

Real-Time Water Quality Report

Waterford River at Kilbride NL02ZM0009

Deployment Period
May 09, 2023 to June 29, 2023



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 May 9, 2023 until removal on June 29, 2023.



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	May 9, 2023	Deployment	Good	Excellent	Poor	Good	Excellent
		Grab Sample # 1701	N/A	Good	Poor	N/A	Excellent
	June 29, 2023	Removal	Excellent	Good	Marginal	Poor	Poor

Upon deployment, all sensors ranked ‘Excellent’ or ‘Good’ with exception to Conductivity of which ranked ‘Poor’ when compared to the QA/QC sonde recorded measurements. Upon review of the grab sample (2023-1701-00-

Waterford River at Kilbride, Newfoundland and Labrador

SI-SP) conductivity ranking it can be assumed that this is the result of a field sonde calibration error or sensor malfunction.

Measured grab sample (#2023-1701-00-SI-SP) parameters pH and Turbidity ranked 'Good' and 'Excellent' respectively in comparison to the field sonde with exception of Conductivity, with a ranking of 'Poor' as discussed above.

Upon removal of the instrument, the parameters Temperature and pH ranked 'Excellent' and 'Good' respectively. Conductivity ranked 'Marginal' due to what is most likely a calibration error and Dissolved Oxygen and Turbidity ranked 'Poor' against the QA/QC sonde after a 52-day deployment period. The 'Poor' rankings are likely due to the lodging of sediment and organic material within the sonde casing.

DATA INTERPRETATION

Water Temperature

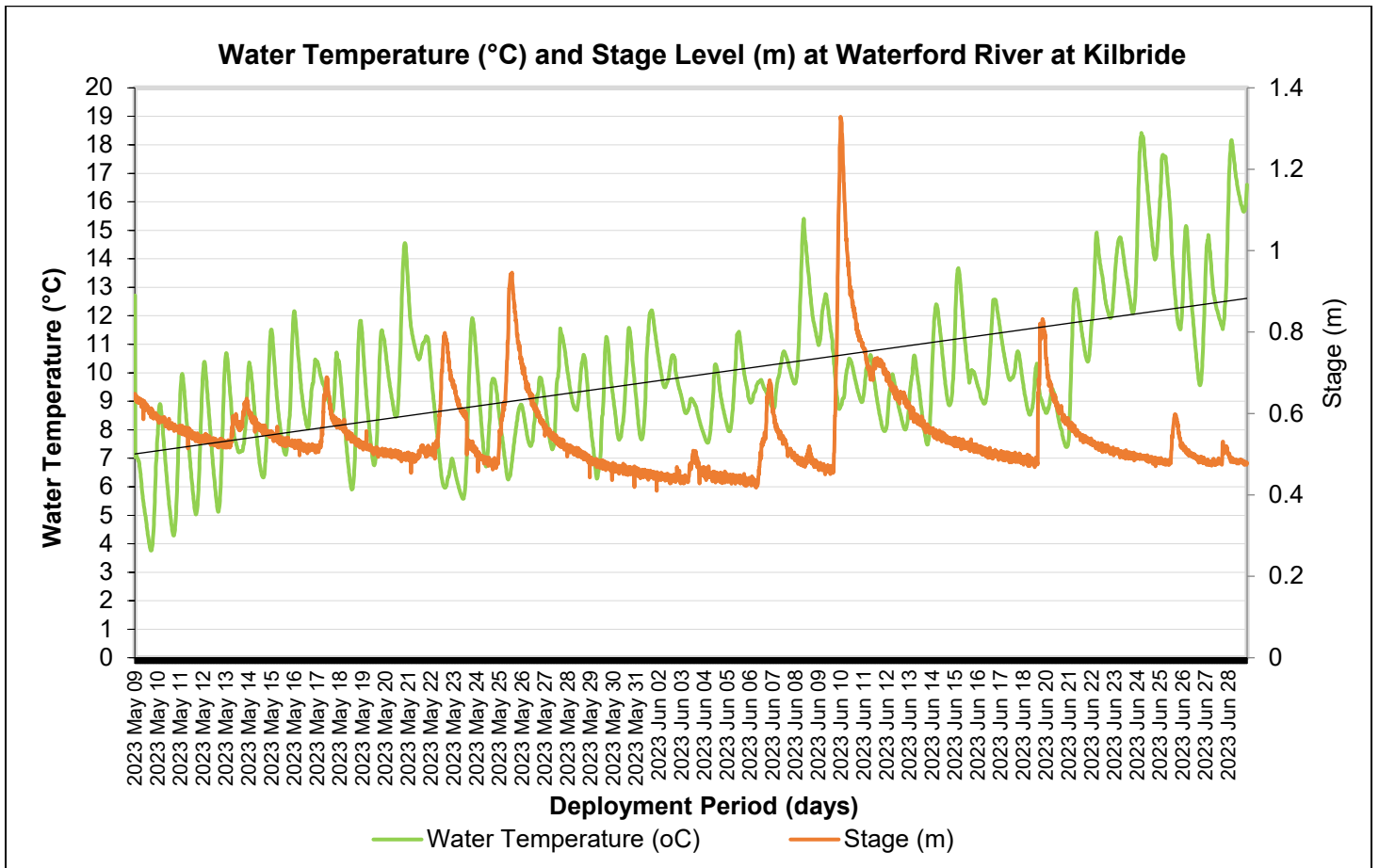
Water temperature ranged from 3.76 °C to 18.42 °C during this deployment period (Figure 2).

