



Real-Time Water Quality Report

Waterford River at Kilbride NL02ZM0009

Deployment Period
October 13, 2022 to December 12, 2022



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

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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 October 13, 2022 until removal on December 12, 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.

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 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 too 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	October 13, 2022	Deployment	Excellent	Good	Fair	Fair	Excellent
		Grab Sample # 1726	N/A	Fair	Fair	N/A	Excellent
	December 12, 2022	Removal	Excellent	Good	Excellent	Excellent	Good

Waterford River at Kilbride, Newfoundland and Labrador

Upon deployment, temperature and turbidity sensors ranked 'Excellent', pH sensor ranked 'Good' and conductivity and dissolved oxygen sensors 'Fair' when compared to the QA/QC sonde recorded measurements.

Measured grab sample (#2022-1726-00-SI-SP) parameters pH and Conductivity ranked 'Fair' in comparison to the field sonde with exception of Turbidity, with a ranking of 'Excellent'.

Upon removal of the instrument, parameters ranked 'Excellent' against the QA/QC sonde with exception to pH and Turbidity which ranked 'Good' after a 61-day deployment period.

DATA INTERPRETATION

Water Temperature

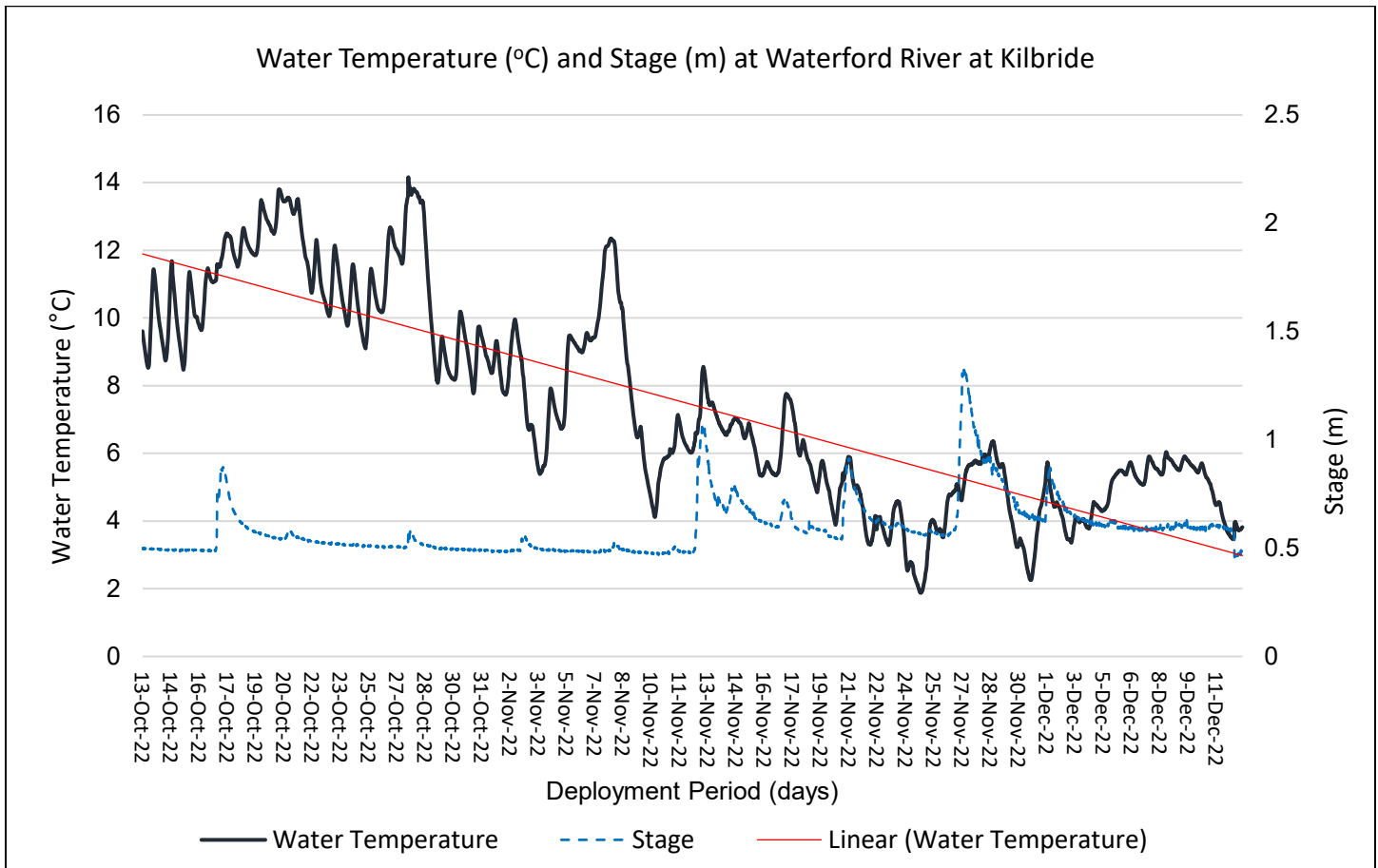
Water temperature ranged from 1.88 °C to 14.16 °C during this deployment period (Figure 2).

