

Real-Time Water Quality Report

Waterford River at Kilbride

Deployment Period
August 3, 2021 to December 6, 2021



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

Waterford River at Kilbride, Newfoundland and Labrador

Water Resources Management Division
Department of Environment & Climate Change
4th Floor, Confederation Building, West Block
PO Box 8700, St. John's NL A1B 4J6

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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 instrument deployment on August 3, 2021 until removal on December 6, 2021.



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

Parameter	Rank				
	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 dependant, 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 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 3	Deployment	Excellent	Excellent	Excellent	Excellent	Excellent
		Grab Sample # 1999	N/A	Excellent	Excellent	N/A	Excellent
	December 6	Removal	Excellent	Excellent	Excellent	Excellent	Excellent

Waterford River at Kilbride, Newfoundland and Labrador

Upon deployment, all sensors ranked 'Excellent'. The grab sample #1999 measured parameters ranked 'Excellent' in comparison to the field sonde.

At removal of the instrument, all parameters ranked 'Excellent' against the QA/QC sonde, despite the long deployment period of 126 days.

Deployment Note

At 126 days, this deployment period was significantly longer than normal due to COVID-19 restrictions and issues with removing the instrument from its casing.

DATA INTERPRETATION

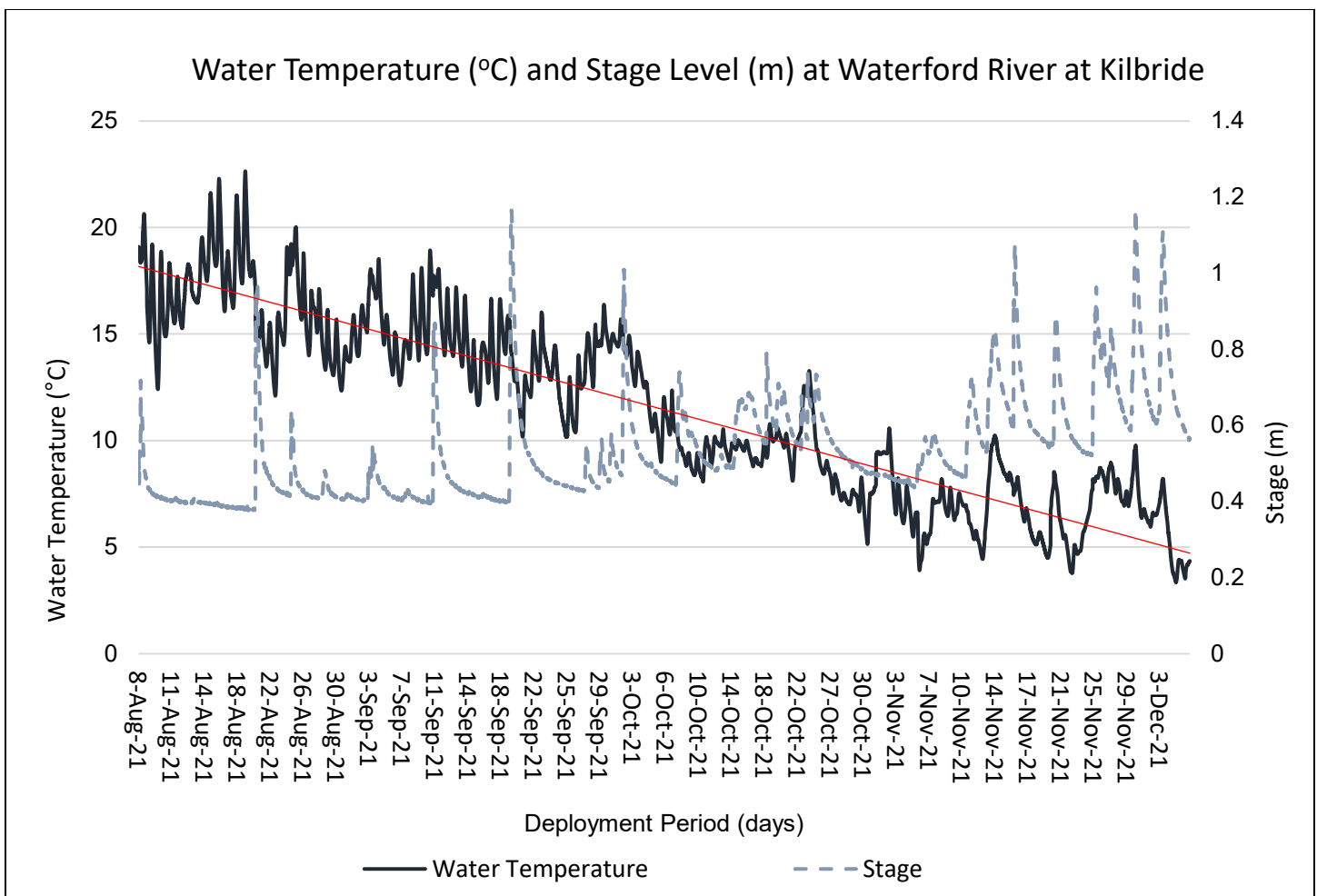
Water Temperature

Water temperature ranged from 3.35 °C to 23.39 °C during this deployment period (Figure 2).