The water temperature was variable and correlated with air temperature (see Appendix A) throughout the deployment period, with an overall increasing trend throughout the spring into the summer 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 May 23-24, 2023, June 10, 2023, and on June 19, 2023.

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
9.88	9.59	3.76	18.42

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

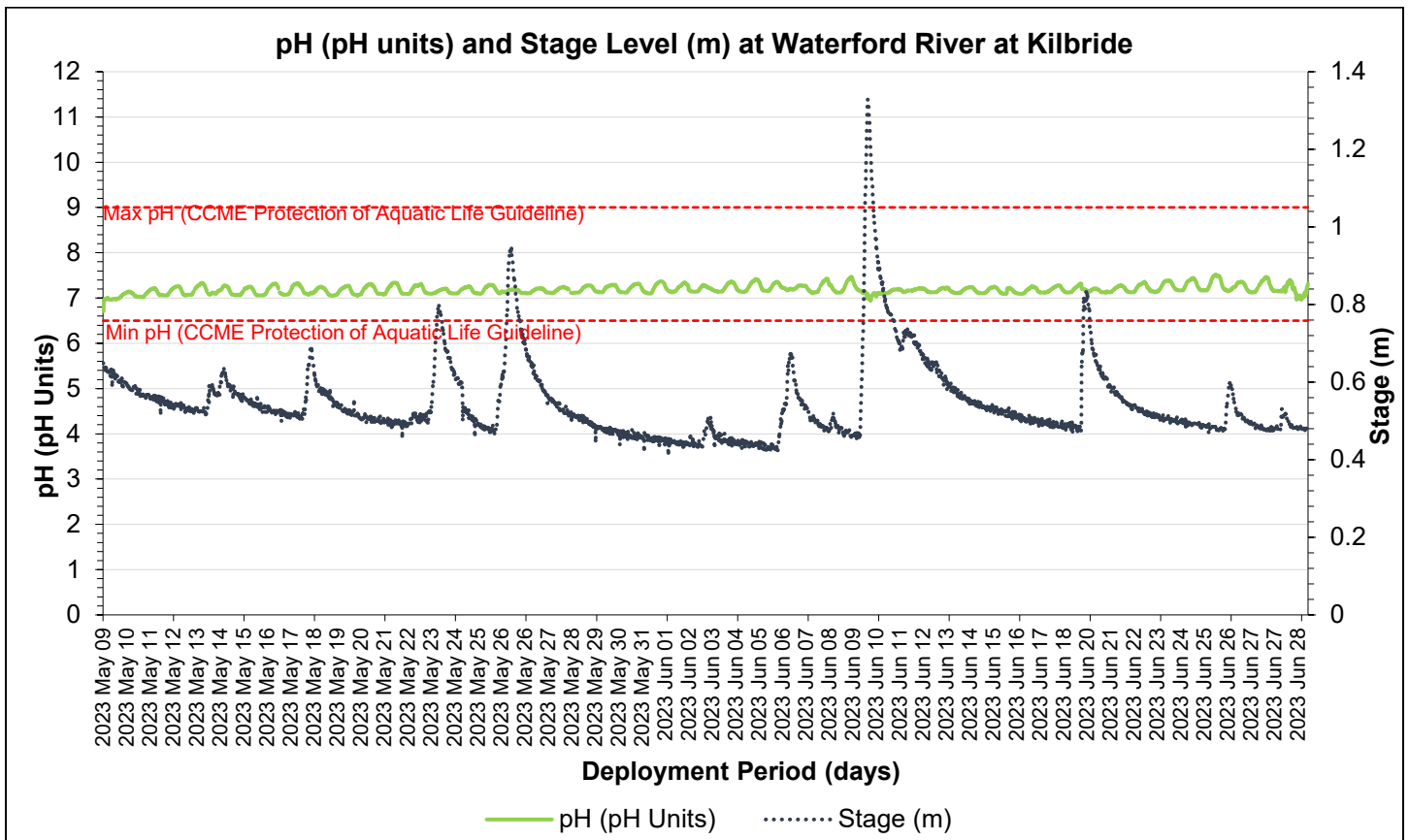
pH

Throughout the deployment period, pH baseline values were stable, with a range between 6.71 pH units and 7.51 