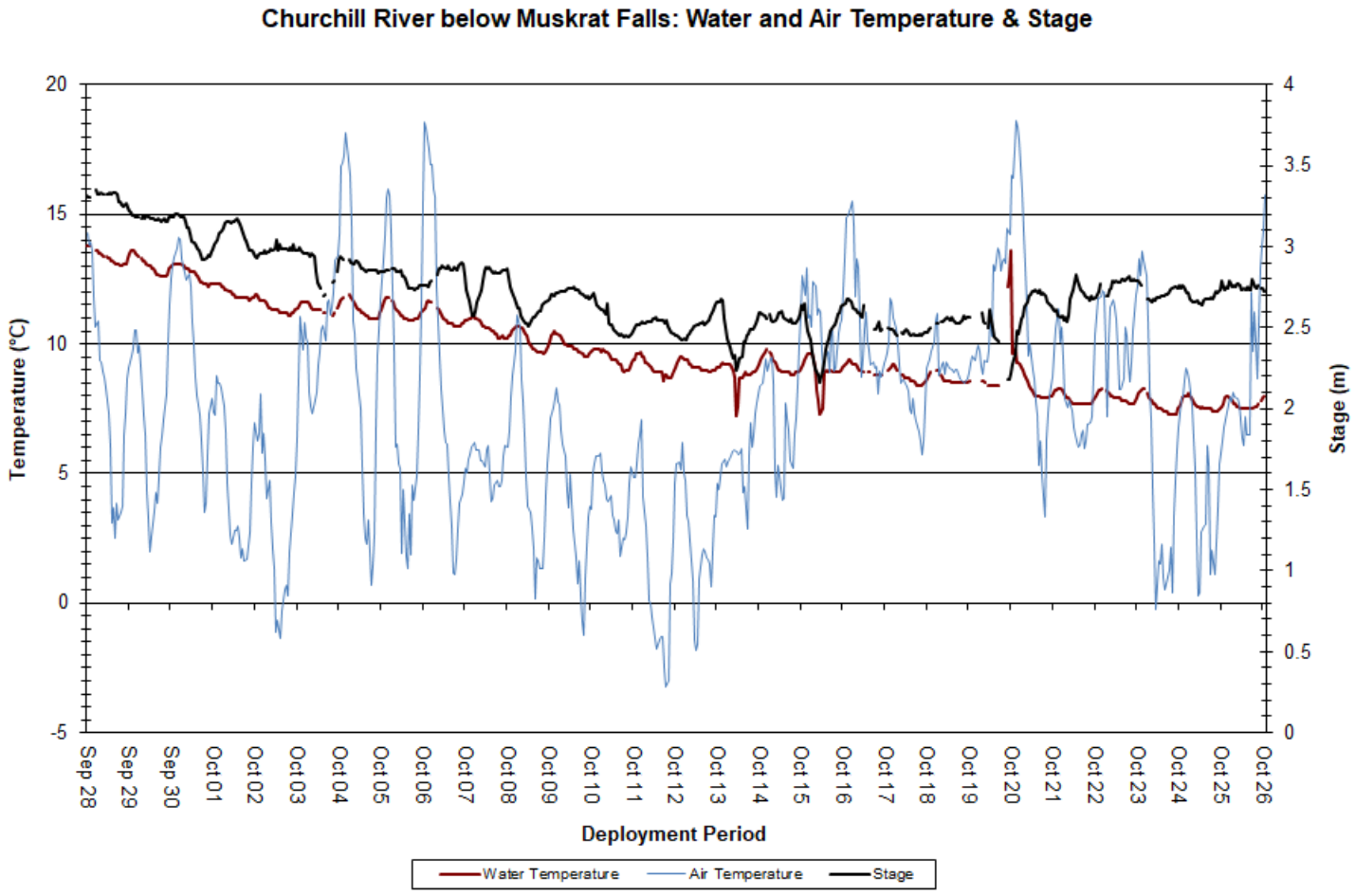

Figure 15: Water and Air Temperature & Stage at Churchill River below Muskrat Falls

pH

- Over the deployment period, pH ranged from 2.17 pH units to 7.35 pH units, with a median value of 6.91 (Figure 16).
- pH values were quite stable over the course of deployment, and remained within the CCME's Guidelines for the Protection of Aquatic Life for the duration of the deployment period. A couple of brief exceptions occurred, which correlated closely with significant sudden decreases in stage (Figure 16).
- 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.

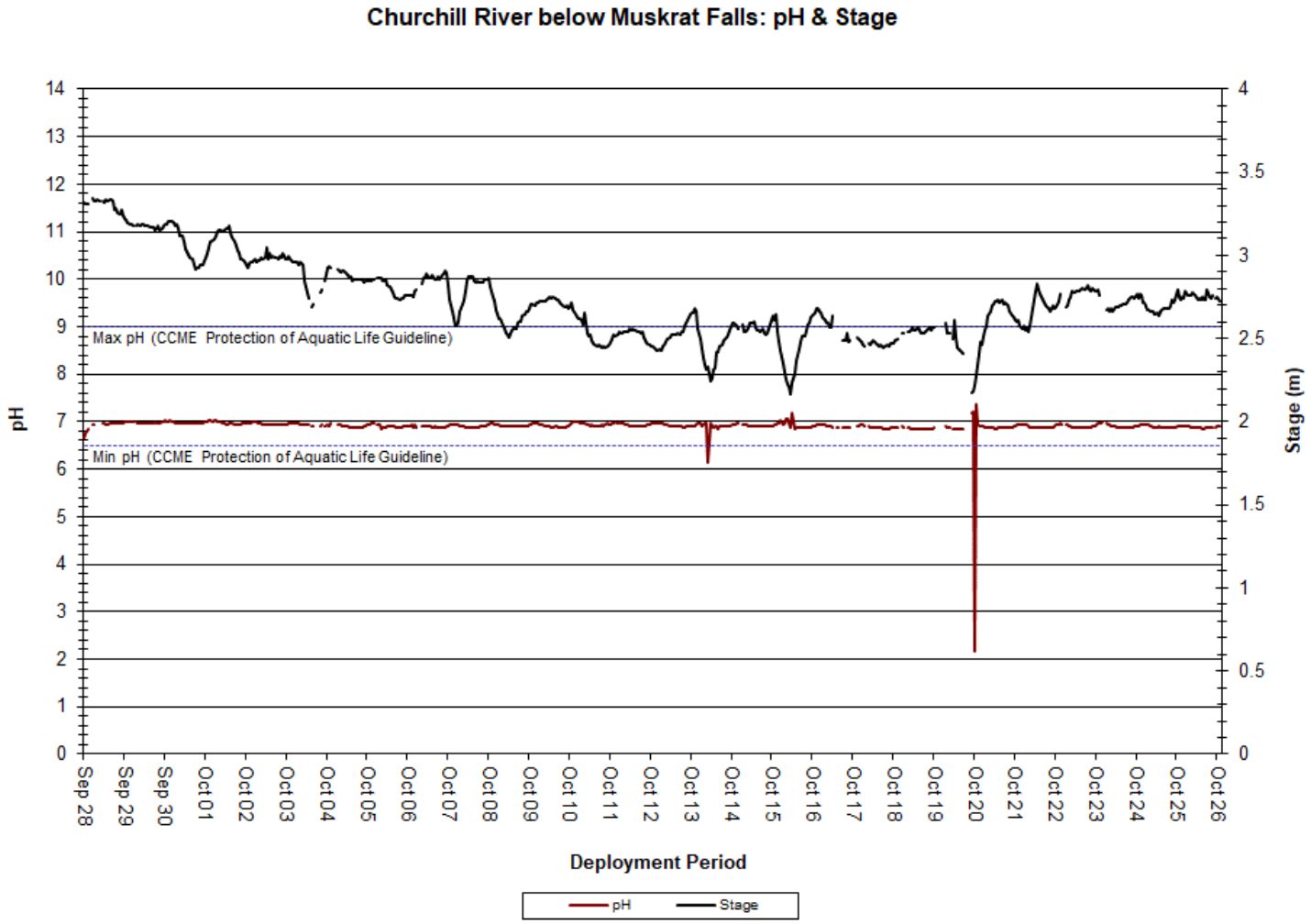

Figure 16: pH & Stage at Churchill River below Muskrat Falls

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 0µS/cm to 19.7µS/cm, with a median value of 17.9µS/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). Instances where specific conductivity levels were zero correlate closely with significant sudden decreases in stage, indicating that the instrument may have briefing come out of the 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.