Over the duration of the deployment period, the water temperature in correlation with air temperatures decreased into and throughout fall season (see Appendix A). Water temperatures dip during and for a short time after higher stage events, which is likely the result of cool rainfall.

Water temperature values display a natural diurnal pattern with temperatures increasing during the day and temperatures decreasing overnight. All brooks and ambient waterways have natural diurnal patterns.

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
11.76	11.86	3.35	23.93

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

pH

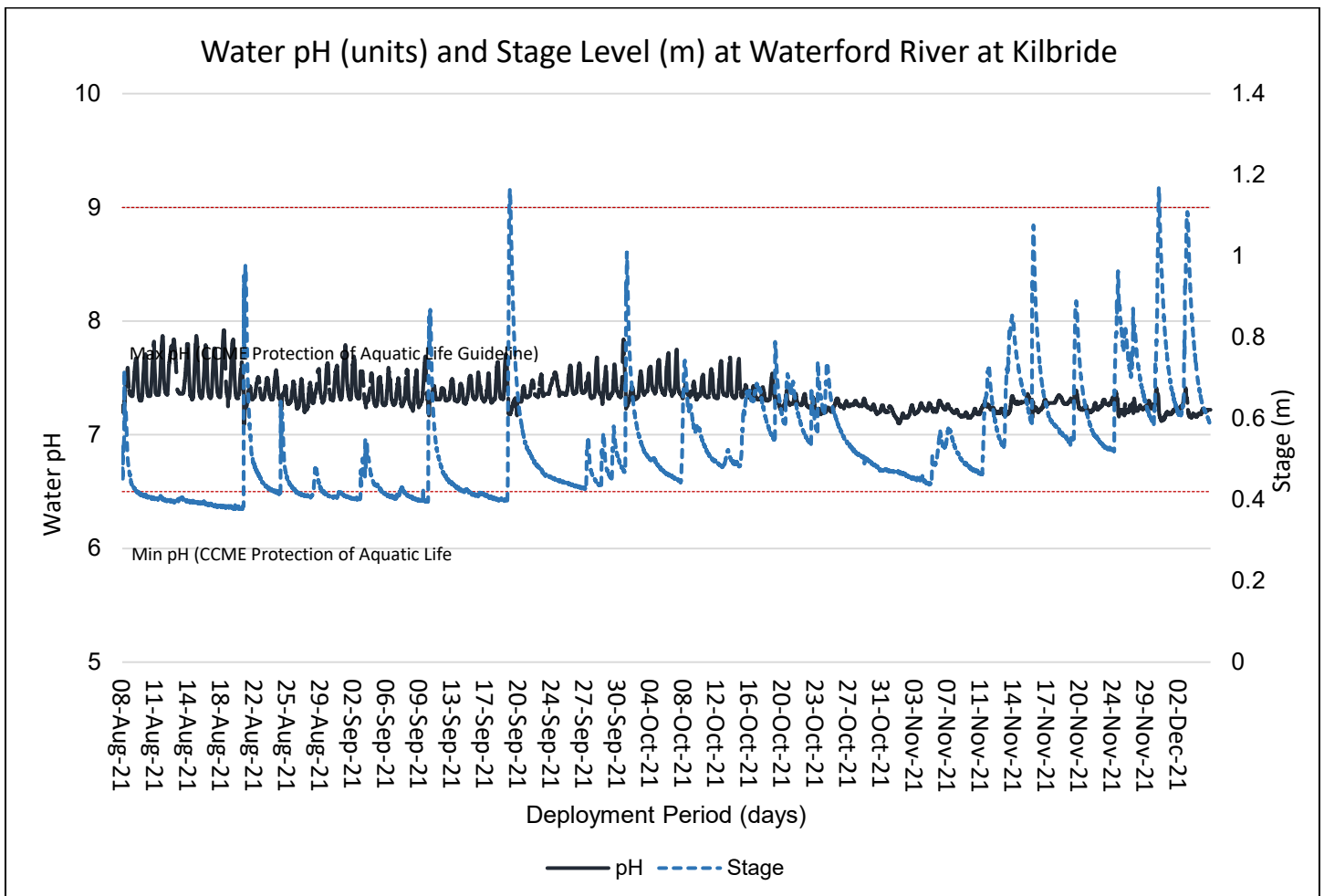
Throughout the deployment period, pH values were relatively stable and ranged between 6.85 pH units and 7.92 pH units, with a mean of 7.35 and median of 7.33 pH units (Figure 3).

The CCME guideline for the protection of aquatic life states the requirement of a minimum pH value of 6.5 and max 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 for the duration of the long deployment.

pH values are temperature dependant as well as influenced by photosynthesis and respiration by aquatic organisms. The concentration of dissolved carbon dioxide in the water throughout the day, especially overnight when oxygen production is reduced relative to carbon dioxide levels. Carbon dioxide dissolved in water yields a slightly acidic solution.

The diurnal variation pattern was visible throughout the deployment period. The magnitude of variation decreased over time in correlation to the smaller daily water temperature range and length of days as expected at this time of the year.