pH units, a mean of 7.19 and median of 7.18 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 maintained a pH level within these guidelines for the duration of the deployment period.

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. pH decreased during several higher stage events due to the addition of lower pH rainwater, as seen on May 23, May 26 and June 10 (Figure 3).

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
7.19	7.18	6.71	7.51

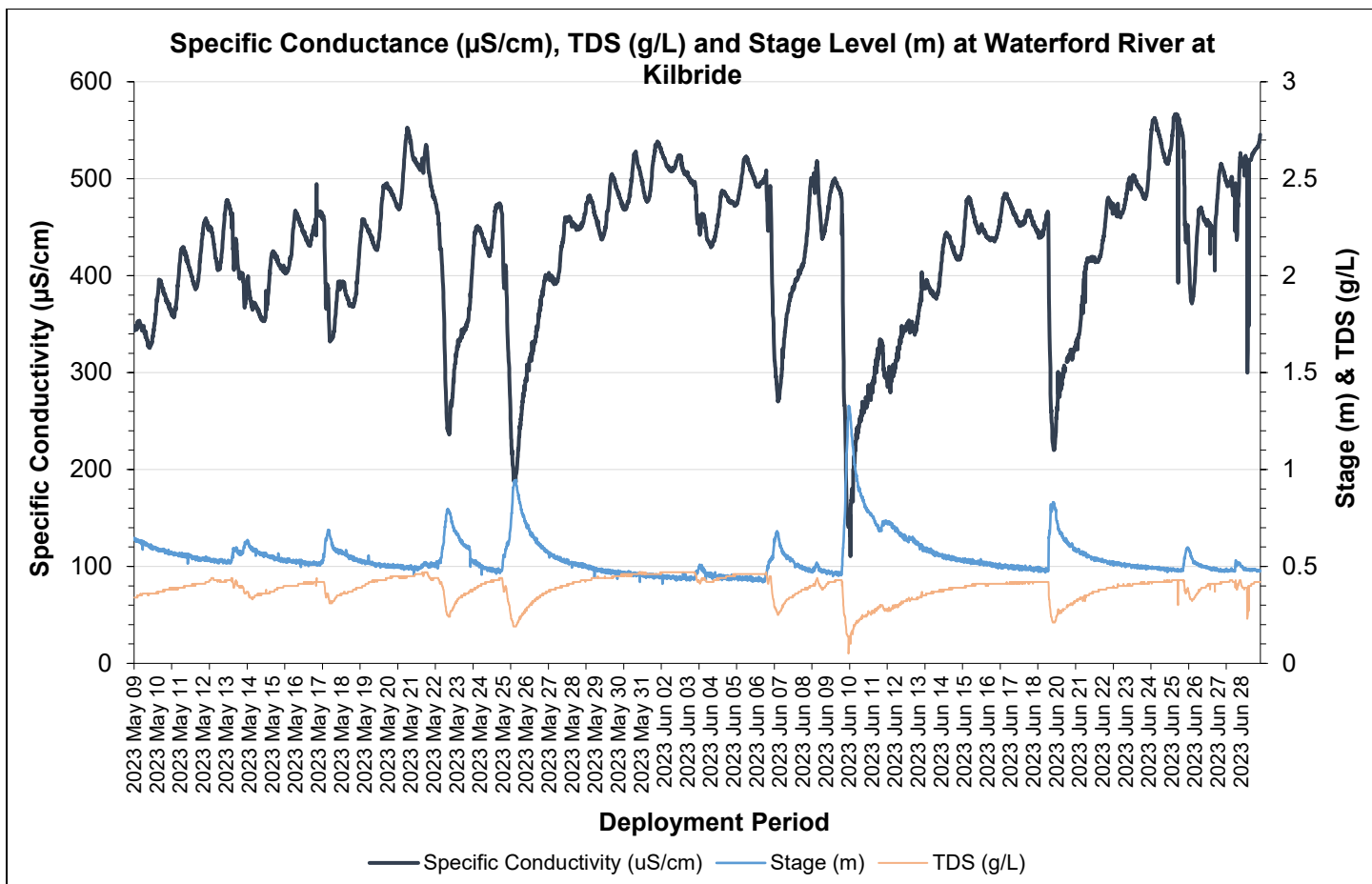
Figure 3: pH (pH units) and stage level (m) values at Waterford River at Kilbride.