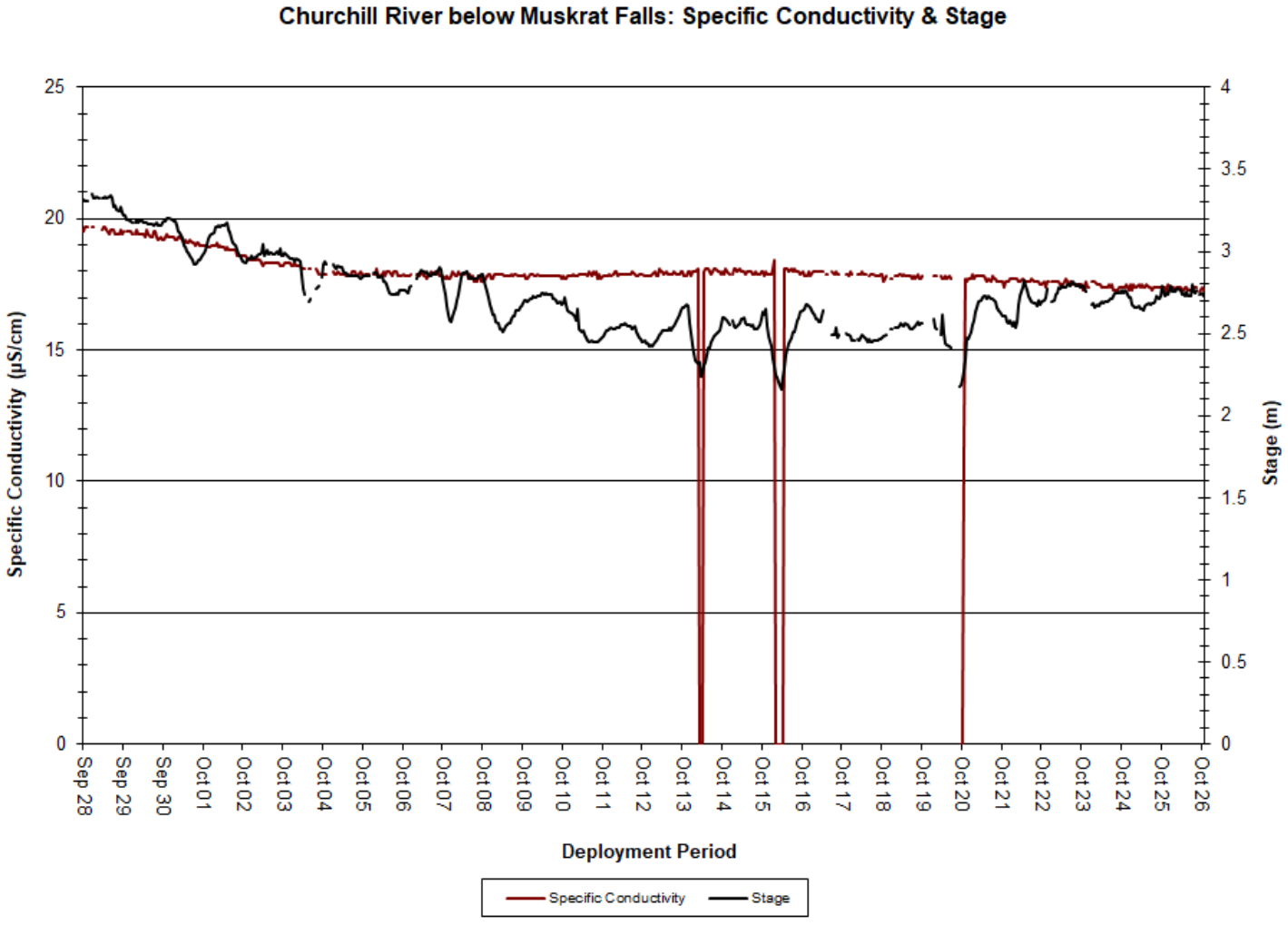

Figure 17: Specific Conductivity & Stage at Churchill River below Muskrat Falls

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 9.68mg/L to 11.79mg/L, with a median value of 10.92mg/L. Saturation of dissolved oxygen ranged from 92.4% to 101.2%, with a median value of 95.8% (Figure 18).
- Dissolved oxygen and water temperature exhibit an inverse relationship: as one parameter increases, the other decreases, and vice versa. Dissolved oxygen levels steadily increased over the course of deployment. This is to be expected since water temperatures were decreasing over the same period. Dissolved oxygen also follows a diurnal pattern as water temperatures rise and fall under the influence of ambient air temperatures.
- Dissolved oxygen levels were above the CCME's Guidelines for the Protection of Early and Other Life Stages for the duration of deployment.