The water temperature was variable and correlated with air temperature (see Appendix A) throughout the deployment period, with an overall decreasing trend throughout the fall into the winter 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 November 10th, and on November 30th, 2022.

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
7.44	6.59	1.88	14.16

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

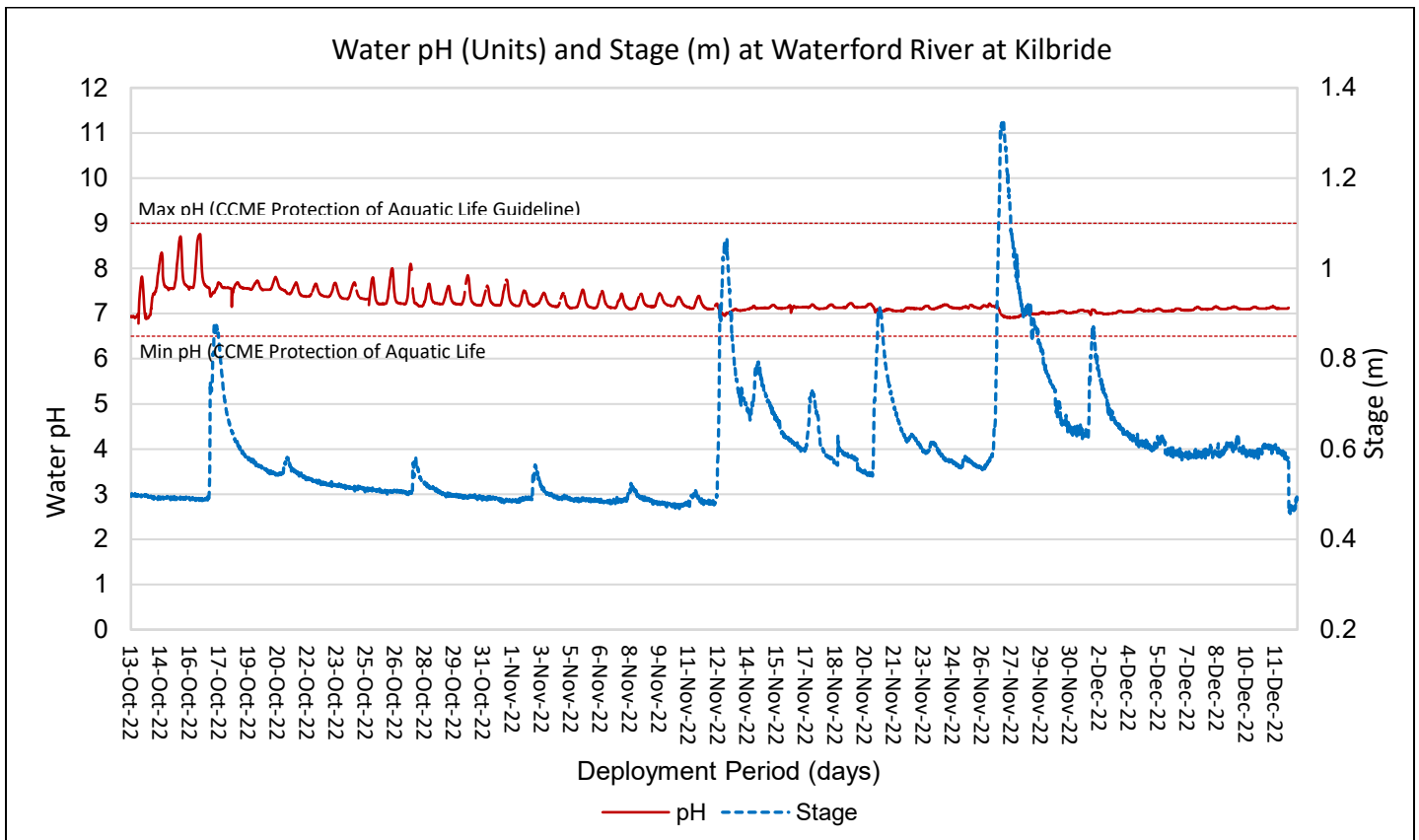
pH

Throughout the deployment period, pH baseline values were stable, with a range between 6.78 pH units and 8.76 pH units, a mean of 7.49 and median of 7.14 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. pH values remained within the guidelines for the duration of the deployment.