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
7.35	7.33	6.85	7.92

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

Specific Conductivity & Total Dissolved Solids

The conductivity concentration levels were within 166 $\mu\text{S}/\text{cm}$ and 1114 $\mu\text{S}/\text{cm}$ during this deployment period. TDS (a calculated value) ranged from 0.1080 g/L to 0.7240 g/L (Figure 4).

Throughout the deployment period conductivity levels at Waterford decreased during high stage events before rebounding slightly. This is likely a result of the minerals and dissolved material present in the brook being diluted and flushed for a short period of time before returning to background levels. Larger than normal spikes in conductivity were observed on November 6th and 19th. These may be a result of road salts being washed into the brook (See Figure 7). Given the location, the river is highly influenced by urban roads, residential housing and pedestrian traffic.

Please note 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.

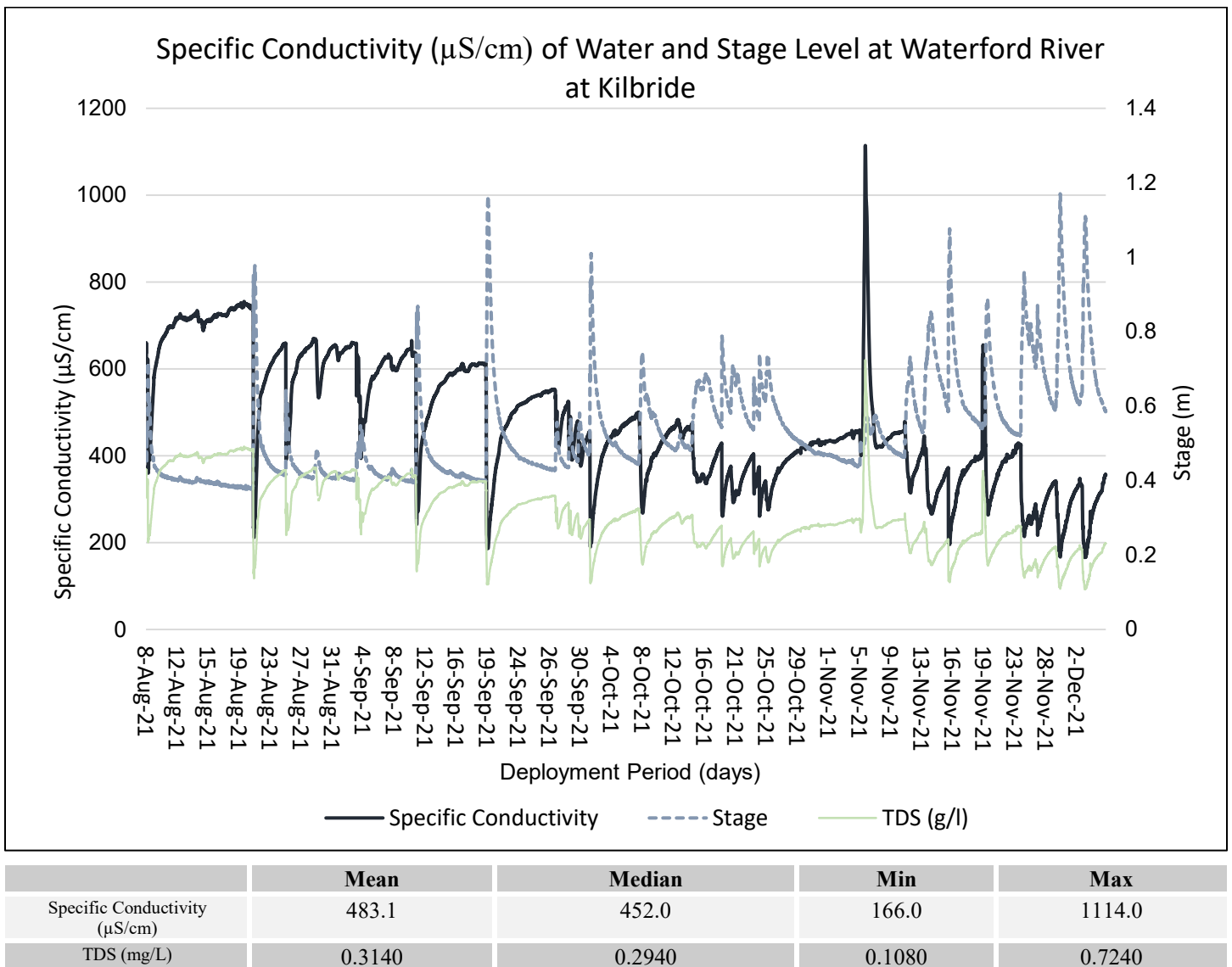


Figure 4: Specific conductivity ($\mu\text{S}/\text{cm}$), TDS (g/L) and stage (m) values at Waterford River at Kilbride.

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.