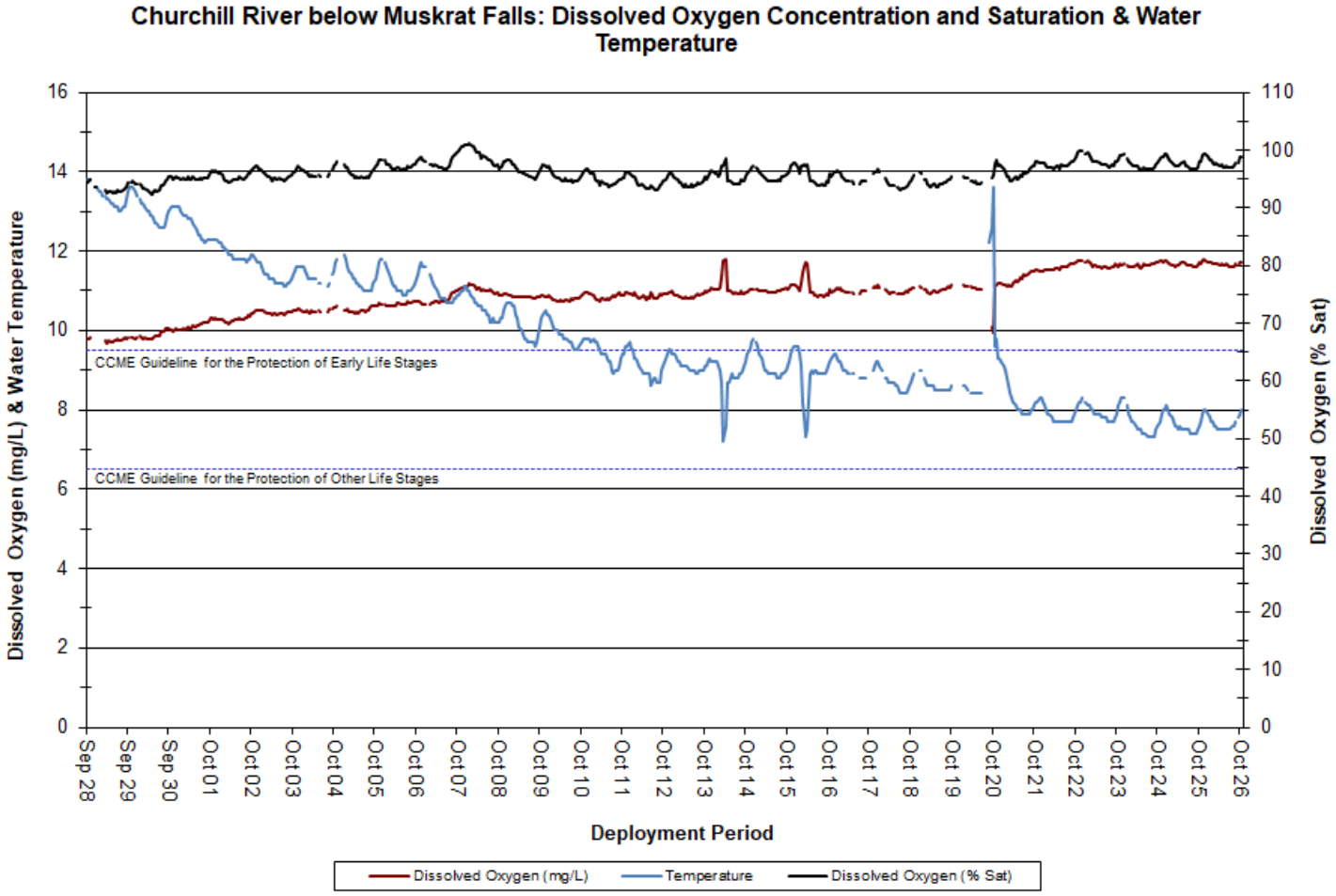

Figure 18: Dissolved Oxygen & Water Temperature at Churchill River below Muskrat Falls

Turbidity

- Over the deployment period, turbidity ranged from 0 NTU to 3000 NTU, with a median value of 3000 NTU. A median value of 3000 NTU indicates a very large amount of natural background turbidity in the waterbody, which is not typical of this station and may be attributed to either sediment build-up around the sensor or a sensor failure. Precipitation data was obtained from the Churchill River at End of Mud Lake Road Weather Station.
- There was limited 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.
- 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.

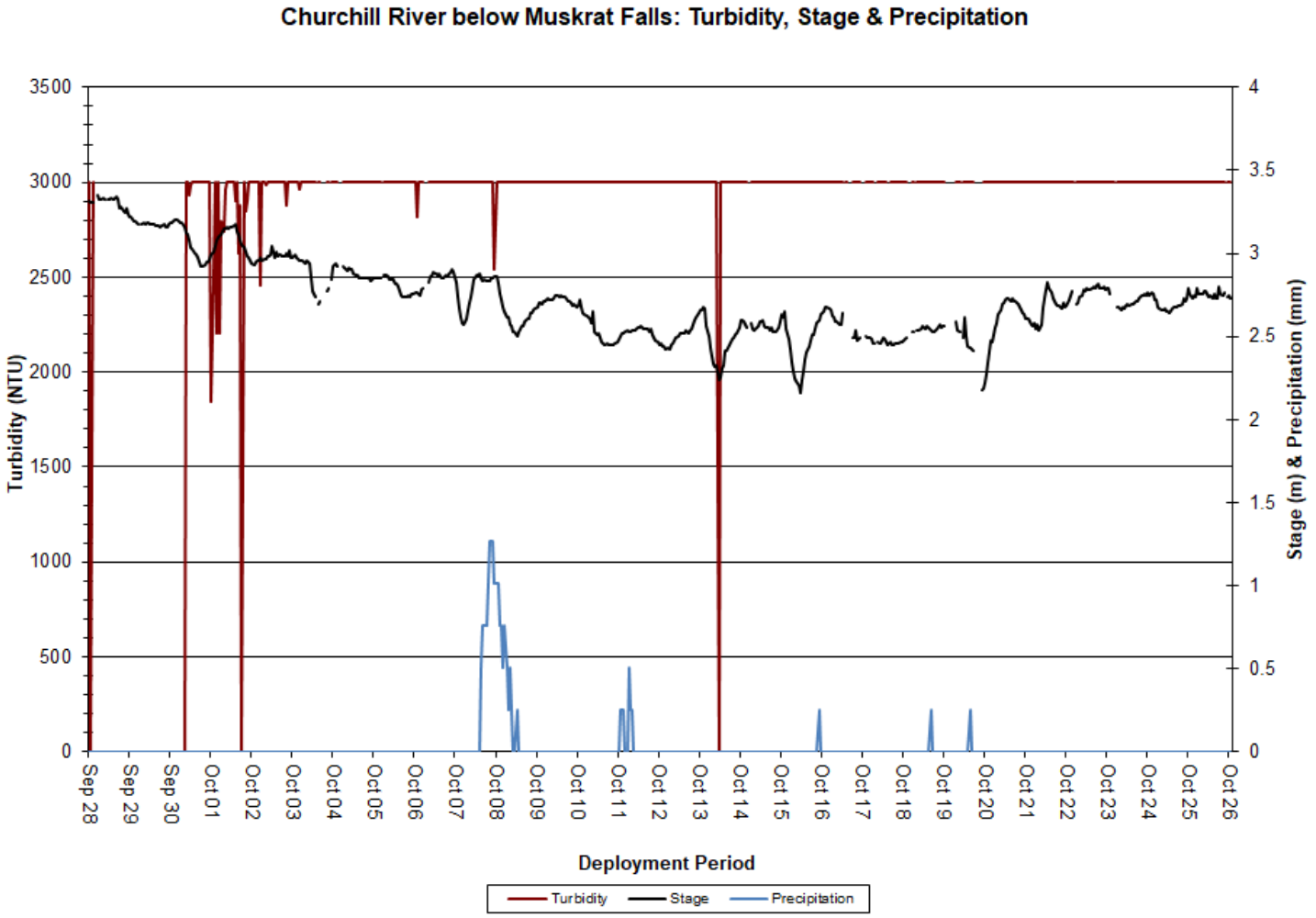

Figure 19: Turbidity, Precipitation & Stage at Churchill River below Muskrat Falls

Stage & Flow

- Over the deployment period, stage ranged from 2.163m to 3.348m, with a median value of 2.707m. Flow ranged from 1169.436m^3/s to 2394.215m^3/s, with a median value of 1693.664m^3/s (Figure 20). Precipitation data was obtained from the Churchill River at End of Mud Lake Road Weather Station.
- Stage and flow were variable but somewhat decreasing over the course of deployment, and loosely correlated 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 is 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.

