Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
August 1, 2022 to October 13, 2022

Newfoundland Labrador

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

Waterford River at Kilbride, Newfoundland and Labrador

Prepared by:

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Department of Environment & Climate Change
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GENERAL

The Water Resources Management Division (WRMD), in partnership with Water Survey of Canada -Environment and Climate Change Canada (WSC-ECCC), maintain a real-time water quality and water quantity monitoring station on Waterford River at Kilbride.

The purpose of the real-time water quality station is to monitor, process and publish real-time water quality data.

This deployment report discusses water quality related events occurring at this station from the instrument deployment on August 1, 2022 until removed on October 13, 2022.

Figure 1: Waterford River at Kilbride Real-Time Water Quality and Quantity 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. The procedure is based on the approach used by the United States Geological Survey (Table 1).

At deployment and removal, a QA/QC Sonde is temporarily deployed adjacent to the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments**.** Based on the degree of difference between the parameters on the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 2).

WRMD staff at the Department of Environment & Climate Change (ECC) are responsible for maintaining and calibrating the water quality instrument, as well as grooming, analyzing and reporting on water quality data recorded at the station.

WSC staff are responsible for the data logging/communication aspect of the network and maintenance of the water quantity monitoring equipment. WSC staff visit the site regularly to ensure the data logging and data transmitting equipment are working properly, and are responsible for handling stage and streamflow data issues. The water quantity data is transmitted via satellite and published online with the water quality data on the WRMD website. Water quantity data has not been corrected or groomed when published online or used in the monthly reports for the stations. WSC is responsible for QA/QC of water quantity data. Corrected stage and streamflow data can be obtained upon request to WSC.

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 > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be divided into subgroups of: temperature dependent, temperature compensated and temperature independent. Due to the temperature sensor's location on the sonde, the entire sonde must be at a constant temperature before the temperature sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is recorded to early it may not accurately portray the water body.

Table 2: Instrument performance rankings for Waterford River at Kilbride

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Waterford River @ Kilbride	**August 1, 2022**	**Deployment**	Excellent	Good	Good	Excellent	Excellent
		Grab Sample # 1724	N/A	Good	Excellent	N/A	Excellent
	October 13, 2022	**Removal**	Excellent	Excellent	Fair	Fair	Excellent

Waterford River at Kilbride, Newfoundland and Labrador

Upon deployment, all sensors ranked ‘Excellent’ and ‘Good’ when compared to the QA/QC sonde recorded measurements.

All measured grab sample (#2022-1724-00-SI-SP) parameters ranked ‘Excellent’ in comparison to the field sonde with exception of a pH ranking of ‘Good’.

Upon removal of the instrument, parameters ranked ‘Excellent’ and ‘Fair’ against the QA/QC sonde after a 74-day deployment period.

DATA INTERPRETATION

Water Temperature

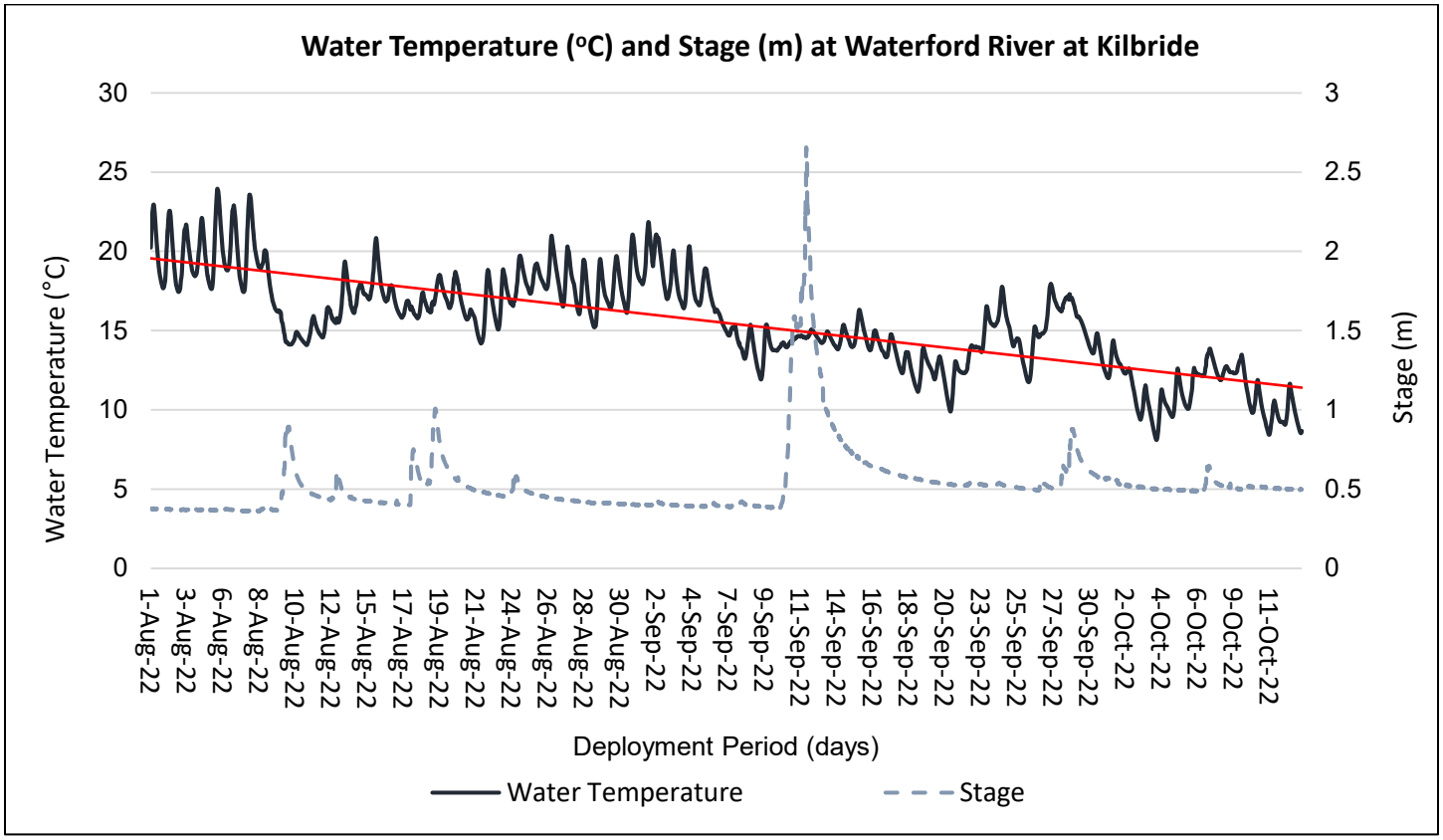
Water temperature ranged from 8.10 °C to 23.95 °C during this deployment period (Figure 2).