Specific Conductivity & Total Dissolved Solids

Conductivity levels were variable with a small increasing trend from May 9, 2023 to June 29, 2023 as depicted in Figure 4. The conductivity levels were within 110.4 $\mu\text{S}/\text{cm}$ and 566.9 $\mu\text{S}/\text{cm}$. 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. 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 ($\mu\text{S}/\text{cm}$)	425.7	443.8	110.4	566.9
TDS (mg/L)	0.3884	0.4000	0.0500	0.4700

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

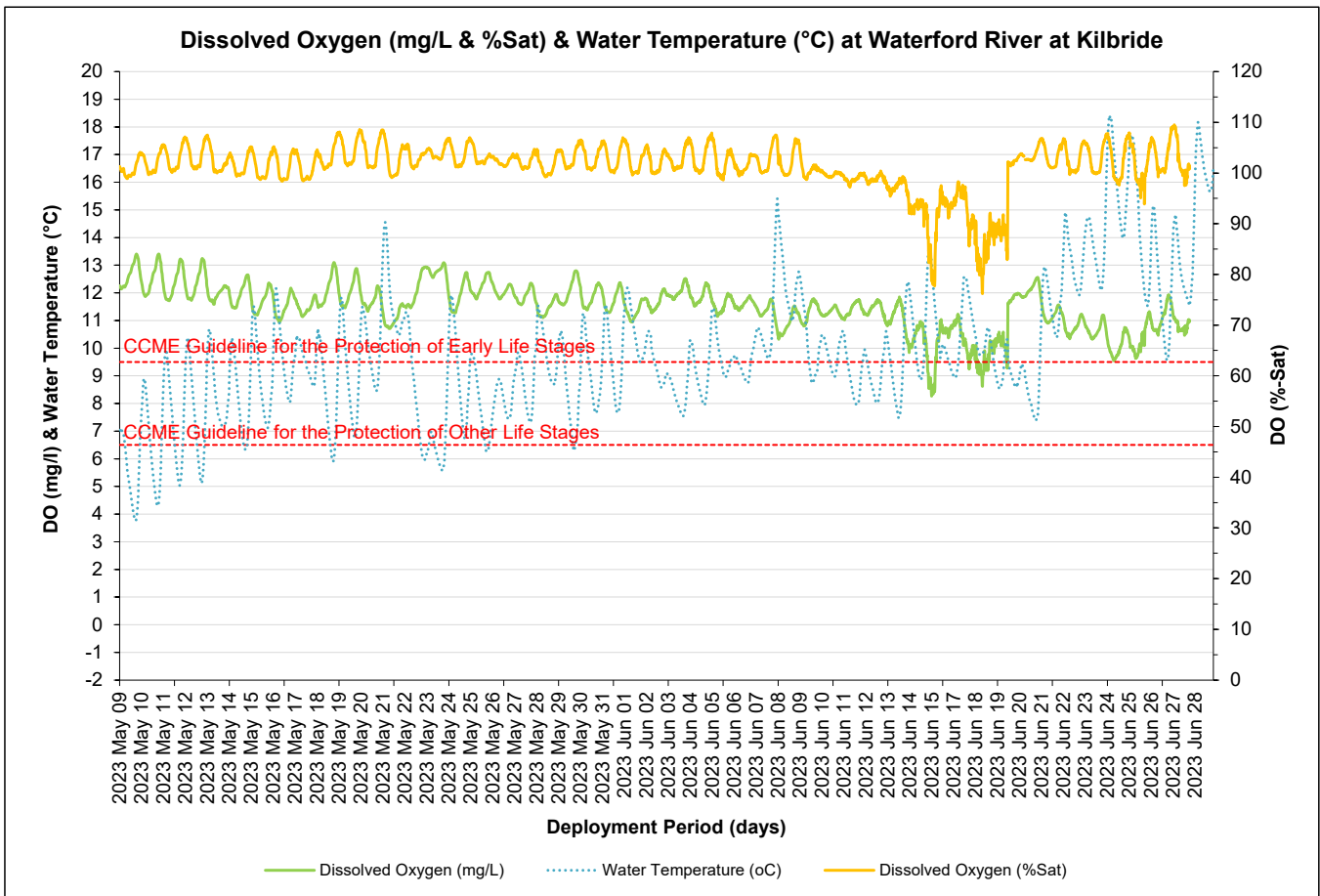
Dissolved Oxygen