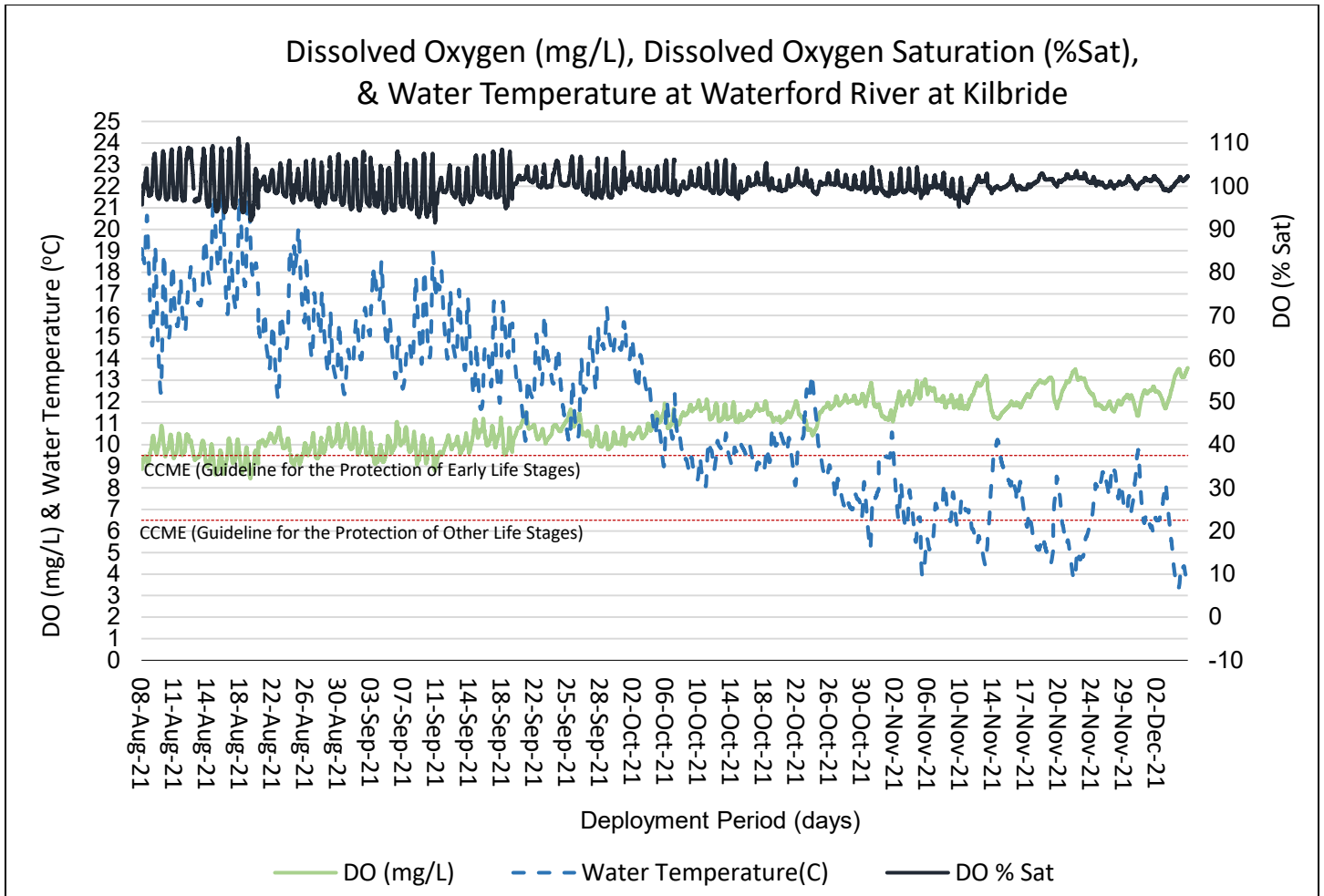
The water quality instrument measures dissolved oxygen (mg/L) with the dissolved oxygen probe. The instrument then calculates percent saturation (% Sat) taking into account the water temperature.

During the deployment, the dissolved oxygen concentration levels ranged within a minimum of 8.43 mg/L to a maximum of 13.61 mg/L. The percent saturation levels for dissolved oxygen ranged within 91.5 % Saturation to 111.2 % Saturation (Figure 5).

The majority of the dissolved oxygen values remained above the CCME Guideline for the Protection of Early life stages (9.5mg/L) and other life stages (6.5 mg/L), dropping below 9.5 mg/L in late summer when water temperatures were warmest.

A considerable increase in dissolved oxygen was observed in early October, in correlation with a significant decrease in water temperature at this time (Figure 2). This is considered a natural occurrence as the transition from fall/winter season begins.

Diurnal variation was most visible from August through the middle of October. The magnitude of variation from the beginning of October throughout the remainder of the deployment period decreased in correlation to the lowering daily water/air temperature range and the length of days.



	Mean	Median	Min	Max
DO (%Sat)	100.3	100.3	91.5	111.2
DO (mg/L)	10.96	10.94	8.43	13.61

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

Turbidity

Turbidity levels during the deployment ranged within -0.2 NTU and 807.0 NTU, with a mean of 5.8 NTU and median of 1.1 NTU (Figure 6).