The water temperature was variable throughout the deployment period with an overall decreasing trend throughout the fall season, as expected for this time of year.

During high stage events, the water temperature often decreased for a short period due to the addition of cooler precipitation, as seen on August 10th, August 19th, 2022, and on September 29th, 2022. A notable precipitation event occurred from September 11-12, 2022, resulting in a spike in stage to a maximum of 2.66 meters. This stage increase caused significant flooding of the local area. (See Appendix A).

Water temperature values display a natural diurnal pattern with temperatures increasing during the day and decreasing overnight. The magnitude of variation was influenced by daily air temperature fluctuations as well as precipitation events.

Please note the stage data is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.



Mean	Median	Min	Max
15.48	15.46	8.10	23.95

Figure 2: Water temperature (°C) and Stage (m) values at Waterford River at Kilbride

pH

Throughout the deployment period, pH baseline values were stable, with a range between 6.87 pH units and 7.49 pH units, a mean of 7.12 and median of 7.10 pH units (Figure 3).

The CCME guideline for the protection of aquatic life states the requirement of a minimum pH value of 6.5 and maximum value of 9.0. The CCME guideline provides a basis by which to judge the overall health of the brook. Waterford River pH values remained within the guidelines throughout the duration of the deployment period with exception to September 12, 2022. pH level decreased temporarily below the minimum guideline due to a significant precipitation event and then returned to background levels as the stage returned to baseline levels.

pH values are temperature dependent as well as influenced by photosynthesis and respiration by aquatic organisms. Dissolved oxygen concentrations decrease throughout the day as CO_2 is extracted via photosynthesis at a faster rate than it is produced through respiration. Overnight, dissolved CO_2 concentration increases, as the rate of CO_2 production is greater than that of photosynthetic consumption. Carbon dioxide dissolved in water yields a slightly acidic solution and as such, a decrease in pH is observed.

A diurnal variation pattern was visible throughout the deployment period. The magnitude of variation correlates to daily water temperature range, length of days and fluctuations in photosynthesis and respiration rates as expected at this time of the year. Variation was influenced by higher stage events due to the addition of lower pH rainwater, as seen on August 10, August 19, and on September 29, 2022. The significant rainfall event from September 10 to 12, 2022 decreased diurnal variation significantly from the middle to end of September as indicated in Figure #7.

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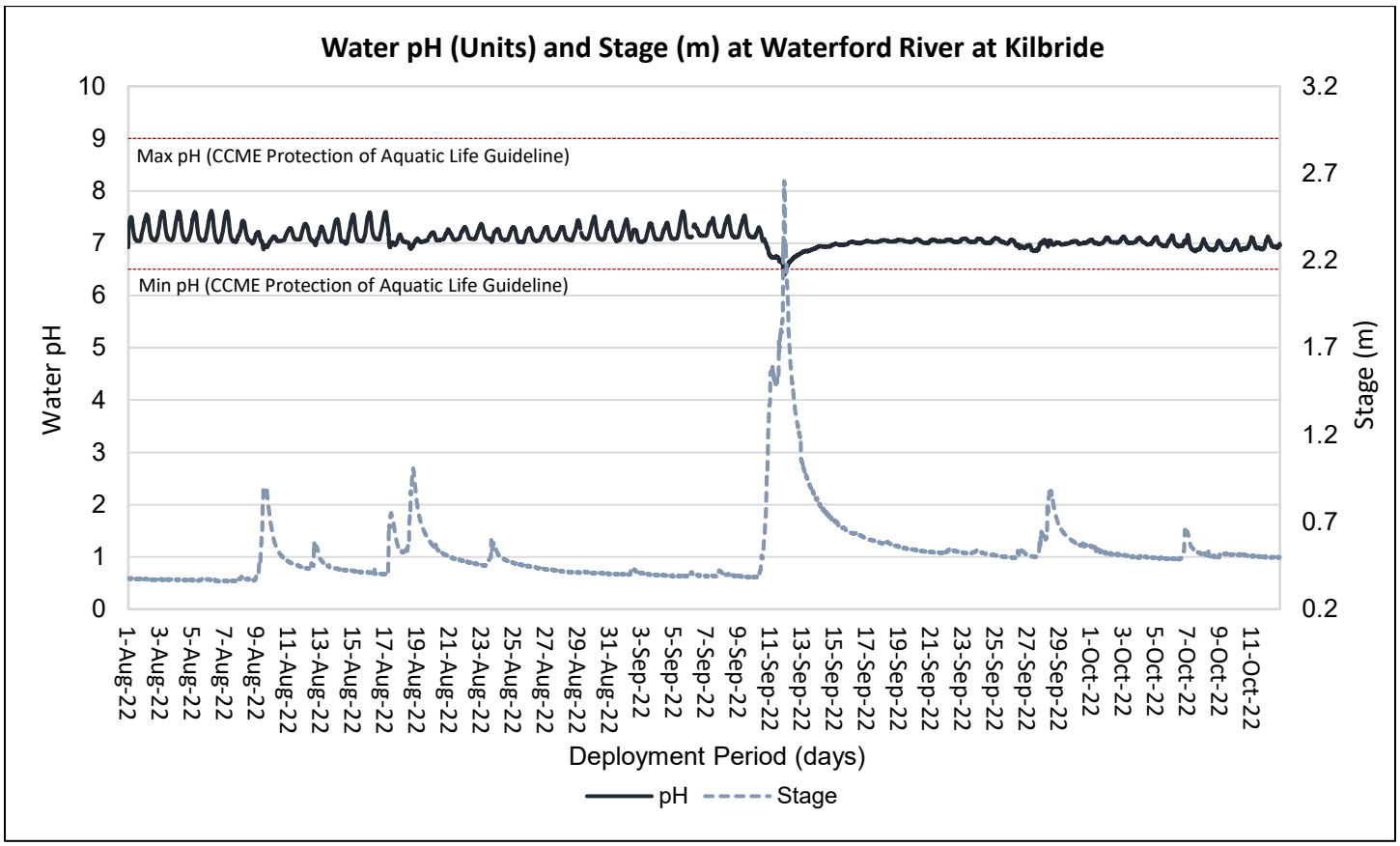