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 8.27 mg/L to a maximum of 13.40 mg/L. The percent saturation (%) levels for dissolved oxygen ranged within 76.2% to 109.5% 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 decrease in dissolved oxygen concentration was observed in correlation with natural warming water temperatures. Sudden decreases in dissolved oxygen are usually in relation to an increase in water temperature. This is evident in Figure 5, particularly for June 15th.

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



	Mean	Median	Min	Max
DO (%Sat)	101.2	101.5	76.2	109.5
DO (mg/L)	11.50	11.57	8.27	13.40

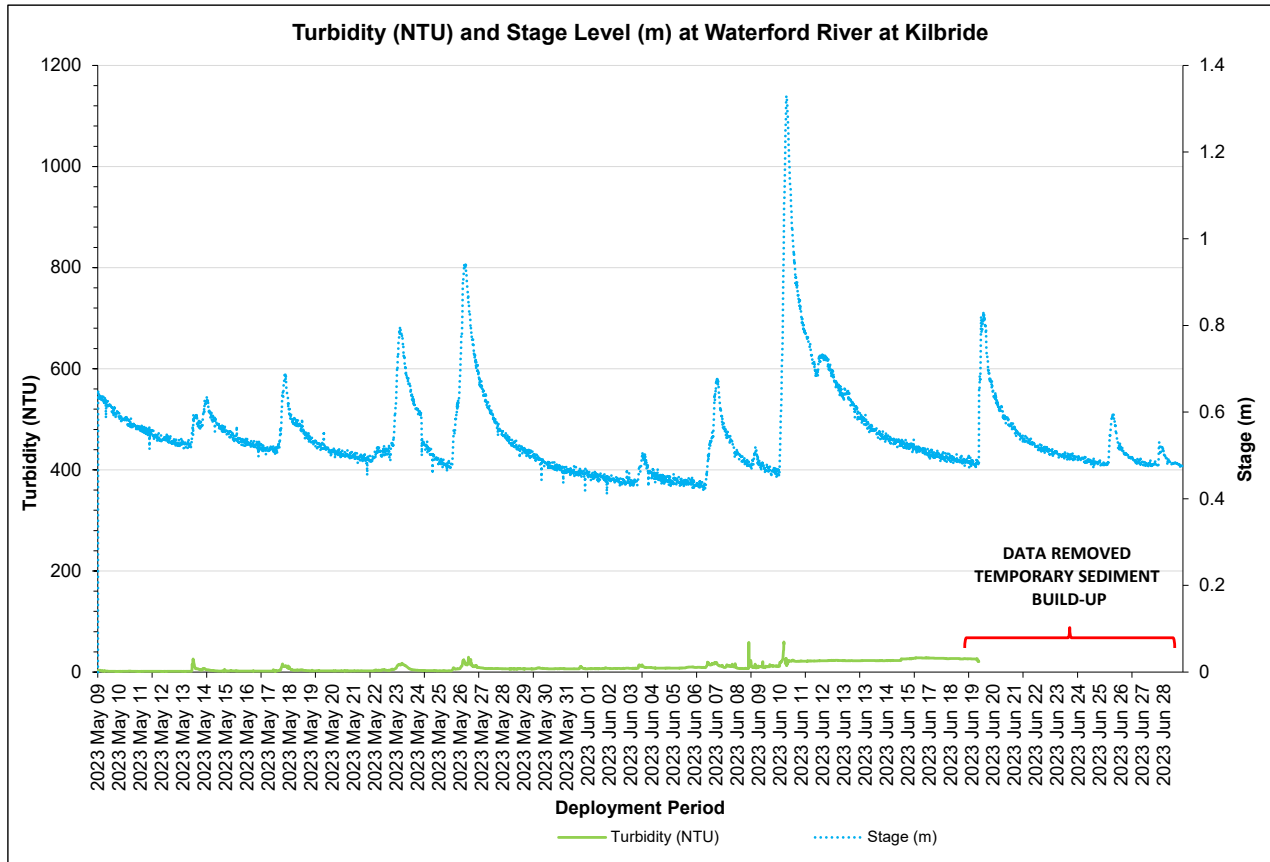
Figure 5: Dissolved Oxygen (mg/L & Percent Saturation) values at Waterford River at Kilbride.