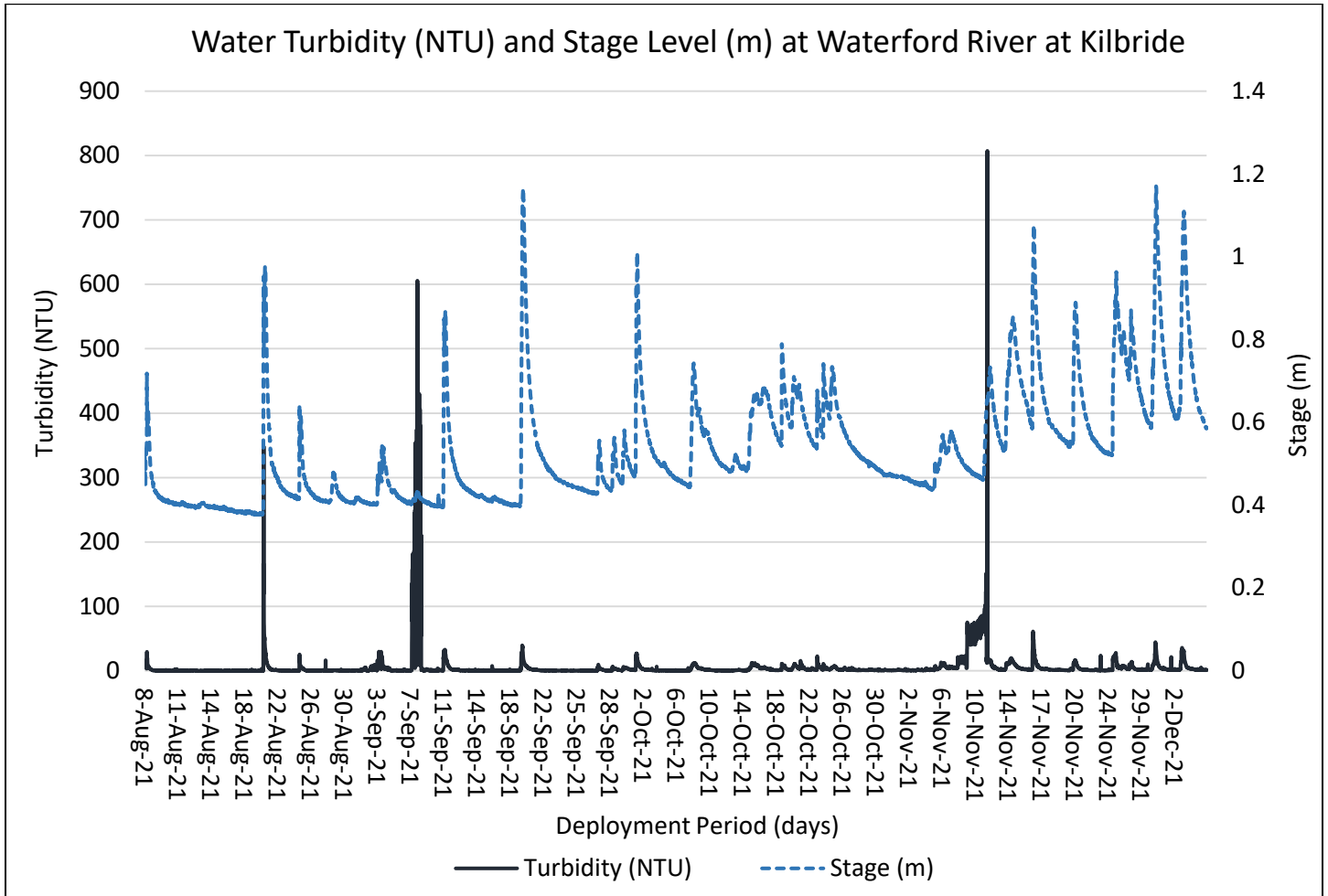
Turbidity measurements over the majority of the deployment period indicated very low turbidity including negative values. This situation is most likely to happen when measuring low-level turbidity. Natural variations in all measurements, instrument and non-instrument related, can lead to a negative result. Some other turbidimeters are designed to round up a negative number to 0.00 NTU, since a result of less than 0.00 NTU is theoretically impossible. However, in practice, these results are actually quite meaningful. The problem could be operator technique or sonde error. It could also indicate a problem with the low turbidity/turbidity-free water used for a blank or a problem with the calibration. If the meter rounds the negative result to 0.00 NTU, the user will not be alerted to a potential problem.

The higher turbidity events correlate with increases in stage. Rainfall was recorded during all of the high stage increases (see Figure 7). Precipitation can increase the presence of suspended material in water through the movement of soil and

Waterford River at Kilbride, Newfoundland and Labrador

sediment from nearby urban areas. Sediments and debris can temporarily become lodged within the sonde casing during precipitation events and cause spikes in turbidity values. This may be what occurred on November 11, 2021.