Mean	Median	Min	Max
7.09	7.06	6.38	7.62

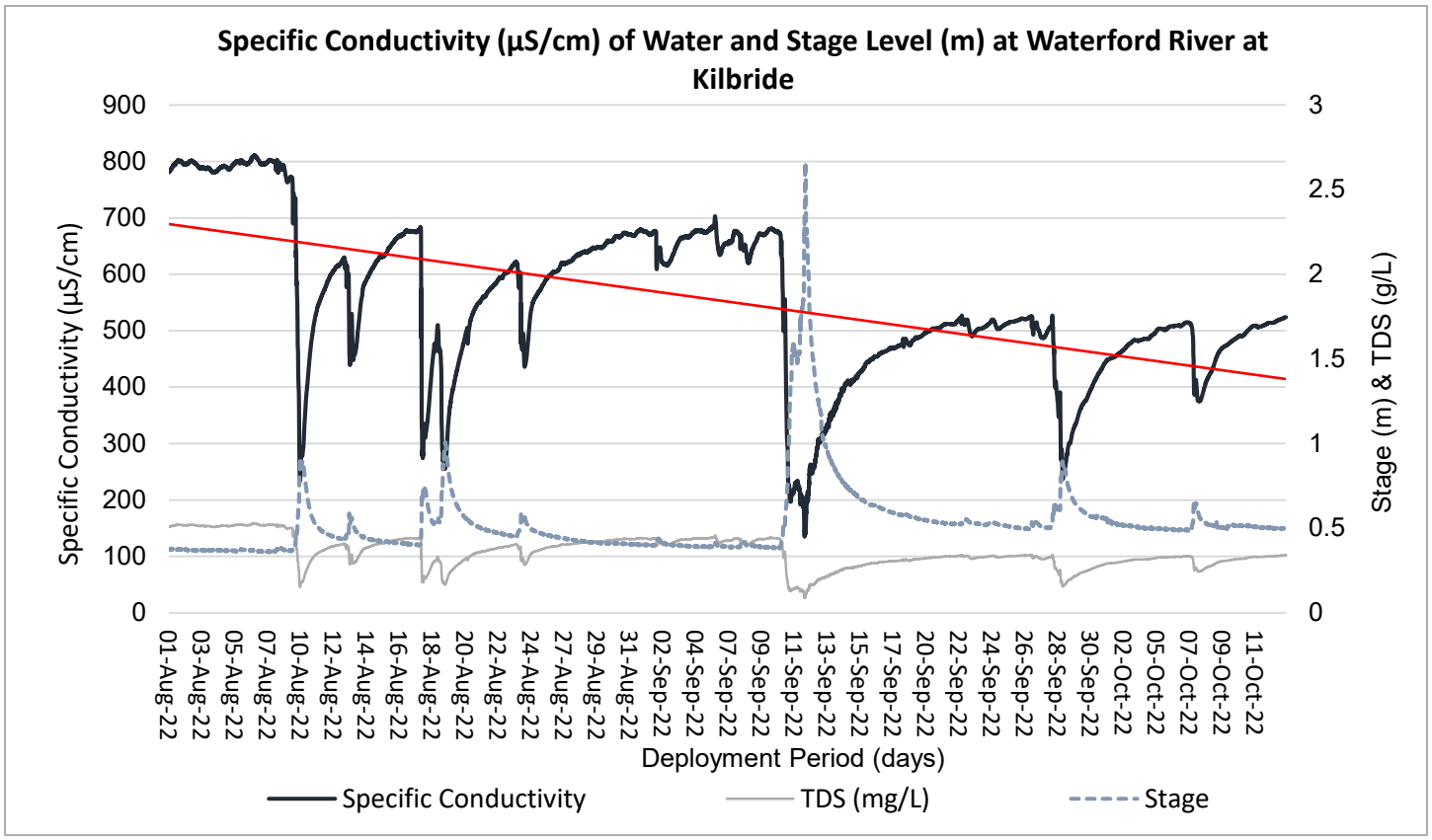
Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride.