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 decreased during higher stage events due to the addition of lower pH rainwater, as seen on October 17th, 2022 and on November 12th, 20th and 27th as indicated in Figure 7. Precipitation resulted in minimal diurnal variation from November 12th to the end of the deployment period on December 12, 2022.

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
7.49	7.14	6.78	8.76

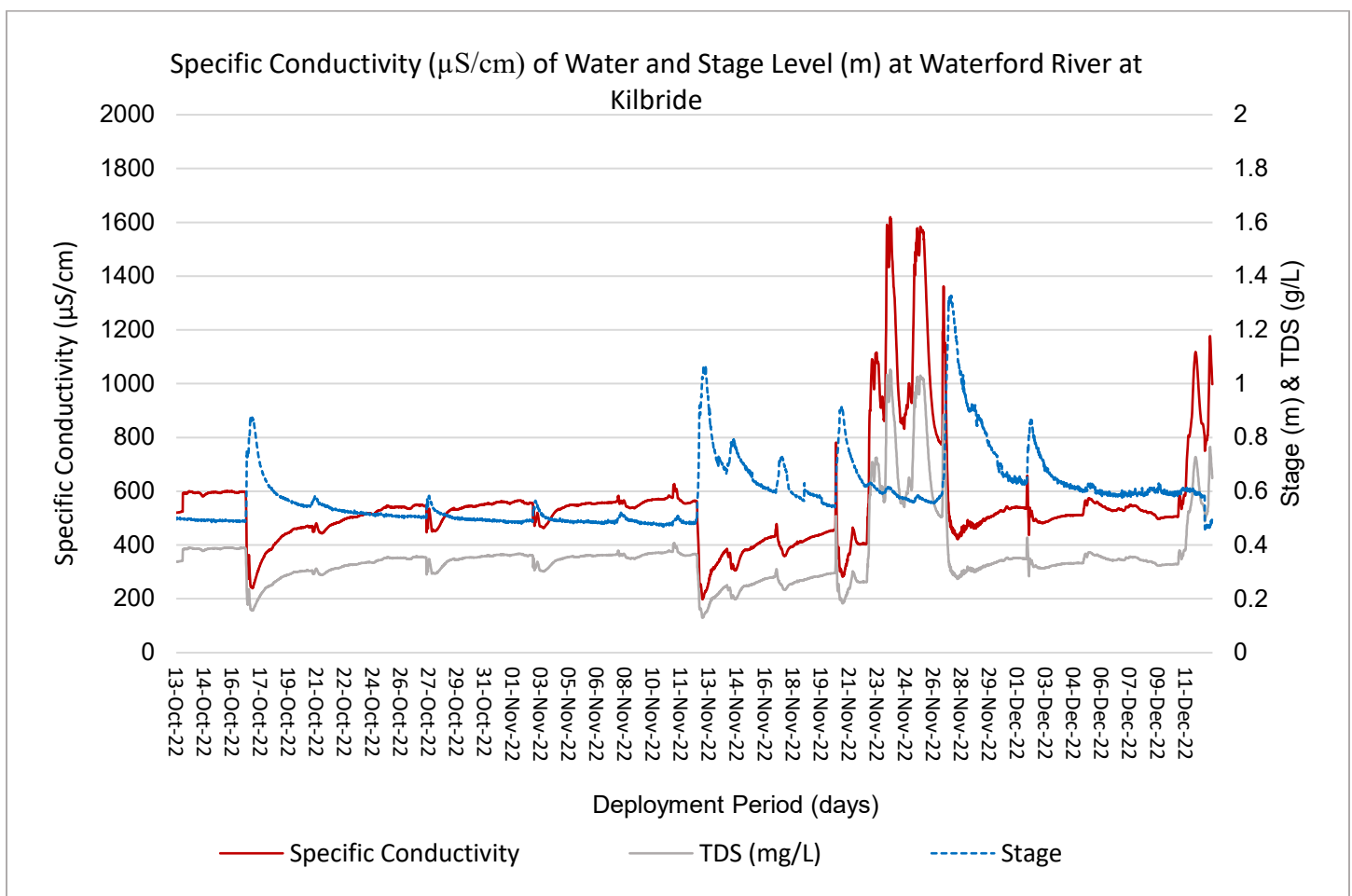
Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride.