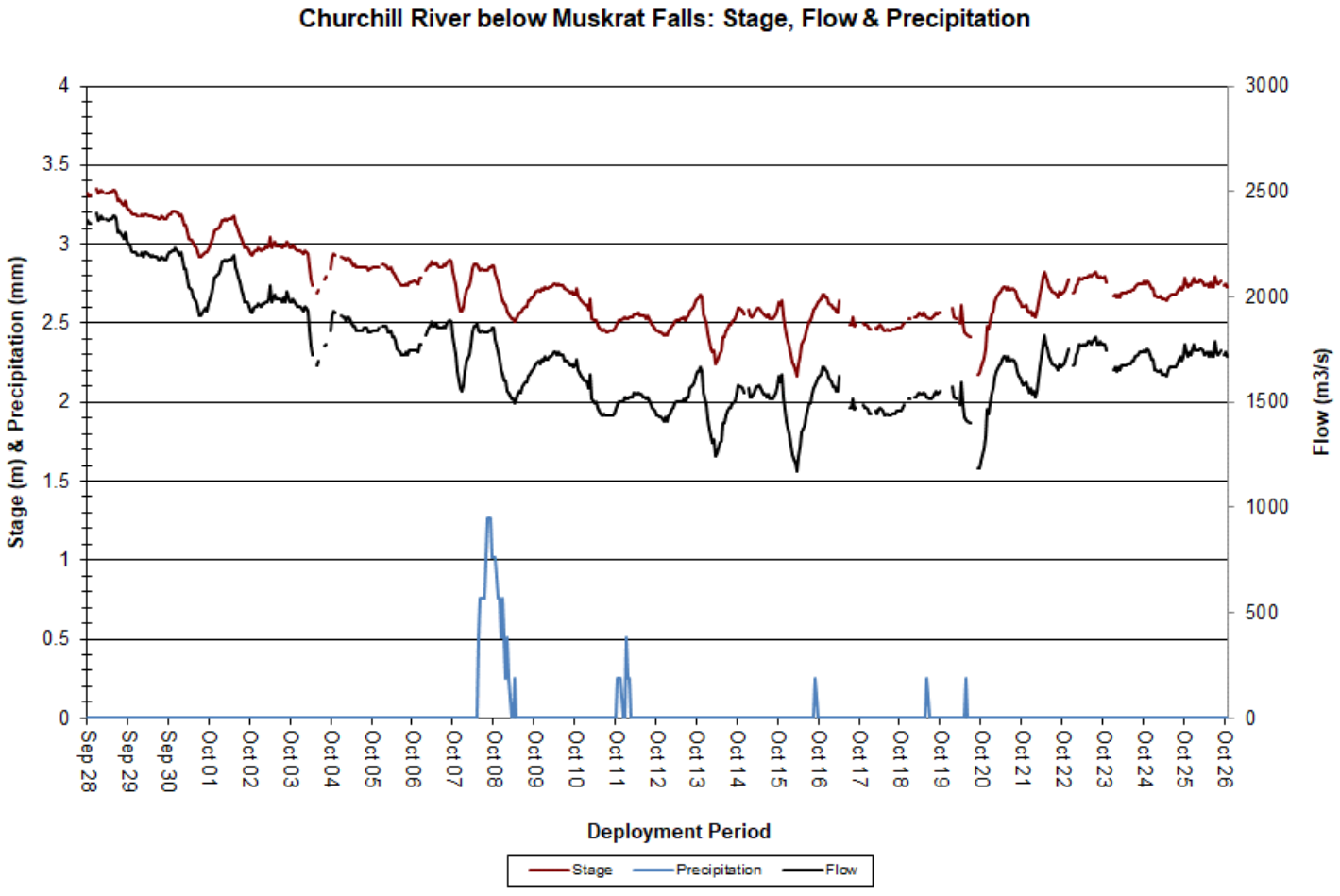

Figure 20: Stage, Flow & Precipitation at Churchill River below Muskrat Falls

Churchill River at English Point

Water Temperature

- Water temperature ranged from 6.9°C to 13.7°C, with a median value of 9.4°C (Figure 21). Air temperature data was obtained from the Churchill River at End of Mud Lake Road Weather Station.
- Water temperature decreased 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.

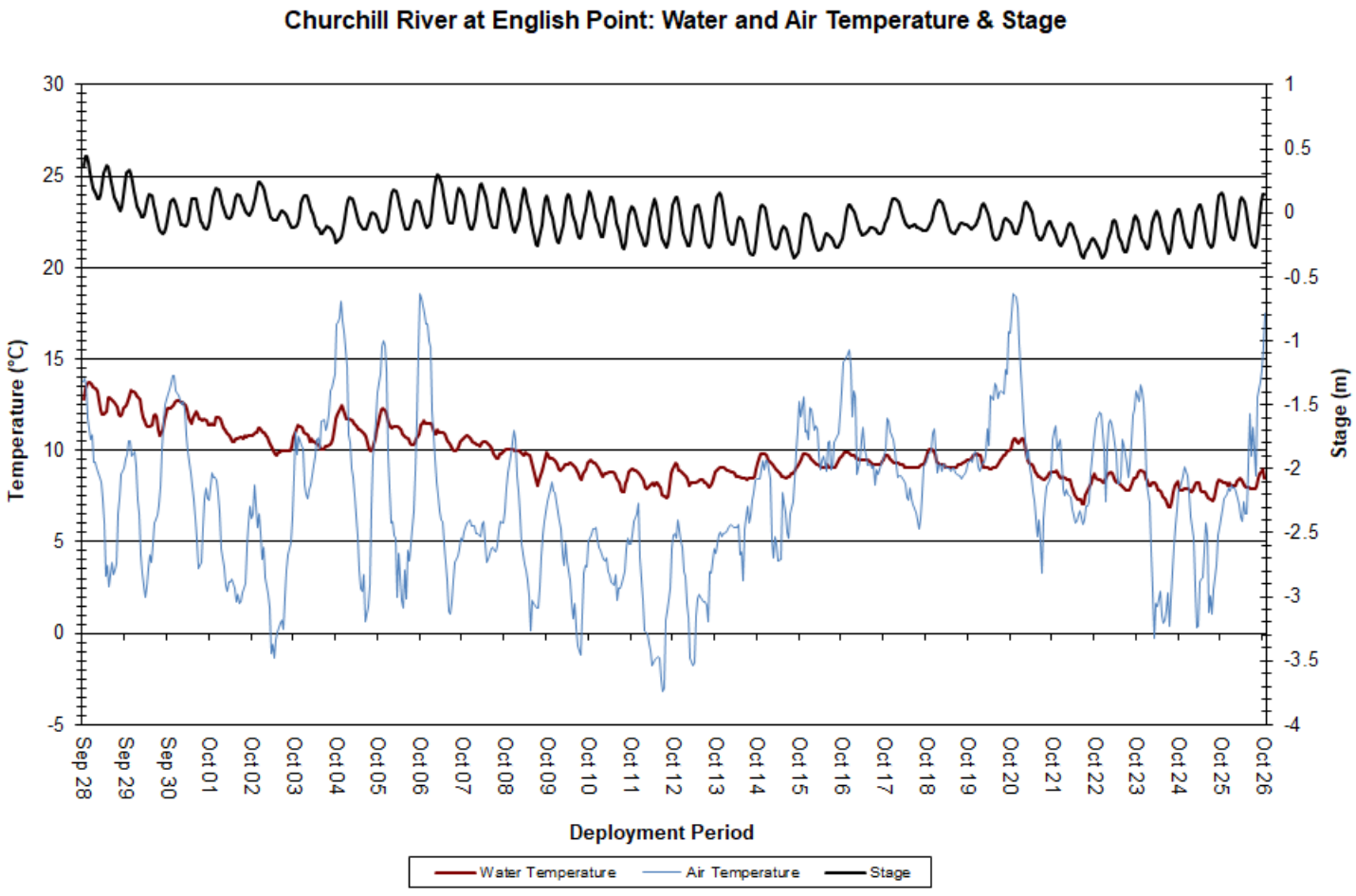

Figure 21: Water and Air Temperature & Stage at Churchill River at English Point

pH

- Over the deployment period, pH ranged from 6.54 pH units to 6.95 pH units, with a median value of 6.74 (Figure 22).
- 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 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.