Please note the stage data is raw. 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
Stage (m)	5.8	1.1	-0.2	807.0

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

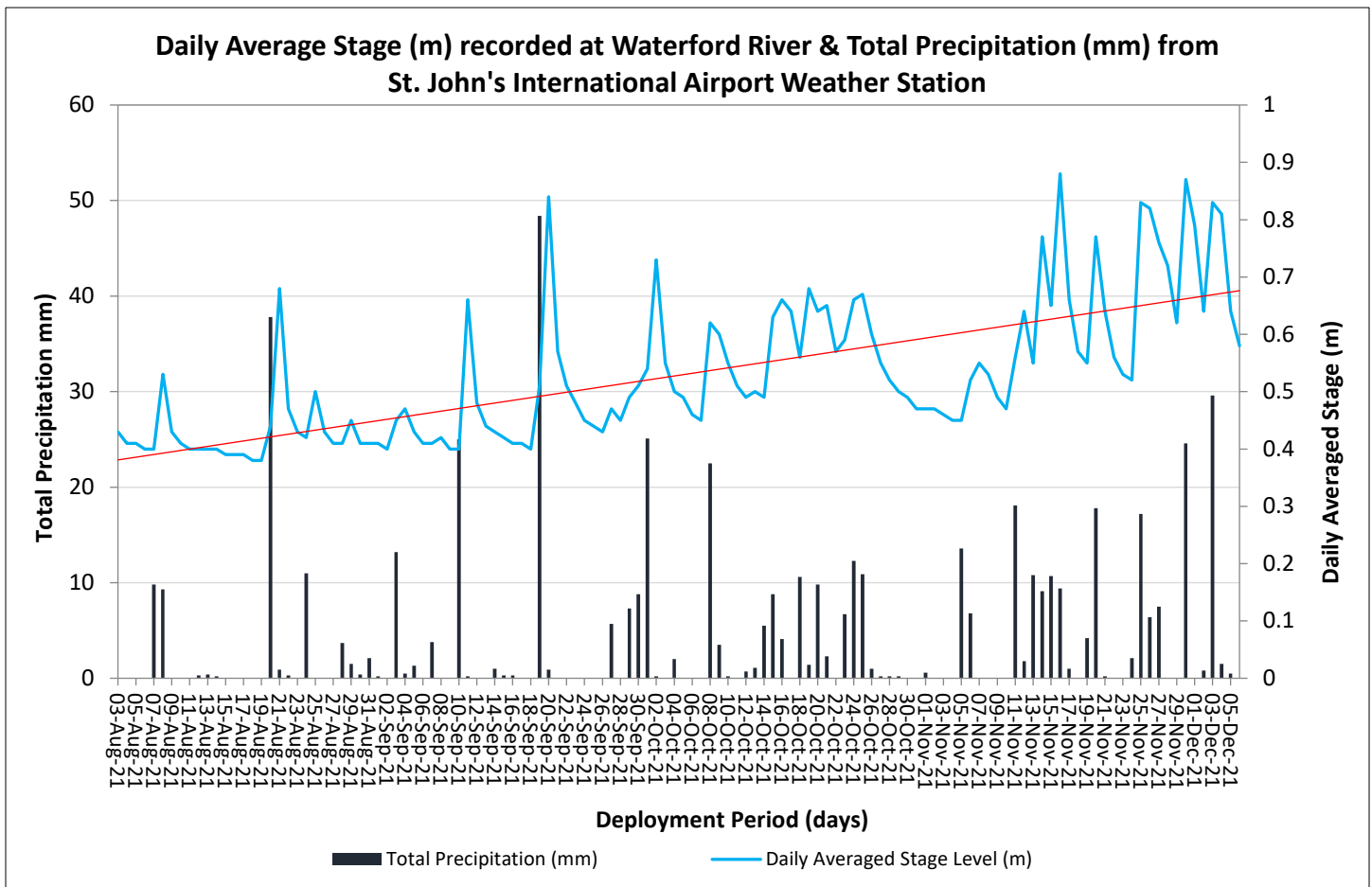
Stage and Precipitation

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 (Figure 7) and during any surrounding snow or ice melt, as runoff will collect in the brooks. However, direct snowfall will not cause stage to rise significantly.

During the deployment period, the stage values ranged from 0.38m to 1.17m. The larger peaks in stage correspond with substantial rainfall events as noted on Figure 7. Precipitation data was collected by Environment Canada’s St. John’s International Airport weather station. Daily Total Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 48.4 mm on September 19, 2021.