Specific Conductivity & Total Dissolved Solids

Conductivity levels were inconsistent with no observable trend from October 13 to December 12, 2022 as depicted in Figure 4. The conductivity levels were within 198.0 $\mu\text{S}/\text{cm}$ and 1619.0 $\mu\text{S}/\text{cm}$. TDS (a calculated value) ranged from 0.1560 g/L to 1.0520 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 October 17-19 and from November 12-19, 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. The spike in conductivity and TDS between November 23 to 27, 2022 is likely the result of an increase in dissolved ions from runoff containing road salt required due to colder air temperatures.

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 ($\mu\text{S}/\text{cm}$)	553.5	531.0	198.0	1619.0
TDS (mg/L)	0.3598	0.3450	0.1560	1.0520

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

Dissolved Oxygen

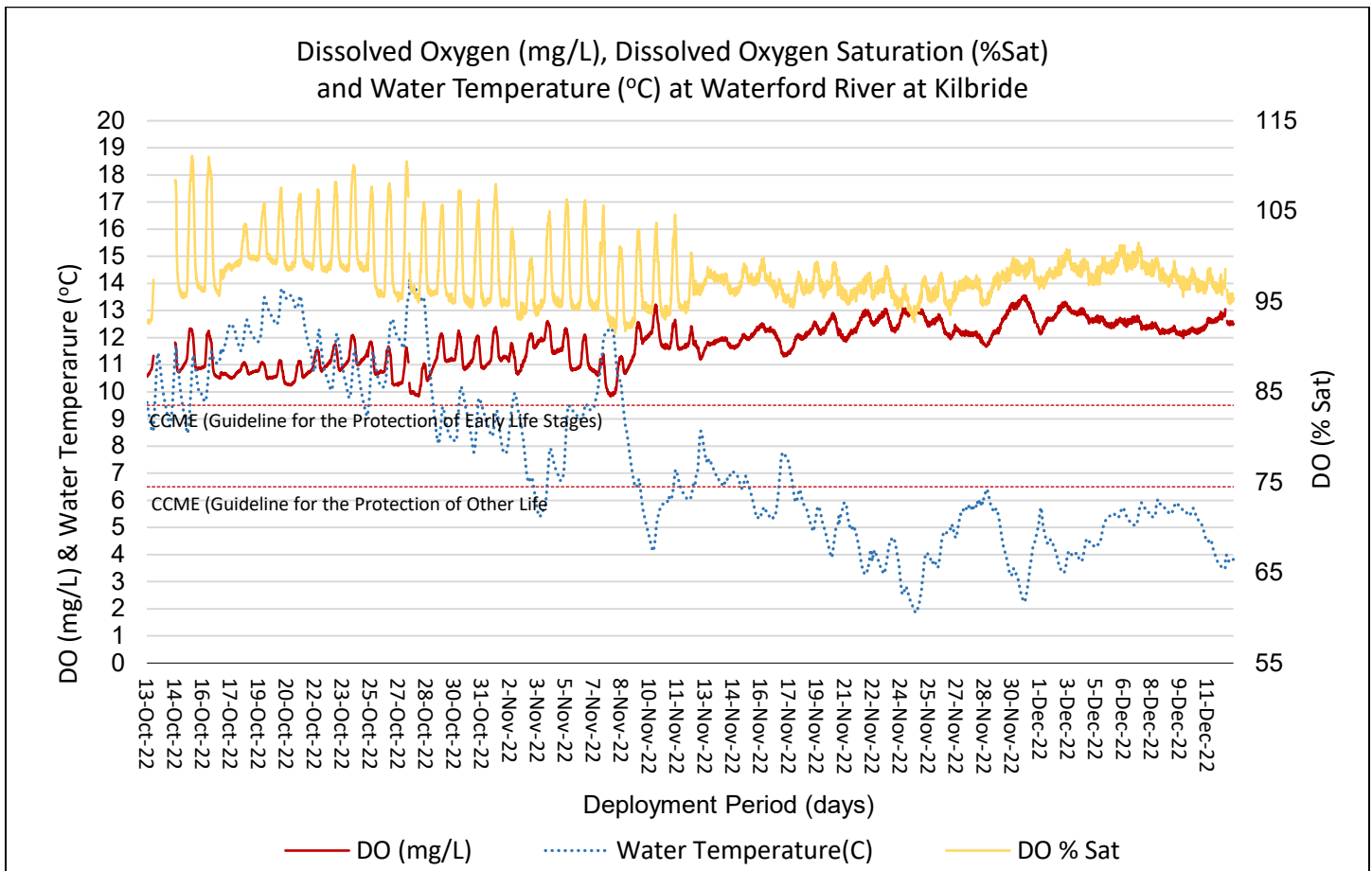
Dissolved oxygen is a metabolic requirement of aquatic plants and animals. The concentration of oxygen in water depends on many factors, especially temperature – the saturation of oxygen in water is inversely proportional to water temperature. Oxygen concentrations also tend to be higher in flowing water 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 9.83 mg/L to a maximum of 12.39 mg/L. The percent saturation (%) levels for dissolved oxygen ranged within 92.6% to 111.1% 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 Guidelines for Other Life Stages (6.5 mg/L) and Early life stages (9.5mg/L) throughout the deployment period.