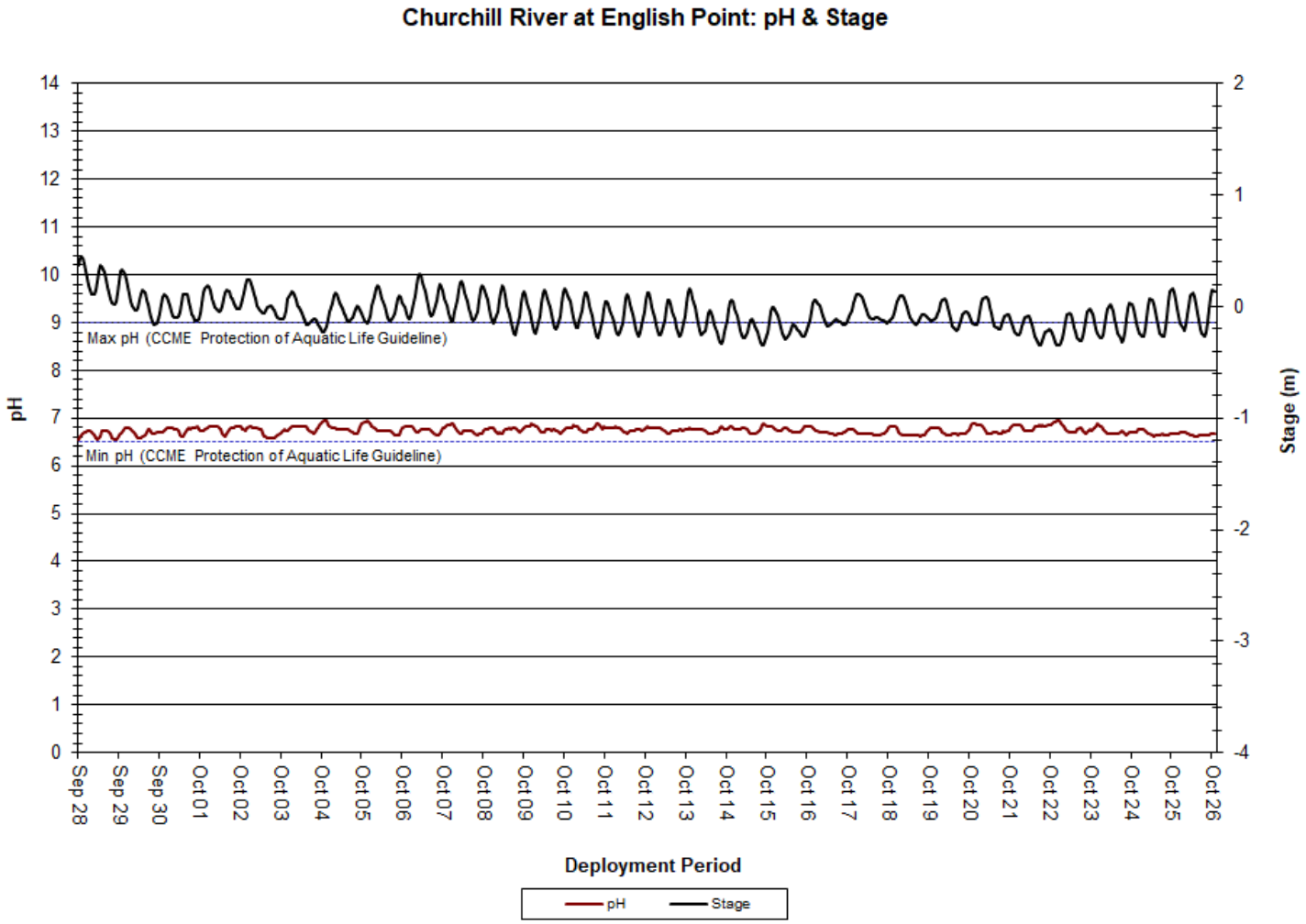

Figure 22: pH & Stage at Churchill River at English Point

Specific Conductivity

- Over the deployment period, specific conductivity ranged from 19.2µS/cm to 49.5µs/cm, with a median value of 26.6µS/cm (Figure 23).
- 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 23).
- 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.

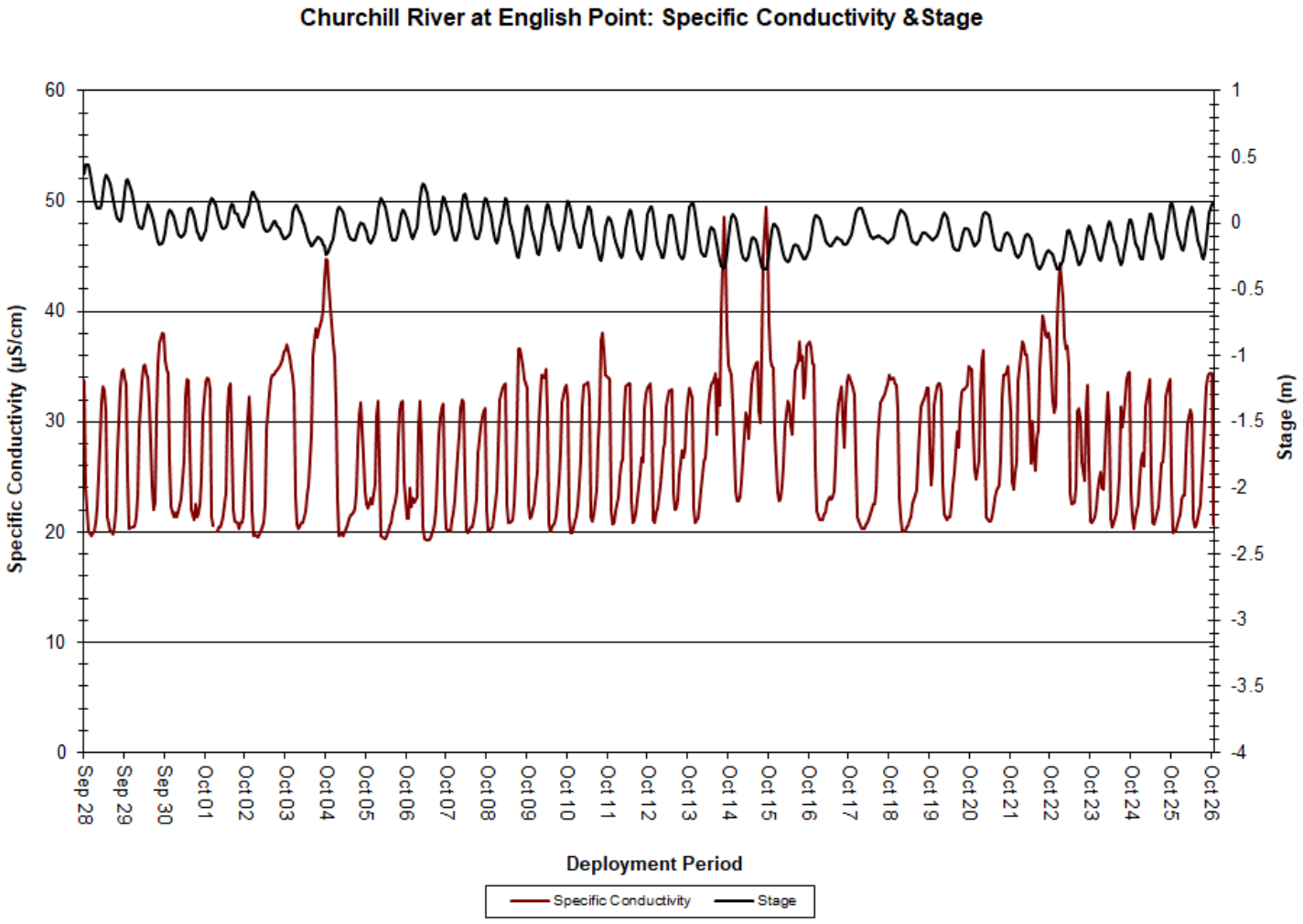

Figure 23: Specific Conductivity & Stage at Churchill River at English Point

Dissolved Oxygen

- Over the deployment period, dissolved oxygen concentration ranged from 9.55mg/L to 12.01mg/L, with a median value of 11.01mg/L. Saturation of dissolved oxygen ranged from 88.5% to 102.3% saturation, with a median value of 95.9% (Figure 24).
- There is an evident relationship between water temperature and dissolved oxygen. As water temperatures decreased over the deployment period, dissolved oxygen levels increased. 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 Guidelines for the Protection of Early and Other Life Stages for the duration of deployment (Figure 24).