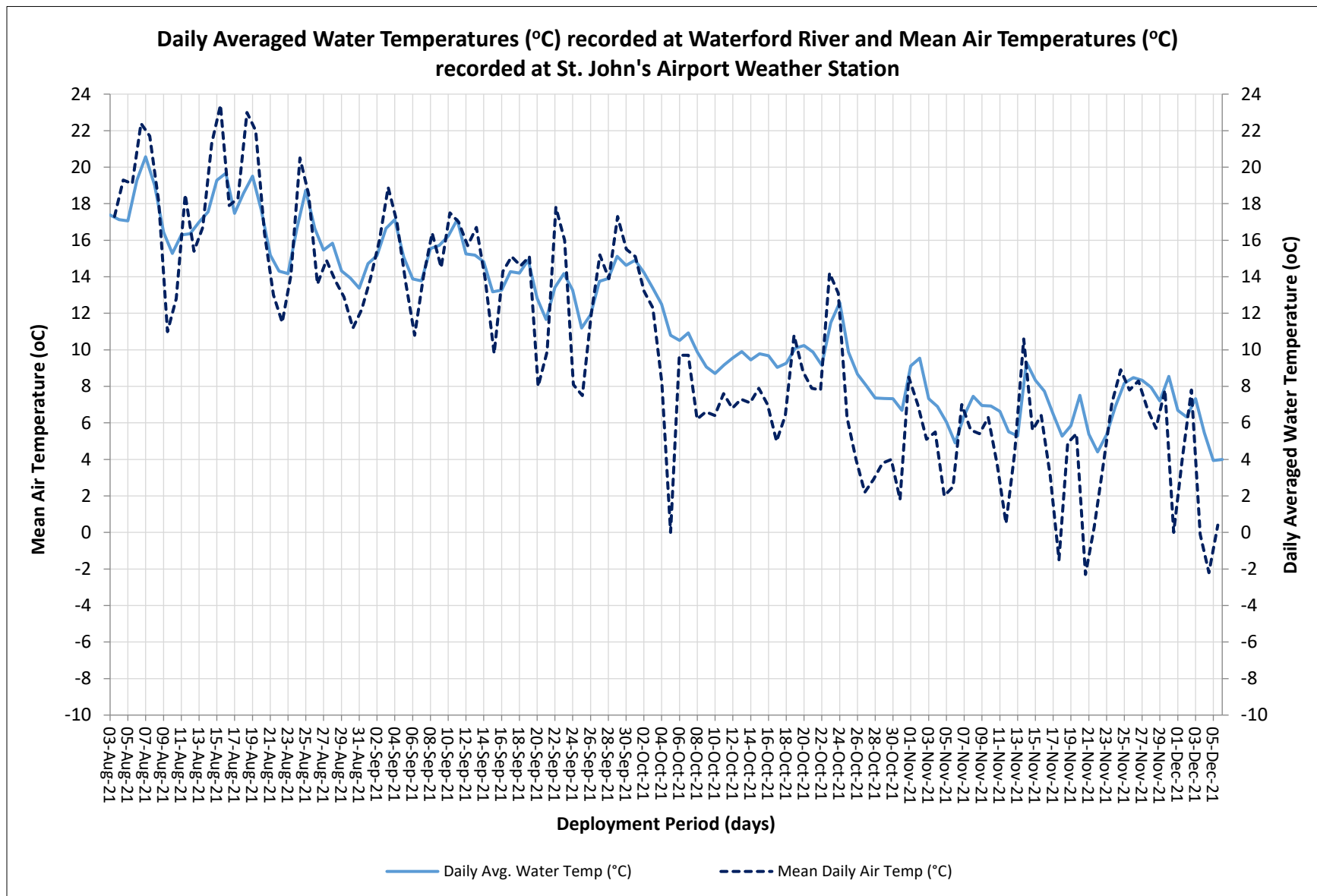
An increase in the daily average stage trend was observed throughout the deployment period as a result of consistent precipitation events throughout the deployment period.



	Mean	Median	Min	Max
Stage (m)	0.53	0.49	0.38	1.17

Figure 7: Stage values recorded at Waterford River at Kilbride and daily total precipitation from St. John’s Airport Weather Station.

APPENDIX A : MEAN DAILY AIR TEMPERATURE AND AVERAGE WATER TEMPERATURE



APPENDIX B : QA/QC GRAB SAMPLE FIELD RESULTS



Your P.O. #: 220028978-5
 Your C.O.C. #: N/A

Attention: Robert Richard Harvey

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

Report Date: 2021/08/17
 Report #: R6769404
 Version: 1 - Final

CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1M3456

Received: 2021/08/09, 09:10

Sample Matrix: Water
 # Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Alkalinity	1	N/A	2021/08/12	ATL SOP 00013	EPA 310.2 R1974 m
Anions (1)	1	N/A	2021/08/13	CAM SOP-00435	SM 23 4110 B m
Colour	1	N/A	2021/08/12	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (2)	1	N/A	2021/08/10	ATL SOP 00203	SM 23 5310B m
Conductance - water	1	N/A	2021/08/11	ATL SOP 00004	SM 23 2510B m
Fluoride	1	N/A	2021/08/11	ATL SOP 00043	SM 23 4500-F- C m
Hardness (calculated as CaCO3)	1	N/A	2021/08/11	ATL SOP 00048	Auto Calc
Mercury - Total (CVAA,LL)	1	2021/08/12	2021/08/12	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Total MS	1	2021/08/10	2021/08/10	ATL SOP 00058	EPA 6020B R2 m
Nitrogen Ammonia - water	1	N/A	2021/08/12	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	1	N/A	2021/08/12	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	1	N/A	2021/08/12	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	1	N/A	2021/08/12	ATL SOP 00018	ASTM D3867-16
pH (3)	1	N/A	2021/08/11	ATL SOP 00003	SM 23 4500-H+ B m
Calculated TDS (DW Pkg)	1	N/A	2021/08/11	N/A	Auto Calc
Total Kjeldahl Nitrogen in Water (1)	1	2021/08/12	2021/08/12	CAM SOP-00938	OMOE E3516 m
Organic carbon - Total (TOC) (2)	1	N/A	2021/08/10	ATL SOP 00203	SM 23 5310B m
Total Phosphorus (Colourimetric) (1)	1	2021/08/12	2021/08/13	CAM SOP-00407	SM 23 4500 P B H m
Total Suspended Solids	1	2021/08/10	2021/08/13	ATL SOP 00007	SM 23 2540D m
Turbidity	1	N/A	2021/08/10	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