Turbidity

Turbidity levels during the deployment period range from 1.3 NTU and 59.8 NTU, with a mean of 10.1 NTU and median of 7.0 NTU (Figure 6).

Turbidity remained low through the first portion of the deployment, increasing periodically during high stage events. By early June, values were gradually increasing and remaining elevated, indicating the sensor was likely covered in sediment or biofouled. After June 19th, the data was erratic: another indication that the sensor was likely covered in sedimentation. The data for June 19th to the end of deployment is erroneous and has been removed from the dataset.

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
10.1	7.0	1.3	59.8

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

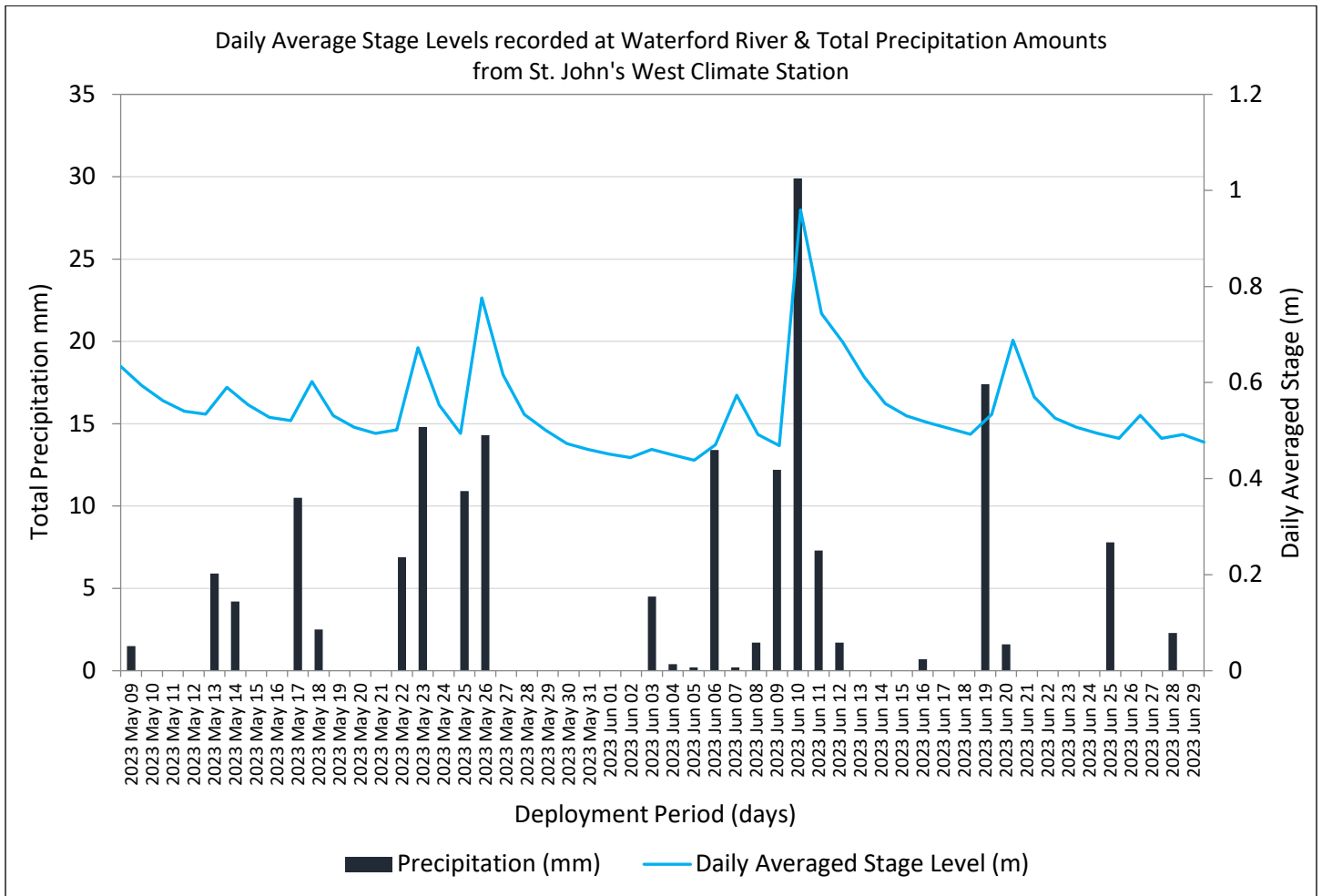
Stage and Precipitation

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 0.41 m to 1.33 m. The larger peaks in stage correspond with substantial rainfall events as observed on June 10 and June 19.