Specific Conductivity & Total Dissolved Solids

Conductivity levels continually decreased from August 1 to October 13, 2022 as depicted in Figure 4. The conductivity levels were within 135.0 µS/cm and 811.0 µS/cm. TDS (a calculated value) ranged from 0.0880 g/L to 0.5270 g/L.

Throughout the deployment period, conductivity levels at Waterford River decreased during high stage events before rebounding slightly as seen during the precipitation event from September 10-12, 2022. This is a result of the dilution of minerals and dissolved material present in the brook and short term flushing before returning to background levels. Given the location, the river is highly influenced by urban roads, residential housing and pedestrian traffic.

Please note that the stage data is raw. It is not corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data can be obtained upon request to WSC.



	Mean	Median	Min	Max
Specific Conductivity (µS/cm)	551.7	519.0	135.0	811.0
TDS (mg/L)	0.3586	0.3380	0.0880	0.5270

Figure 4: Specific conductivity (µS/cm), TDS (g/mL) and stage (m) values at Waterford River at Kilbride.

Dissolved Oxygen

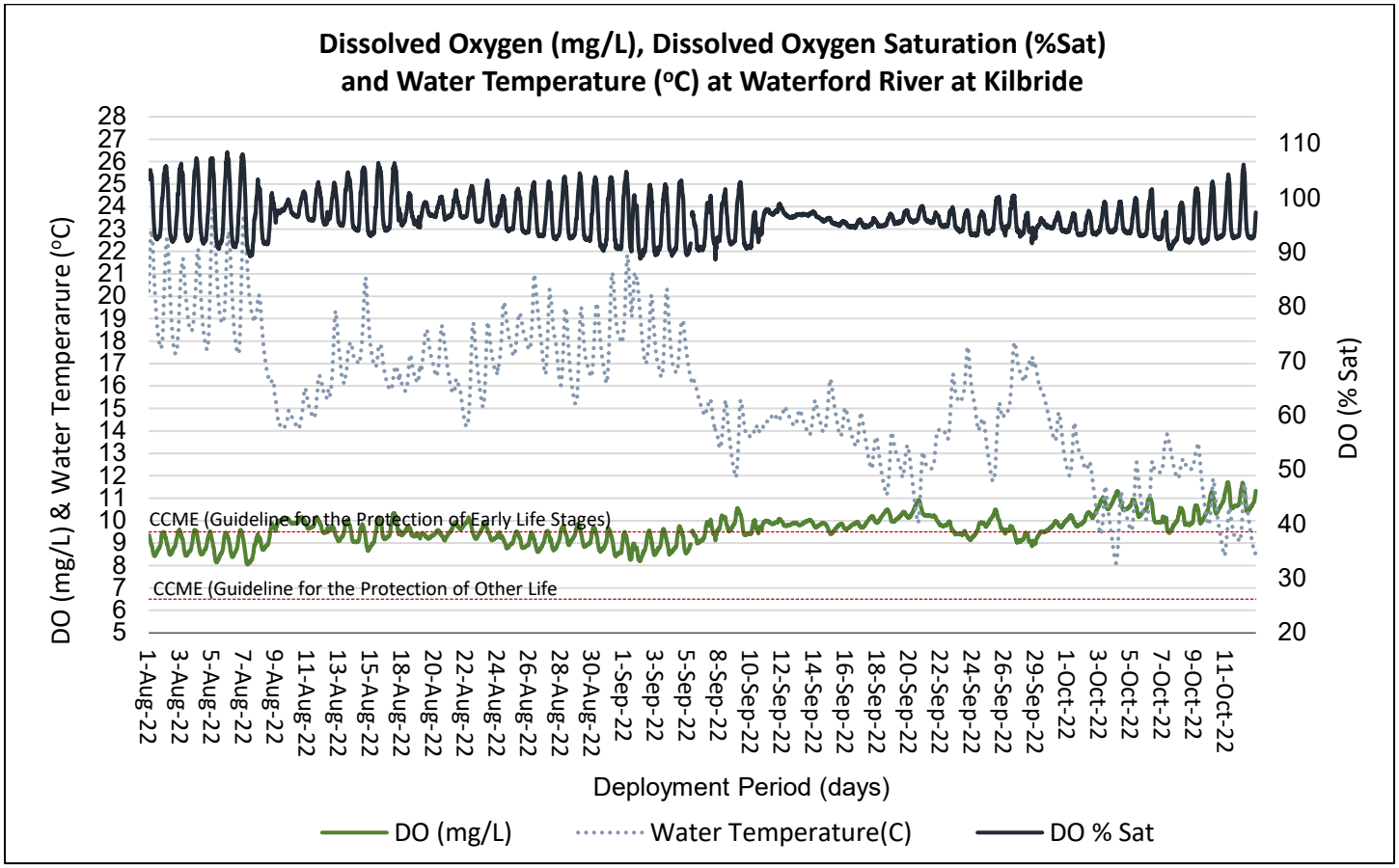
Dissolved oxygen is a metabolic requirement of aquatic plants and animals. The concentration of oxygen in water depends on many factors, especially temperature – the saturation of oxygen in water is inversely proportional to water temperature. Oxygen concentrations also tend to be higher in flowing water compared to still, lake environments. Low oxygen concentrations can give an indication of excessive decomposition of organic matter or the presence of oxidizing materials.

The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account the water temperature.