(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. #: 220028978-5
Your C.O.C. #: N/A

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CERTIFICATE OF ANALYSIS

BV LABS JOB #: C1M3456
Received: 2021/08/09, 09:10

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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Report Date: 2021/08/17

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Your P.O. #: 220028978-5

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QIA680 WATERFORD RIVER AT KILBRIDE								
Sampling Date		2021/08/03 13:15						
Matrix		W						
Sample #		2021-1999-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	48	1.0	mg/L	N/A	2021/08/11		7507863
Nitrate (N)	-	0.56	0.050	mg/L	N/A	2021/08/12		7507867
Total dissolved solids (calc., EC)	-	390	1.0	mg/L	N/A	2021/08/11		7508459
Inorganics								
Conductivity	-	700	1.0	uS/cm	N/A	2021/08/11	SHW	7512632
Chloride (Cl-)	-	200	1.0	mg/L	N/A	2021/08/13	FD	7516676
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2021/08/13	FD	7516676
Sulphate (SO4)	-	16	1.0	mg/L	N/A	2021/08/13	FD	7516676
Total Alkalinity (Total as CaCO3)	-	25	5.0	mg/L	N/A	2021/08/12	EMT	7513539
Colour	-	18	5.0	TCU	N/A	2021/08/12	EMT	7513554
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2021/08/11	SHW	7512636
Total Kjeldahl Nitrogen (TKN)	-	0.21	0.10	mg/L	2021/08/12	2021/08/12	MJ1	7515331
Nitrate + Nitrite (N)	-	0.56	0.050	mg/L	N/A	2021/08/12	EMT	7513558
Nitrite (N)	-	ND	0.010	mg/L	N/A	2021/08/12	EMT	7513559
Nitrogen (Ammonia Nitrogen)	-	0.050	0.050	mg/L	N/A	2021/08/12	EMT	7515133
Dissolved Organic Carbon (C)	-	3.5	0.50	mg/L	N/A	2021/08/10	NGI	7510126
Total Organic Carbon (C)	-	3.7	0.50	mg/L	N/A	2021/08/10	NGI	7510309
pH	-	7.52		pH	N/A	2021/08/11	SHW	7512635
Total Phosphorus	-	0.020	0.004	mg/L	2021/08/12	2021/08/13	SSV	7515602
Total Suspended Solids	-	1.8	1.0	mg/L	2021/08/10	2021/08/13	GTH	7510172
Turbidity	-	1.4	0.10	NTU	N/A	2021/08/10	SHW	7510147
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2021/08/12	2021/08/12	NHU	7512966
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.039	0.0050	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Antimony (Sb)	-	ND	0.0010	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Arsenic (As)	-	ND	0.0010	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Barium (Ba)	-	0.017	0.0010	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Boron (B)	-	ND	0.050	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Cadmium (Cd)	-	0.000010	0.000010	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Calcium (Ca)	-	15	0.10	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Chromium (Cr)	-	ND	0.0010	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Copper (Cu)	-	0.0016	0.00050	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Iron (Fe)	-	0.20	0.050	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Lead (Pb)	-	ND	0.00050	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Magnesium (Mg)	-	2.5	0.10	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Manganese (Mn)	-	0.036	0.0020	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Nickel (Ni)	-	ND	0.0020	mg/L	2021/08/10	2021/08/10	MLB	7510075



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Report Date: 2021/08/17

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Municipalities
Your P.O. #: 220028978-5

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
QIA680 WATERFORD RIVER AT KILBRIDE								
Sampling Date		2021/08/03 13:15						
Matrix		W						
Sample #		2021-1999-00-SI-SP						
Registration #		WS-S-0000						
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Selenium (Se)	-	ND	0.00050	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Sodium (Na)	-	110	0.10	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Strontium (Sr)	-	0.059	0.0020	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Uranium (U)	-	ND	0.00010	mg/L	2021/08/10	2021/08/10	MLB	7510075
Total Zinc (Zn)	-	ND	0.0050	mg/L	2021/08/10	2021/08/10	MLB	7510075



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Your P.O. #: 220028978-5

GENERAL COMMENTS

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

Package 1	9.7°C
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Results relate only to the items tested.



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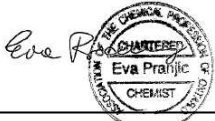
BV Labs Job #: C1M3456
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Your P.O. #: 220028978-5

VALIDATION SIGNATURE PAGE

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

Eric Dearman, Scientific Specialist



Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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