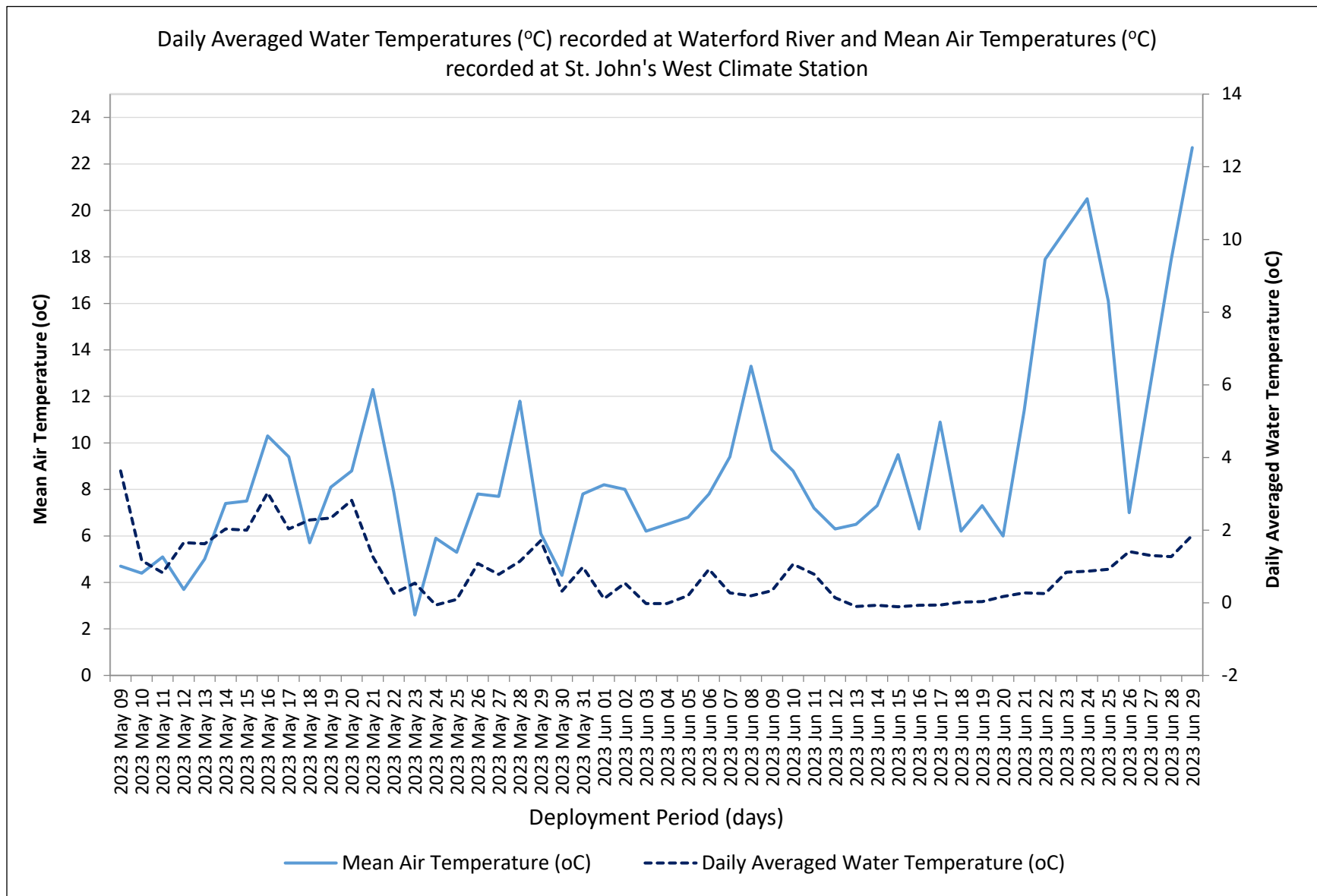
Precipitation data was collected by Environment Canada’s St. John’s West Climate station. Daily Total Precipitation ranges for the deployment period were a minimum of 0.0 mm and a maximum of 29.9 mm on June 10.