During the deployment, dissolved oxygen concentration levels range within a minimum of 8.05 mg/L to a maximum of 11.71 mg/L. The percent saturation (%) levels for dissolved oxygen ranged within 88.7% to 108.5% saturation (Figure 5). Dissolved oxygen (% Saturation) readings of greater than 100% air saturation can occur in ambient water because of the production of pure oxygen by photosynthetically-active organisms and/or because of non-ideal equilibration of dissolved oxygen between the water and the air above it.

A gradual increase in dissolved oxygen concentration was observed in correlation with natural cooling water temperatures. Sudden increases in dissolved oxygen are most likely in relation to a decrease in water temperature and an increase in stage and flow rate.

Dissolved oxygen concentrations remained above the Guideline for Other Life Stages (6.5 mg/L) and predominantly near and above the CCME Guideline for the Protection of Early life stages (9.5mg/L) throughout the deployment period.



	Mean	Median	Min	Max
DO (%Sat)	96.3	95.9	88.7	108.5
DO (mg/L)	9.63	9.64	8.05	11.71

Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment period range from -0.3 NTU and 259.5 NTU, with a mean of 2.8 NTU and median of 0.8 NTU (Figure 6).

Turbidity events above baseline values are the result of higher stage events and an associated increase in flow. The turbidity spike (259.5 NTU) observed on September 10th-12th, 2022 (Figure 6) correlates with a significant increase in stage, where a high volume of precipitation fell within a short period of time. This increased the presence of suspended material in water through the movement of runoff, soil and sediment from nearby urban areas.

Sediments and debris can also become temporarily lodged within the sonde casing during normal water flow and cause increases in turbidity values as observed on October 1, 2022.

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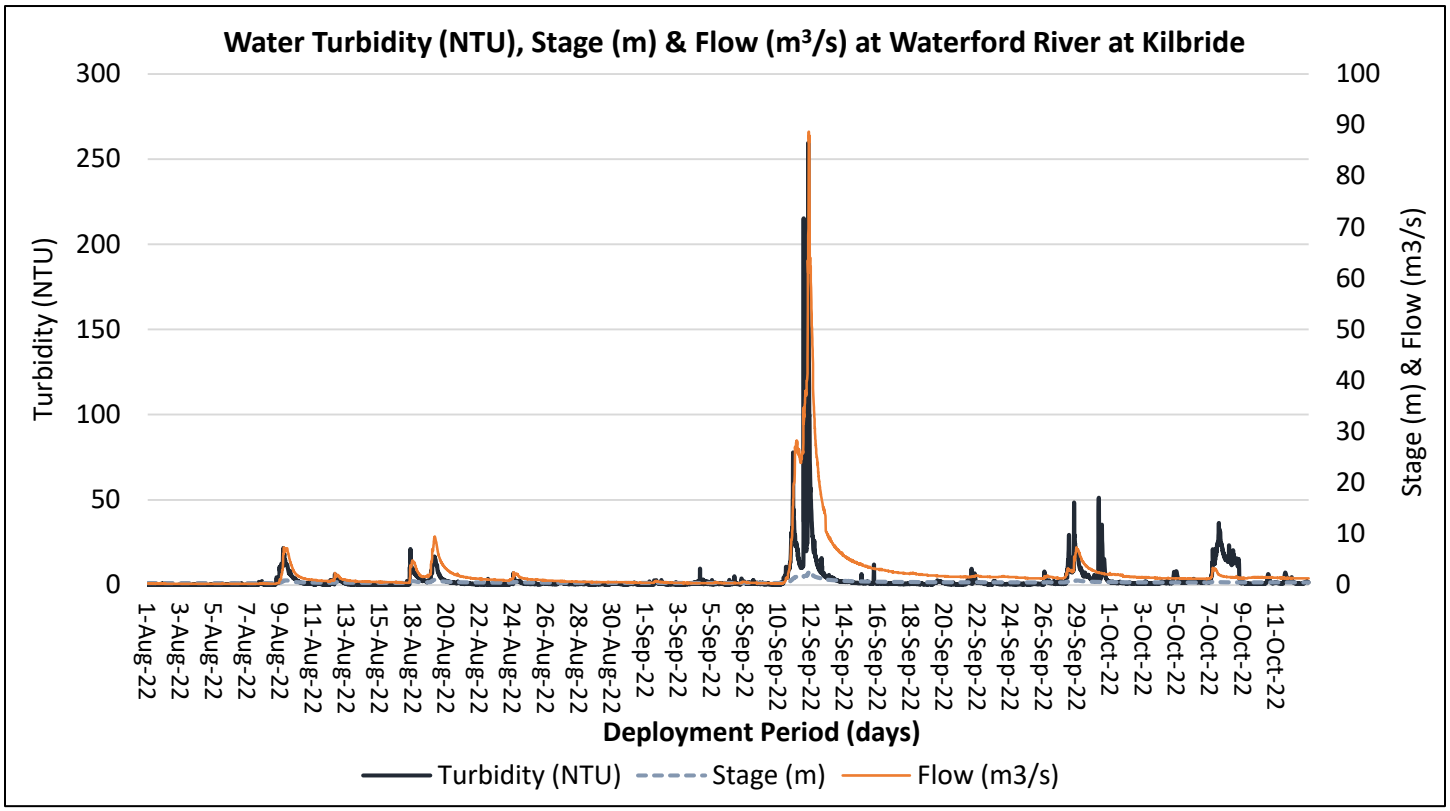


Mean	Median	Min	Max
2.8	0.80	-0.3	259.5

Figure 6: Turbidity (NTU) and stage (m) values at Waterford River at Kilbride.