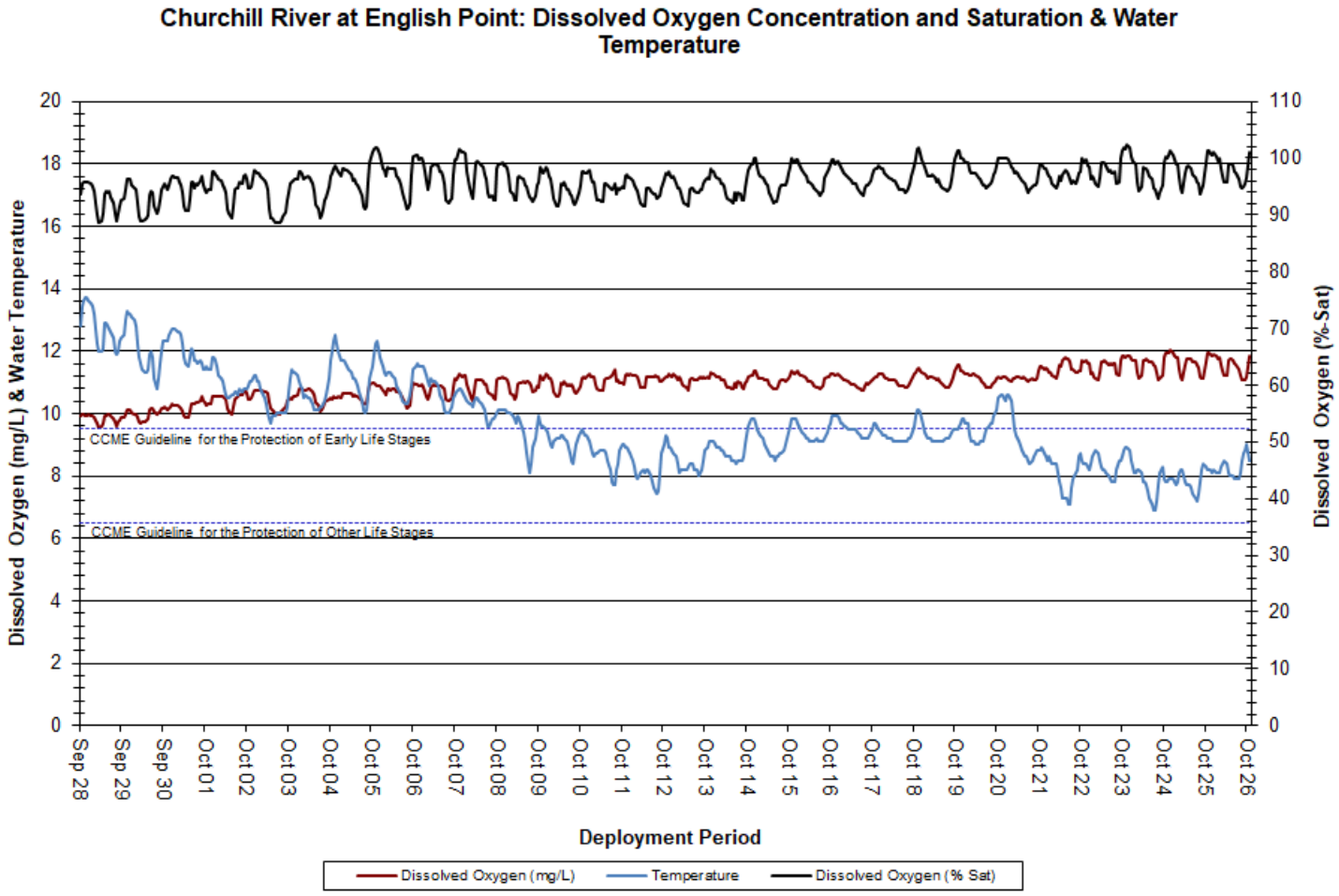

Figure 24: Dissolved Oxygen & Water Temperature at Churchill River at English Point

Turbidity

- Over the deployment period, turbidity ranged from 0 NTU to 34.6 NTU, with a median value of 0 NTU (Figure 25). A median value of 0 NTU indicates a very low level of background turbidity; which is not typical considering the sandy river bed and tidal influences present at this station. Precipitation data was obtained from the Churchill River at End of Mud Lake Road Weather Station.
- Turbidity events often correlate with precipitation events, as these can increase the presence of suspended material in water. High winds and tidal influences also contribute to turbidity events at this station by disturbing sediment from the river bed (Figure 25). Wind speed data was obtained from the Churchill River at 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.