	Mean	Median	Min	Max
DO (%Sat)	99.9	99.0	92.6	111.1
DO (mg/L)	11.01	10.93	9.83	12.39

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

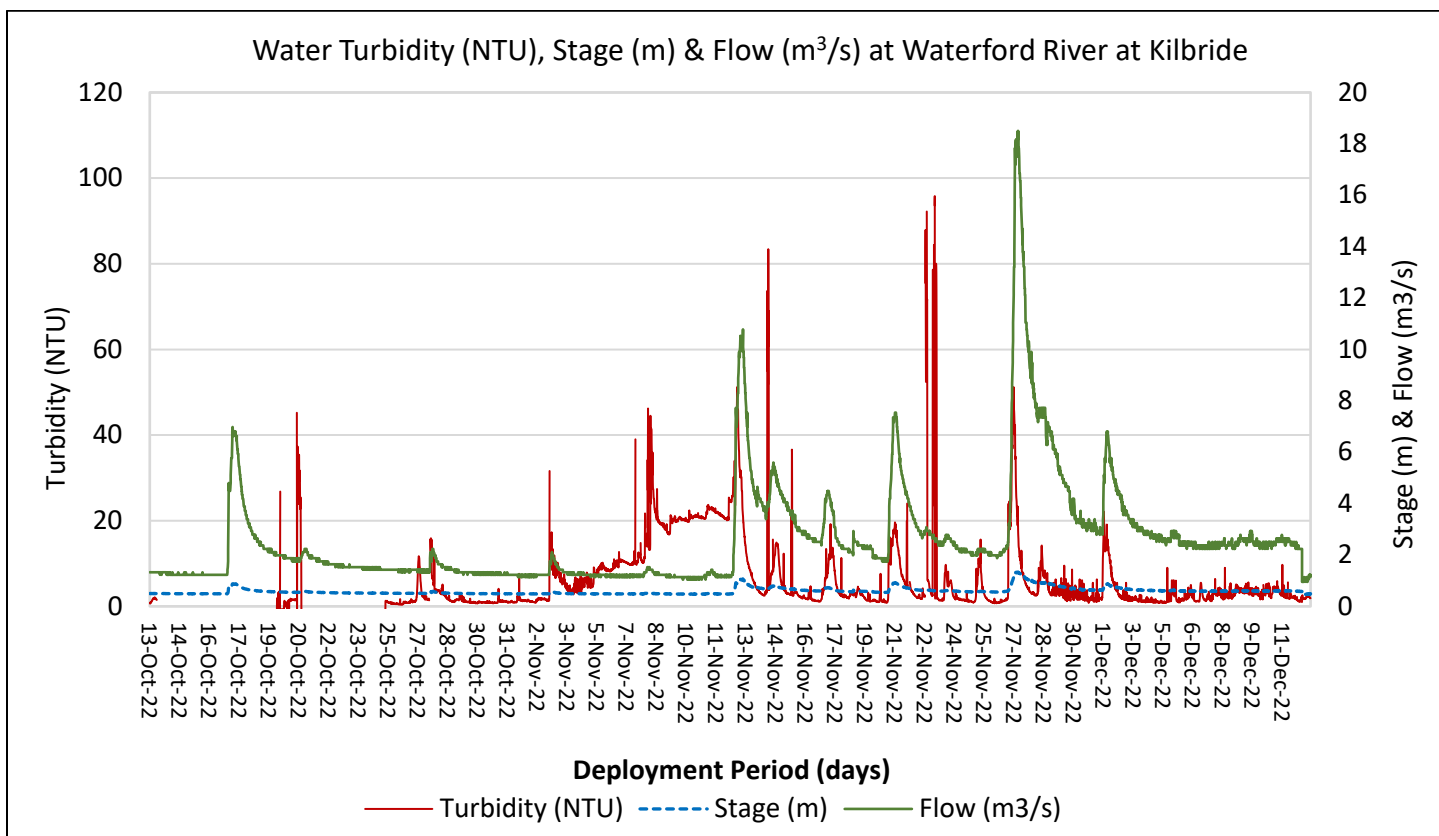
Turbidity

Turbidity levels during the deployment period range from -15.4 NTU and 45.2 NTU, with a mean of -0.2 NTU and median of -2.3 NTU (Figure 6).

Negative turbidity values, seen early in the deployment period, are indicative of a calibration error or degradation of the sensor. These numbers were included in the statistical analysis within this report. Turbidity events above baseline values are the result of higher stage events and an associated increase in flow. The turbidity spikes observed between November 12, 2022 through December 1, 2022 (Figure 6) correlate with multiple (near daily) precipitation events. 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 November 5-14, 2022.