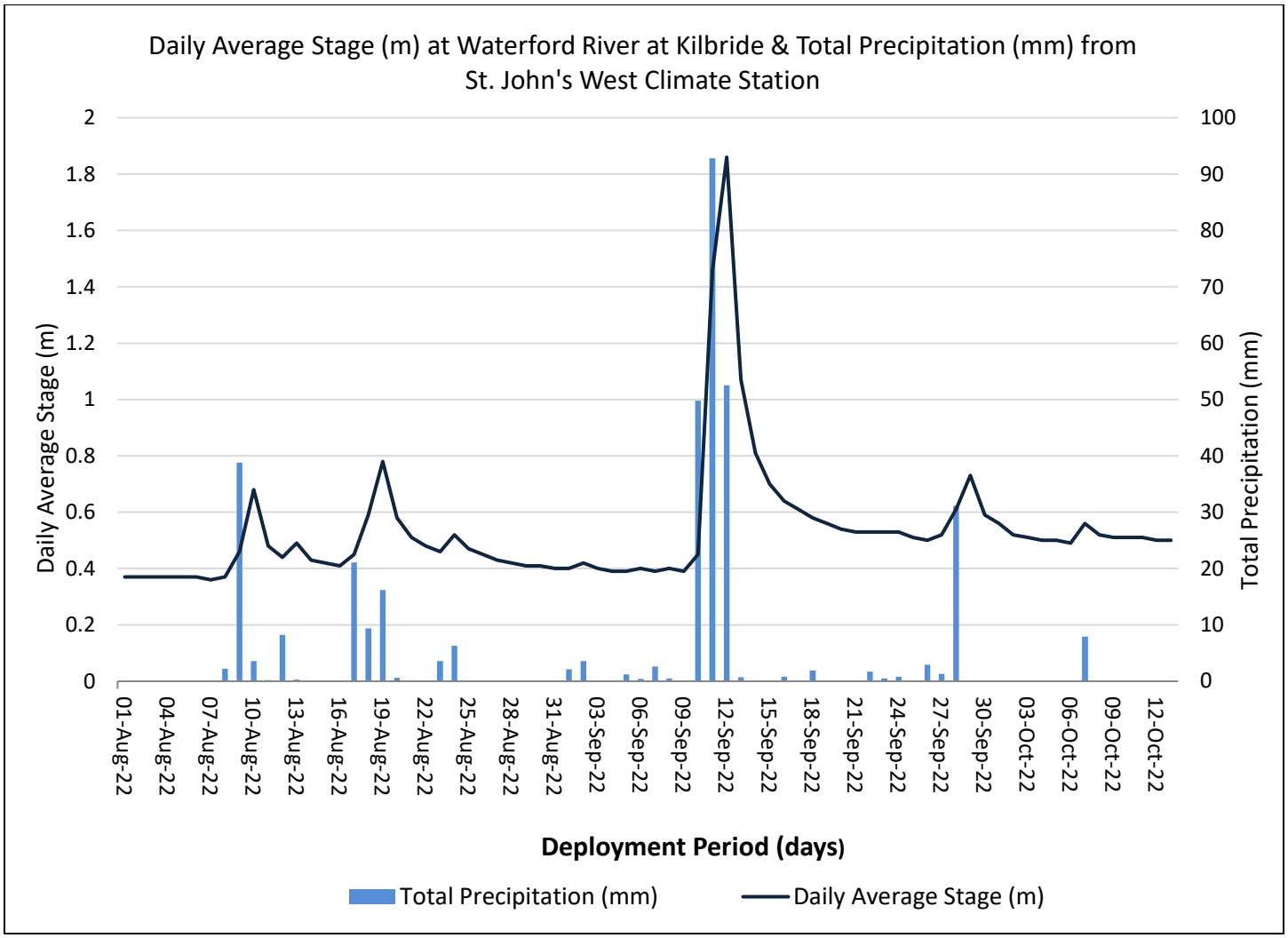
Stage and Precipitation

Please note the stage data graphed below is raw data. It has not been corrected for backwater effect. WSC is responsible for QA/QC of water quantity data. Corrected data is available upon request to WSC.

Stage is an estimation of water level at the station and can explain some of the events that are occurring with other parameters (i.e. specific conductivity, DO, turbidity). Stage will increase during rainfall events as depicted in Figure 7.

During the deployment period, the stage values range from 0.367 m to 2.66 m. The larger peaks in stage correspond with substantial rainfall events. On September 10-12, 2022, a total of 195.1 mm of rain fell causing significant flooding within the local area. Baseline stage level remained high for the remainder of the deployment period.

Precipitation data was collected by Environment Canada's St. John's West Climate station. Daily Total Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 92.8 mm on September 11, 2022.