Mean	Median	Min	Max
0.55	0.52	0.41	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
VERITAS

Bureau Veritas Job #: C3D5391
Report Date: 2023/05/18

NL Department of Environment, Climate Change and
Municipalities
Your P.O. #: 220028978-9
Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
VUG984 WATERFRONT RIVER @KILLBRIDE								
Sampling Date		2023/05/09 13:50						
Matrix		W						
Sample #		2023-1701-00-SI-SP						
Registration #		SA-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	34	1.0	mg/L	N/A	2023/05/15		8660957
Nitrate (N)	-	0.52	0.050	mg/L	N/A	2023/05/17		8660960
Total dissolved solids (calc., EC)	-	290	1.0	mg/L	N/A	2023/05/17		8661508
Inorganics								
Conductivity	-	520	1.0	uS/cm	N/A	2023/05/16	NGI	8666595
Chloride (Cl-)	-	130	1.0	mg/L	N/A	2023/05/17	LKH	8668059
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2023/05/17	LKH	8668059
Sulphate (SO4)	-	14	1.0	mg/L	N/A	2023/05/17	LKH	8668059
Total Alkalinity (Total as CaCO3)	-	11	2.0	mg/L	N/A	2023/05/16	NGI	8666904
Colour	-	19	5.0	TCU	N/A	2023/05/16	TGO	8665197
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2023/05/16	NGI	8666611
Total Kjeldahl Nitrogen (TKN)	-	0.15	0.10	mg/L	2023/05/16	2023/05/17	RTY	8667799
Nitrate + Nitrite (N)	-	0.52	0.050	mg/L	N/A	2023/05/17	TGO	8665188
Nitrite (N)	-	ND	0.010	mg/L	N/A	2023/05/17	TGO	8665182
Nitrogen (Ammonia Nitrogen)	-	0.069	0.050	mg/L	N/A	2023/05/17	TGO	8667383
Dissolved Organic Carbon (C)	-	3.1	0.50	mg/L	N/A	2023/05/15	CPP	8665314
Total Organic Carbon (C)	-	3.3	0.50	mg/L	N/A	2023/05/15	CPP	8665296
pH	-	7.04		pH	N/A	2023/05/16	NGI	8666603
Total Phosphorus	-	0.011	0.004	mg/L	2023/05/16	2023/05/17	GYA	8666060
Total Suspended Solids	-	1.8	1.0	mg/L	2023/05/15	2023/05/16	RDM	8665200
Turbidity	-	1.8	0.10	NTU	N/A	2023/05/17	NGI	8669351
Dup.Turbidity	-	1.7	0.10	NTU	N/A	2023/05/17	NGI	8669351
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2023/05/15	2023/05/16	SGK	8665028
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.14	0.0050	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Antimony (Sb)	-	ND	0.0010	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Arsenic (As)	-	ND	0.0010	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Barium (Ba)	-	0.018	0.0010	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Boron (B)	-	ND	0.050	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Cadmium (Cd)	-	0.000020	0.000010	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Calcium (Ca)	-	11	0.10	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Chromium (Cr)	-	ND	0.0010	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Copper (Cu)	-	0.0017	0.00050	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Iron (Fe)	-	0.20	0.050	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Lead (Pb)	-	ND	0.00050	mg/L	2023/05/15	2023/05/15	BCZ	8664315



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Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
VUG984 WATERFRONT RIVER @KILLBRIDE								
Sampling Date		2023/05/09 13:50						
Matrix		W						
Sample #		2023-1701-00-SI-SP						
Registration #		SA-0000						
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Magnesium (Mg)	-	1.8	0.10	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Manganese (Mn)	-	0.073	0.0020	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Nickel (Ni)	-	ND	0.0020	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Phosphorus (P)	-	ND	0.10	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Potassium (K)	-	1.5	0.10	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Selenium (Se)	-	ND	0.00050	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Sodium (Na)	-	85	0.10	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Strontium (Sr)	-	0.039	0.0020	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Uranium (U)	-	ND	0.00010	mg/L	2023/05/15	2023/05/15	BCZ	8664315
Total Zinc (Zn)	-	0.0077	0.0050	mg/L	2023/05/15	2023/05/15	BCZ	8664315