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
-0.2	-2.3	-15.4	45.2

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

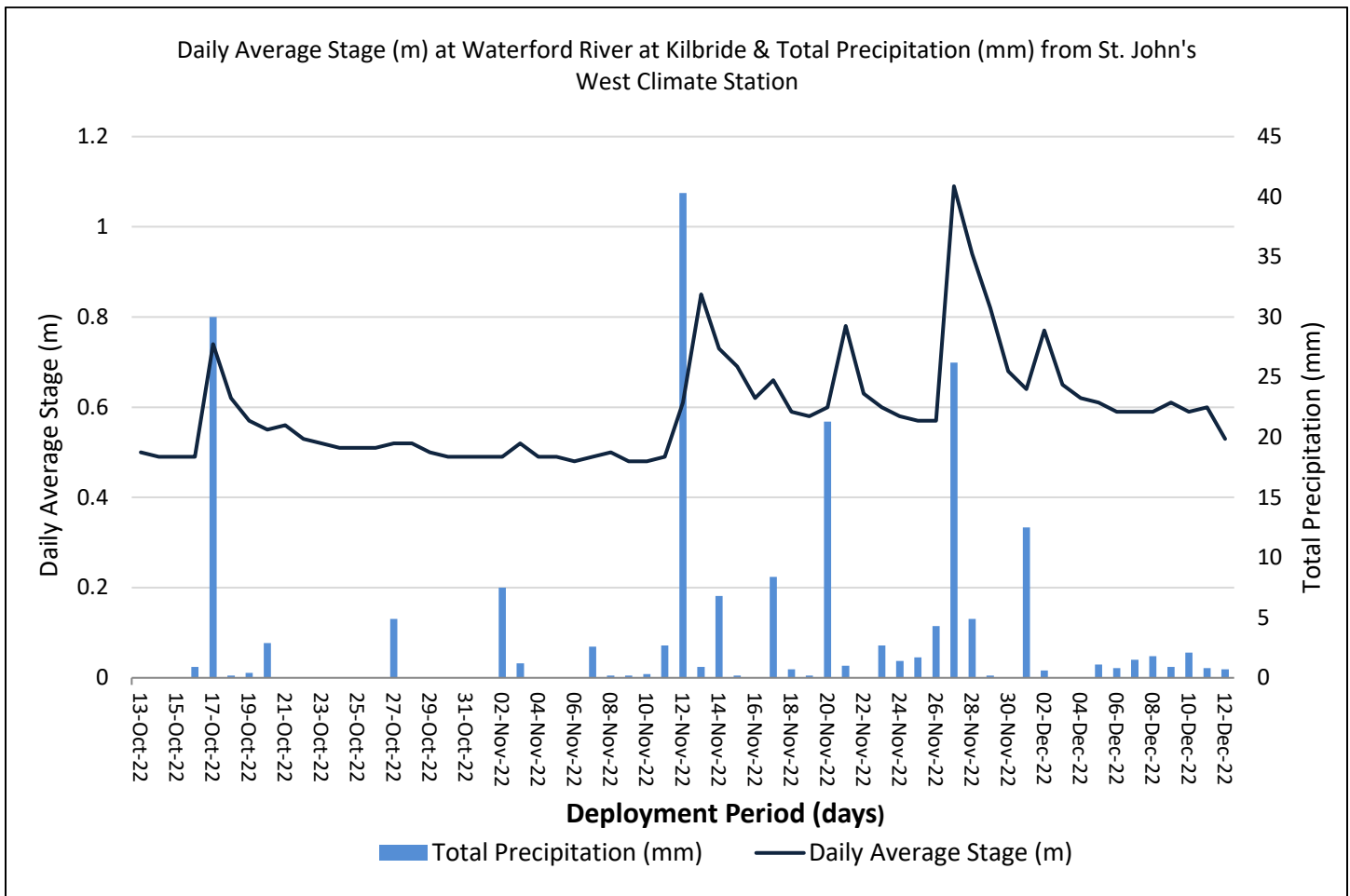
Stage and Precipitation

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 0.45 m to 1.33 m. The larger peaks in stage correspond with substantial rainfall events as observed on October 17th and November 12th, 20th and 27th, 2022. Baseline