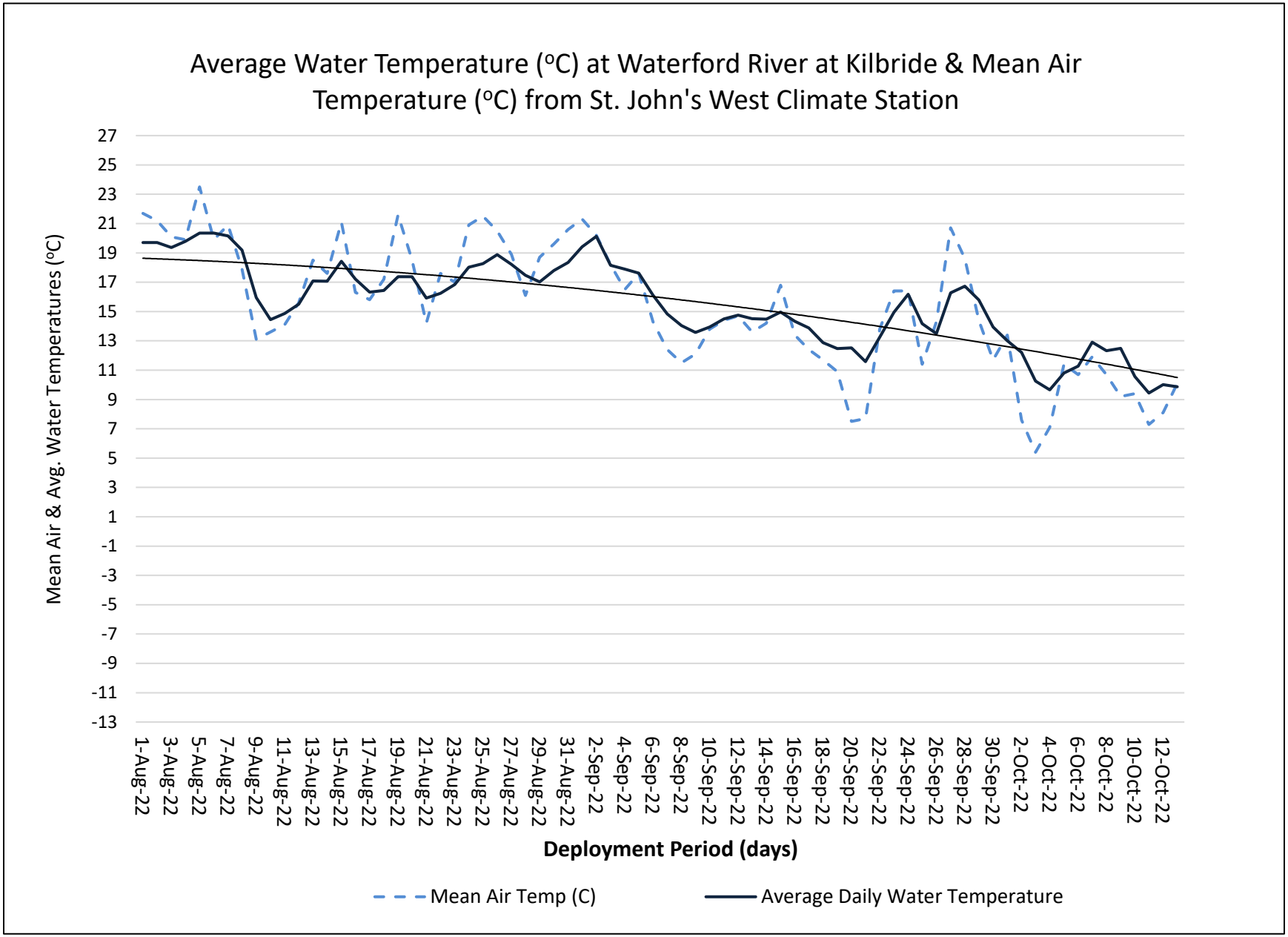


Mean	Median	Min	Max
0.53	0.50	0.36	2.66

Figure 7: Daily average stage (m) values recorded at Waterford River at Kilbride and daily total precipitation (mm) from St. John's West Climate Station.

APPENDIX A : MEAN DAILY AIR TEMPERATURE AND AVERAGE WATER TEMPERATURE

Waterford River at Kilbride, Newfoundland and Labrador



APPENDIX B : QA/QC GRAB SAMPLE FIELD RESULTS

Your P.O. #: 220028978-6
Site Location: WATERFORD RIVER @KILBRIDE
Your C.O.C. #: N/A, 2022-1724-00-TI-RE

Attention: Janice McCarthy

NL Department of Environment, Climate Change and Municipalities
Water Resources
PO Box 8700
St. John's, NL
CANADA A1B 4J6

Report Date: 2022/08/15
Report #: R7254146
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2L9228
Received: 2022/08/03, 10:14

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity	1	N/A	2022/08/08	ATL SOP 00142	SM 23 2320 B
Anions (1)	1	N/A	2022/08/10	CAM SOP-00435	SM 23 4110 B m
Colour	1	N/A	2022/08/09	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (2)	1	N/A	2022/08/08	ATL SOP 00203	SM 23 5310B m
Conductance - water	1	N/A	2022/08/08	ATL SOP 00004	SM 23 2510B m
Fluoride	1	N/A	2022/08/08	ATL SOP 00043	SM 23 4500-F- C m
Hardness (calculated as CaCO3)	1	N/A	2022/08/09	ATL SOP 00048	Auto Calc
Mercury - Total (CVAA,LL)	1	2022/08/08	2022/08/08	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Total MS	1	2022/08/08	2022/08/08	ATL SOP 00058	EPA 6020B R2 m
Nitrogen Ammonia - water	1	N/A	2022/08/09	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	1	N/A	2022/08/09	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	1	N/A	2022/08/09	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	1	N/A	2022/08/10	ATL SOP 00018	ASTM D3867-16
pH (3)	1	N/A	2022/08/08	ATL SOP 00003	SM 23 4500-H+ B m
Calculated TDS (DW Pkg)	1	N/A	2022/08/08	N/A	Auto Calc
Total Kjeldahl Nitrogen in Water (1)	1	2022/08/10	2022/08/11	CAM SOP-00938	OMOE E3516 m
Organic carbon - Total (TOC) (2)	1	N/A	2022/08/08	ATL SOP 00203	SM 23 5310B m
Total Phosphorus (Colourimetric) (1)	1	2022/08/10	2022/08/12	CAM SOP-00407	SM 23 4500-P I
Total Suspended Solids	1	2022/08/05	2022/08/08	ATL SOP 00007	SM 23 2540D m
Turbidity	1	N/A	2022/08/09	ATL SOP 00011	EPA 180.1 R2 m

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.