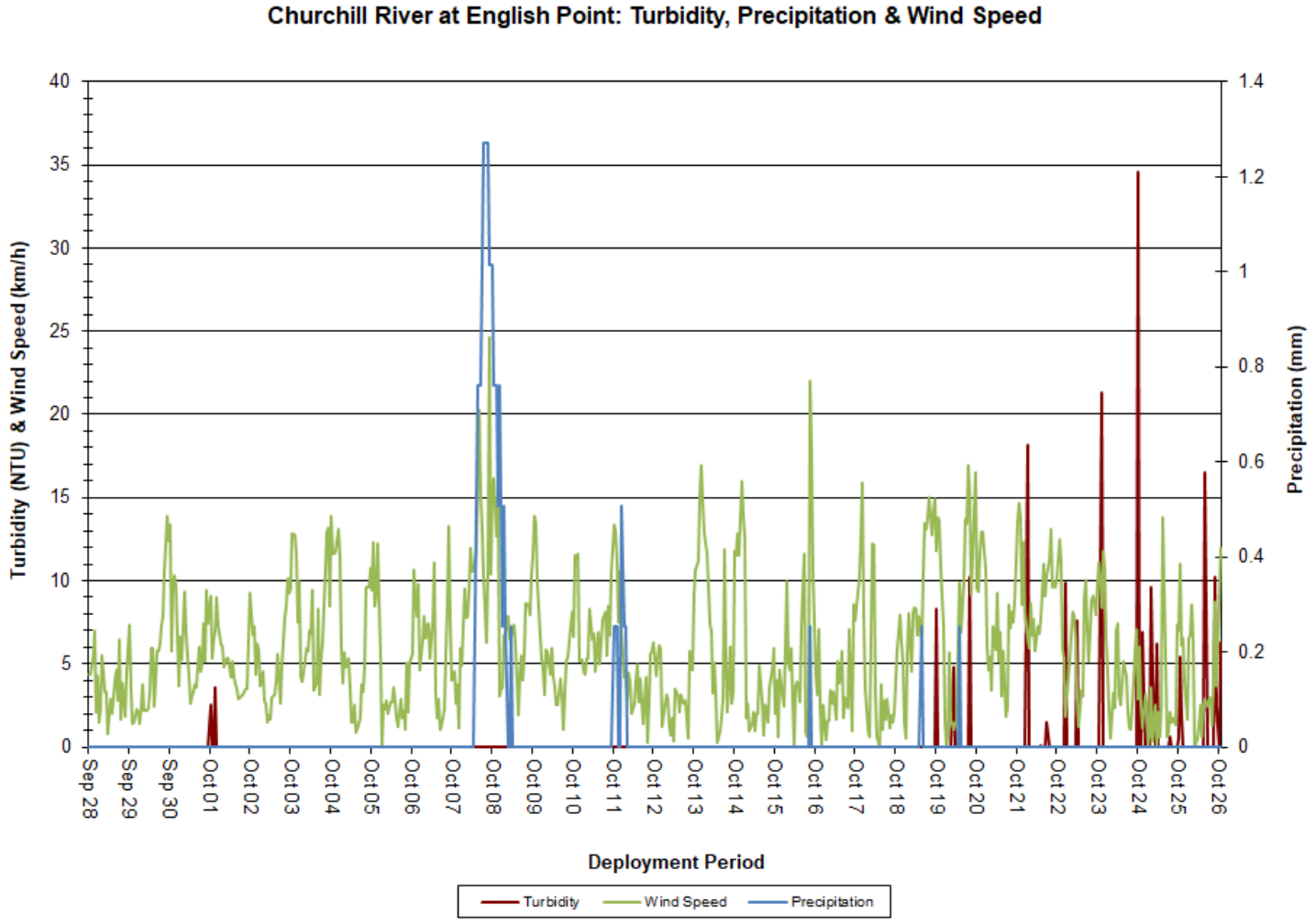

Figure 25: Turbidity, Precipitation & Wind Speed at Churchill River at English Point

Stage

- Over the deployment period, stage ranged from -0.352m to 0.442m, with a median value of -0.069m (Figure 26). Precipitation data was obtained from the Churchill River at 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.

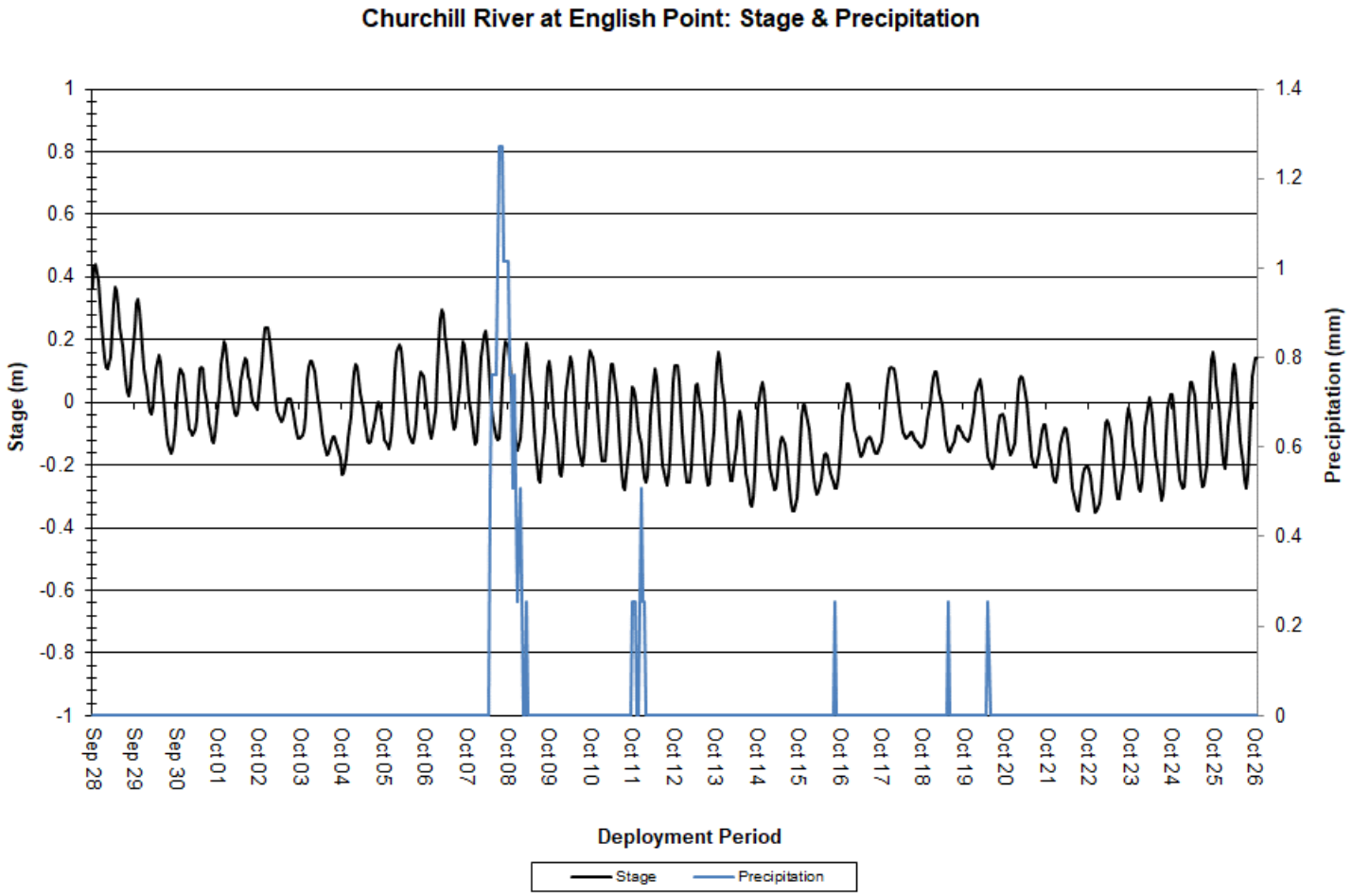

Figure 26: Stage & Precipitation at Churchill River at English Point

Conclusions

- Instruments at four water quality monitoring stations on the Lower Churchill River were deployed from September 21/28 through October 18/26, 2022.
- Water temperature decreased 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 September and October.
- 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 all stations.
- Specific conductivity was generally stable 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 increased over the course of deployment at all stations as water temperatures decreased into the fall. Dissolved oxygen levels are generally higher in water at cooler temperatures. Dissolved oxygen levels were above the CCME's Guidelines for the Protection of Early and Other Life Stages for the duration of deployment at all stations.
- Turbidity events occurred at all stations and were somewhat related to precipitation, wind or tidal events. Several stations experienced issues with turbidity sensors and sediment build-up around the instruments.

References

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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

Bureau Veritas Job #: C2S0076
Report Date: 2022/10/17

NL Department of Environment, Climate Change and Municipalities
Client Project #: RTWQ
Site Location: LABRADOR
Your P.O. #: 220028978-6
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TVX759 CR ABOVE GR								
Sampling Date 2022/09/21 13:15								
Matrix W								
Sample # 2022-6329-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	9.8	1.0	mg/L	N/A	2022/10/07		8251565
Nitrate (N)	-	ND	0.050	mg/L	N/A	2022/10/16		8251571
Total dissolved solids (calc., EC)	-	11	1.0	mg/L	N/A	2022/10/07		8251721
Inorganics								
Conductivity	-	20	1.0	uS/cm	N/A	2022/10/07	NGI	8270800
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2022/10/03	LKH	8258839
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/10/03	LKH	8258839
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2022/10/03	LKH	8258839
Total Alkalinity (Total as CaCO3)	-	8.5	2.0	mg/L	N/A	2022/10/07	NGI	8270803
Colour	-	26	5.0	TCU	N/A	2022/10/17	TGO	8283925
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/10/07	NGI	8270804
Total Kjeldahl Nitrogen (TKN)	-	0.20	0.10	mg/L	2022/09/30	2022/10/03	MJ1	8257978
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2022/10/16	KMC	8284153
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/10/14	TGO	8284154
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2022/10/11	TGO	8275677
Dissolved Organic Carbon (C)	-	4.2	0.50	mg/L	N/A	2022/10/04	RSL	8260570
Total Organic Carbon (C)	-	3.7	0.50	mg/L	N/A	2022/10/06	RSL	8268007
pH	-	7.15		pH	N/A	2022/10/07	NGI	8270802
Total Phosphorus	-	ND	0.004	mg/L	2022/09/30	2022/10/05	SPC	8258026
Total Suspended Solids	-	1.0	1.0	mg/L	2022/09/28	2022/10/05	RMK	8252361
Turbidity	-	0.38	0.10	NTU	N/A	2022/10/07	NGI	8271185
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/10/06	2022/10/06	FJO	8266183
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.039	0.0050	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Barium (Ba)	-	0.0074	0.0010	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Boron (B)	-	ND	0.050	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Calcium (Ca)	-	2.5	0.10	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Copper (Cu)	-	ND	0.00050	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Iron (Fe)	-	0.13	0.050	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Magnesium (Mg)	-	0.84	0.10	mg/L	2022/10/06	2022/10/06	JHY	8268212