stage level remained higher post the November 12th, 2022, rainfall event for the remainder of the deployment period due to continuous variable daily volumes of precipitation.

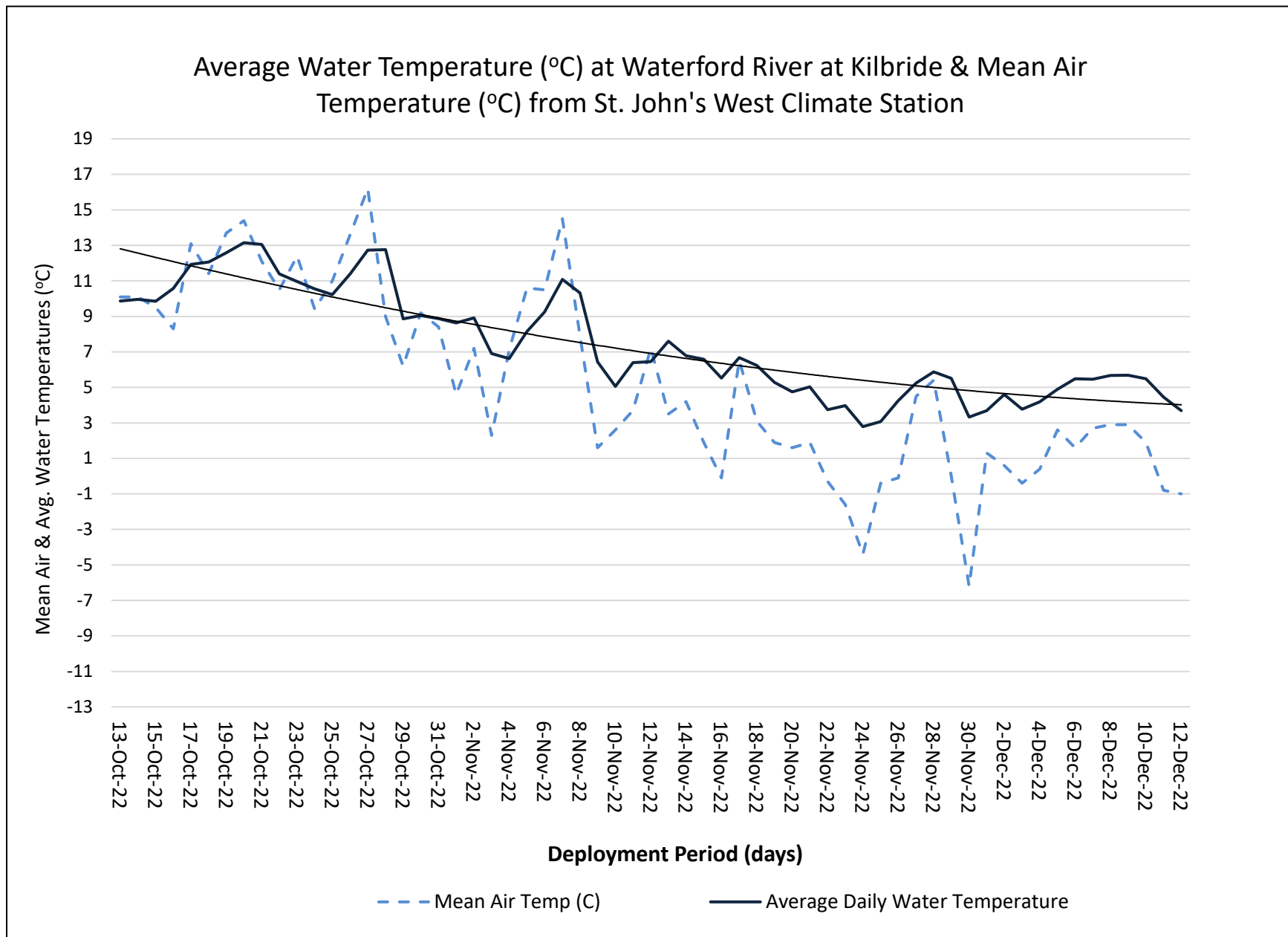
Precipitation data was collected by Environment Canada’s St. John’s West Climate station. Daily Total Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 40.3 mm on November 12, 2022.