(1) This test was performed by Bureau Veritas Mississauga, 6740 Campobello Rd , Mississauga, ON, L5N 2L8
(2) TOC / DOC present in the sample should be considered as non-purgeable TOC / DOC.
(3) The APHA Standard Method require pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the APHA Standard Method holding time.

Your P.O. #: 220028978-6
Site Location: WATERFORD RIVER @KILBRIDE
Your C.O.C. #: N/A, 2022-1724-00-TI-RE

Attention: Janice McCarthy

NL Department of Environment, Climate Change and Municipalities
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PO Box 8700
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Report Date: 2022/08/15
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Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2L9228
Received: 2022/08/03, 10:14

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Maryann Comeau, Customer Experience Supervisor/PM
Email: Maryann.COMEAU@bureauveritas.com
Phone# (902)420-0203 Ext:298

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Bureau Veritas Job #: C2L9228
Report Date: 2022/08/15

NL Department of Environment, Climate Change and Municipalities
Site Location: WATERFORD RIVER @KILBRIDE
Your P.O. #: 220028978-6
Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TIY162 WATERFORD RIVER								
Sampling Date 2022/08/01 13:17								
Matrix W								
Sample # 2022-1724-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	53	1.0	mg/L	N/A	2022/08/09		8146560
Nitrate (N)	-	0.59	0.050	mg/L	N/A	2022/08/10		8146564
Total dissolved solids (calc., EC)	-	440	1.0	mg/L	N/A	2022/08/08		8147783
Inorganics								
Conductivity	-	800	1.0	uS/cm	N/A	2022/08/08	NGI	8152652
Chloride (Cl-)	-	210	2.0	mg/L	N/A	2022/08/10	SUR	8157143
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/08/10	SUR	8157143
Sulphate (SO4)	-	16	1.0	mg/L	N/A	2022/08/10	SUR	8157143
Total Alkalinity (Total as CaCO3)	-	23	2.0	mg/L	N/A	2022/08/08	NGI	8152654
Colour	-	13	5.0	TCU	N/A	2022/08/09	TGO	8153280
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/08/08	NGI	8152655
Total Kjeldahl Nitrogen (TKN)	-	0.10	0.10	mg/L	2022/08/10	2022/08/11	RTY	8157953
Nitrate + Nitrite (N)	-	0.61	0.050	mg/L	N/A	2022/08/09	TGO	8153278
Nitrite (N)	-	0.018	0.010	mg/L	N/A	2022/08/09	TGO	8153274
Nitrogen (Ammonia Nitrogen)	-	0.086	0.050	mg/L	N/A	2022/08/09	TGO	8149993
Dissolved Organic Carbon (C)	-	3.1	0.50	mg/L	N/A	2022/08/08	JHH	8152631
Total Organic Carbon (C)	-	3.4	0.50	mg/L	N/A	2022/08/08	JHH	8152627
pH	-	7.44		pH	N/A	2022/08/08	NGI	8152653
Total Phosphorus	-	0.011	0.004	mg/L	2022/08/10	2022/08/12	SSV	8159615
Total Suspended Solids	-	1.2	1.0	mg/L	2022/08/05	2022/08/08	A1M	8149187
Turbidity	-	0.54	0.10	NTU	N/A	2022/08/09	NGI	8154953
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/08/08	2022/08/08	FJO	8149838
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.027	0.0050	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Barium (Ba)	-	0.020	0.0010	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Boron (B)	-	ND	0.050	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Calcium (Ca)	-	17	0.10	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Copper (Cu)	-	0.0025	0.00050	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Iron (Fe)	-	0.12	0.050	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Magnesium (Mg)	-	2.5	0.10	mg/L	2022/08/08	2022/08/08	JHY	8152634

Bureau Veritas 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

Bureau Veritas Job #: C2L9228
Report Date: 2022/08/15

NL Department of Environment, Climate Change and Municipalities
Site Location: WATERFORD RIVER @KILBRIDE
Your P.O. #: 220028978-6
Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TIY162 WATERFORD RIVER								
Sampling Date 2022/08/01 13:17								
Matrix W								
Sample # 2022-1724-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.036	0.0020	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Potassium (K)	-	1.7	0.10	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Sodium (Na)	-	120	0.10	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Strontium (Sr)	-	0.067	0.0020	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Uranium (U)	-	ND	0.00010	mg/L	2022/08/08	2022/08/08	JHY	8152634
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/08/08	2022/08/08	JHY	8152634

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Site Location: WATERFORD RIVER @KILBRIDE
Your P.O. #: 220028978-6
Sampler Initials: LB

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	20.7°C

Average temperature >10°C.

Results relate only to the items tested.

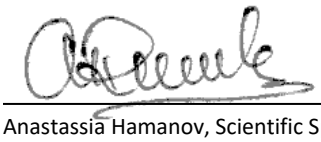
Bureau Veritas 200 Bluewater Rd, Suite 105, Bedford, Nova Scotia Canada B4B 1G9 Tel: 902-420-0203 Toll-free: 800-565-7227 Fax: 902-420-8612 www.bvlabs.com

Bureau Veritas Job #: C2L9228
Report Date: 2022/08/15

NL Department of Environment, Climate Change and Municipalities
Site Location: WATERFORD RIVER @KILBRIDE
Your P.O. #: 220028978-6
Sampler Initials: LB

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:



Anastassia Hamanov, Scientific Specialist

Colleen Acker, B.Sc, Scientific Service Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

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