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Bureau Veritas Job #: C2S0076
Report Date: 2022/10/17

NL Department of Environment, Climate Change and Municipalities
Client Project #: RTWQ
Site Location: LABRADOR
Your P.O. #: 220028978-6
Sampler Initials: MM

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TVX759 CR ABOVE GR Sampling Date 2022/09/21 13:15 Matrix W Sample # 2022-6329-00-SI-SP Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.0094	0.0020	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Potassium (K)	-	0.33	0.10	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Sodium (Na)	-	0.64	0.10	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Strontium (Sr)	-	0.012	0.0020	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Uranium (U)	-	ND	0.00010	mg/L	2022/10/06	2022/10/06	JHY	8268212
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/10/06	2022/10/06	JHY	8268212

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Bureau Veritas Job #: C2S8346
Report Date: 2022/10/25

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TXR436 CR ABOVE MF								
Sampling Date 2022/09/28 11:10								
Matrix W								
Sample # 2022-6330-00-SI-SP								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	9.4	1.0	mg/L	N/A	2022/10/18		8265416
Nitrate (N)	-	ND	0.050	mg/L	N/A	2022/10/24		8265420
Total dissolved solids (calc., EC)	-	11	1.0	mg/L	N/A	2022/10/13		8265426
Inorganics								
Conductivity	-	20	1.0	uS/cm	N/A	2022/10/12	AA0	8277417
Chloride (Cl-)	-	ND	1.0	mg/L	N/A	2022/10/07	LKH	8270326
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/10/07	LKH	8270326
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2022/10/07	LKH	8270326
Total Alkalinity (Total as CaCO3)	-	8.2	2.0	mg/L	N/A	2022/10/12	AA0	8277442
Colour	-	34	5.0	TCU	N/A	2022/10/24	TGO	8298281
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/10/12	AA0	8277478
Total Kjeldahl Nitrogen (TKN)	-	0.13	0.10	mg/L	2022/10/17	2022/10/17	RTY	8286903
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2022/10/24	TGO	8298301
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/10/22	TGO	8298305
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2022/10/14	TGO	8283582
Dissolved Organic Carbon (C)	-	4.8	0.50	mg/L	N/A	2022/10/13	RSL	8277791
Total Organic Carbon (C)	-	4.8	0.50	mg/L	N/A	2022/10/14	RSL	8282760
pH	-	7.19		pH	N/A	2022/10/12	AA0	8277426
Total Phosphorus	-	0.006	0.004	mg/L	2022/10/17	2022/10/19	SPC	8286915
Total Suspended Solids	-	3.2	1.0	mg/L	2022/10/05	2022/10/11	RMK	8266350
Turbidity	-	1.8	0.10	NTU	N/A	2022/10/19	AA0	8292268
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/10/14	2022/10/14	FJO	8280807
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.15	0.0050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Barium (Ba)	-	0.0080	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Boron (B)	-	ND	0.050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Calcium (Ca)	-	2.4	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Copper (Cu)	-	ND	0.00050	mg/L	2022/10/20	2022/10/21	JHY	8294921
Total Iron (Fe)	-	0.27	0.050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Magnesium (Mg)	-	0.84	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Manganese (Mn)	-	0.012	0.0020	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021

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Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TXR436 CR ABOVE MF Sampling Date 2022/09/28 11:10 Matrix W Sample # 2022-6330-00-SI-SP								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Potassium (K)	-	0.33	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Sodium (Na)	-	0.67	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Strontium (Sr)	-	0.012	0.0020	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Uranium (U)	-	ND	0.00010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/10/17	2022/10/17	JHY	8287021

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Bureau Veritas Job #: C2S8346
Report Date: 2022/10/25

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TXR437 CR @ EP								
Sampling Date 2022/09/28 12:10								
Matrix W								
Sample # 2022-6331-00-SI-SP								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	10	1.0	mg/L	N/A	2022/10/18		8265416
Nitrate (N)	-	ND	0.050	mg/L	N/A	2022/10/24		8265420
Total dissolved solids (calc., EC)	-	19	1.0	mg/L	N/A	2022/10/13		8265426
Inorganics								
Conductivity	-	34	1.0	uS/cm	N/A	2022/10/12	AA0	8277417
Chloride (Cl-)	-	4.8	1.0	mg/L	N/A	2022/10/07	LKH	8270326
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/10/07	LKH	8270326
Sulphate (SO4)	-	ND	1.0	mg/L	N/A	2022/10/07	LKH	8270326
Total Alkalinity (Total as CaCO3)	-	7.0	2.0	mg/L	N/A	2022/10/12	AA0	8277442
Colour	-	70	25	TCU	N/A	2022/10/24	TGO	8298281
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/10/12	AA0	8277478
Total Kjeldahl Nitrogen (TKN)	-	0.13	0.10	mg/L	2022/10/17	2022/10/17	RTY	8286903
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2022/10/24	TGO	8298301
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/10/22	TGO	8298305
Nitrogen (Ammonia Nitrogen)	-	0.11	0.050	mg/L	N/A	2022/10/14	TGO	8283582
Dissolved Organic Carbon (C)	-	6.7	0.50	mg/L	N/A	2022/10/13	RSL	8280538
Total Organic Carbon (C)	-	6.9	0.50	mg/L	N/A	2022/10/14	RSL	8282758
pH	-	6.95		pH	N/A	2022/10/12	AA0	8277426
Total Phosphorus	-	0.015	0.004	mg/L	2022/10/17	2022/10/19	SPC	8286915
Total Suspended Solids	-	7.6	2.0	mg/L	2022/10/05	2022/10/11	RMK	8266350
Turbidity	-	2.1	0.10	NTU	N/A	2022/10/19	AA0	8292268
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/10/14	2022/10/14	FJO	8280807
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.44	0.0050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Barium (Ba)	-	0.011	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Boron (B)	-	ND	0.050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Calcium (Ca)	-	2.2	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Chromium (Cr)	-	0.0013	0.0010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Copper (Cu)	-	0.0011	0.00050	mg/L	2022/10/20	2022/10/21	JHY	8294921
Total Iron (Fe)	-	0.93	0.050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Magnesium (Mg)	-	1.1	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Manganese (Mn)	-	0.031	0.0020	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021

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Bureau Veritas Job #: C2S8346
Report Date: 2022/10/25

NL Department of Environment, Climate Change and Municipalities
Your P.O. #: 220028978-6

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TXR437 CR @ EP Sampling Date 2022/09/28 12:10 Matrix W Sample # 2022-6331-00-SI-SP								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Potassium (K)	-	0.56	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Sodium (Na)	-	3.7	0.10	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Strontium (Sr)	-	0.016	0.0020	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Uranium (U)	-	ND	0.00010	mg/L	2022/10/17	2022/10/17	JHY	8287021
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/10/17	2022/10/17	JHY	8287021

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