Mean	Median	Min	Max
0.59	0.57	0.45	1.33

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



APPENDIX B : QA/QC GRAB SAMPLE FIELD RESULTS



BUREAU
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Bureau Veritas Job #: C2U4231
Report Date: 2022/11/03

NL Department of Environment, Climate Change and
Municipalities

Site Location: WATERFORD RIVER @ KILLBRIDE

Your P.O. #: 220028978-5

Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
UAZ533 WATERFORD RIVER @ KILBRIDE								
Sampling Date		2022/10/13 10:20						
Matrix		W						
Sample #		2022-1726-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	45	1.0	mg/L	N/A	2022/11/01		8292860
Nitrate (N)	-	0.80	0.050	mg/L	N/A	2022/11/03		8292542
Total dissolved solids (calc., EC)	-	330	1.0	mg/L	N/A	2022/10/23		8291856
Inorganics								
Conductivity	-	600	1.0	uS/cm	N/A	2022/10/23	KMC	8300210
Chloride (Cl-)	-	150	1.0	mg/L	N/A	2022/10/26	LKH	8302930
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/10/26	LKH	8302930
Sulphate (SO4)	-	15	1.0	mg/L	N/A	2022/10/26	LKH	8302930
Total Alkalinity (Total as CaCO3)	-	18	2.0	mg/L	N/A	2022/10/23	KMC	8300212
Colour	-	13	5.0	TCU	N/A	2022/11/02	TGO	8316465
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/10/23	KMC	8300213
Total Kjeldahl Nitrogen (TKN)	-	ND	0.10	mg/L	2022/10/26	2022/10/27	JJH	8307590
Nitrate + Nitrite (N)	-	0.81	0.050	mg/L	N/A	2022/11/01	TGO	8316487
Nitrite (N)	-	0.010	0.010	mg/L	N/A	2022/11/02	TGO	8316490
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2022/10/25	TGO	8301779
Dissolved Organic Carbon (C)	-	3.0	0.50	mg/L	N/A	2022/10/25	RSL	8301808
Total Organic Carbon (C)	-	3.1	0.50	mg/L	N/A	2022/10/21	RSL	8297689
pH	-	7.46		pH	N/A	2022/10/23	KMC	8300211
Total Phosphorus	-	0.020	0.004	mg/L	2022/10/26	2022/10/28	SSV	8306854
Total Suspended Solids	-	4.0	1.0	mg/L	2022/10/20	2022/10/26	A1M	8295390
Turbidity	-	0.78	0.10	NTU	N/A	2022/10/25	KMC	8301001
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/10/26	2022/10/26	EPU	8303795
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.045	0.0050	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Barium (Ba)	-	0.017	0.0010	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Boron (B)	-	ND	0.050	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Cadmium (Cd)	-	0.000019	0.000010	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Calcium (Ca)	-	14	0.10	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Copper (Cu)	-	0.0017	0.00050	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Iron (Fe)	-	0.19	0.050	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Magnesium (Mg)	-	2.3	0.10	mg/L	2022/10/31	2022/10/31	JHY	8315950



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Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
UAZ533 WATERFORD RIVER @ KILBRIDE								
Sampling Date 2022/10/13 10:20								
Matrix W								
Sample # 2022-1726-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.057	0.0020	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Potassium (K)	-	1.7	0.10	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Sodium (Na)	-	92	0.10	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Strontium (Sr)	-	0.056	0.0020	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Uranium (U)	-	ND	0.00010	mg/L	2022/10/31	2022/10/31	JHY	8315950
Total Zinc (Zn)	-	0.0055	0.0050	mg/L	2022/10/31	2022/10/31	JHY	8315950