Real-Time Water Quality Report

Waterford River at Kilbride
NL02ZM0009

Deployment Period
April 25, 2024 to May 22, 2024

Newfoundland Labrador

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

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TABLE OF CONTENTS

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 April 25, 2024, until removal on May 22, 2024, 27 days later.

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. While WSC oversees the hydrometric component of these stations, due to differences in protocols, quality control for WSC hydrometric data occurs less frequently than for water quality data.

The hydrometric data presented in this report is provisional and has not undergone quality control checks. Accurate hydrometric data can be accessed at https://wateroffice.ec.gc.ca/ or by request to Water Survey Canada.

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

Table 2: Instrument performance rankings for Waterford River at Kilbride

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Waterford River @ Kilbride	**April 25, 2025**	**Deployment**	Excellent	Excellent	Excellent	Excellent	Excellent
		Grab Sample # **2024-1702-00-SI-SP**	N/A	Excellent	Excellent	N/A	Excellent
	May 22, 2024	**Removal**	Fair	Good	Good	Fair	Excellent

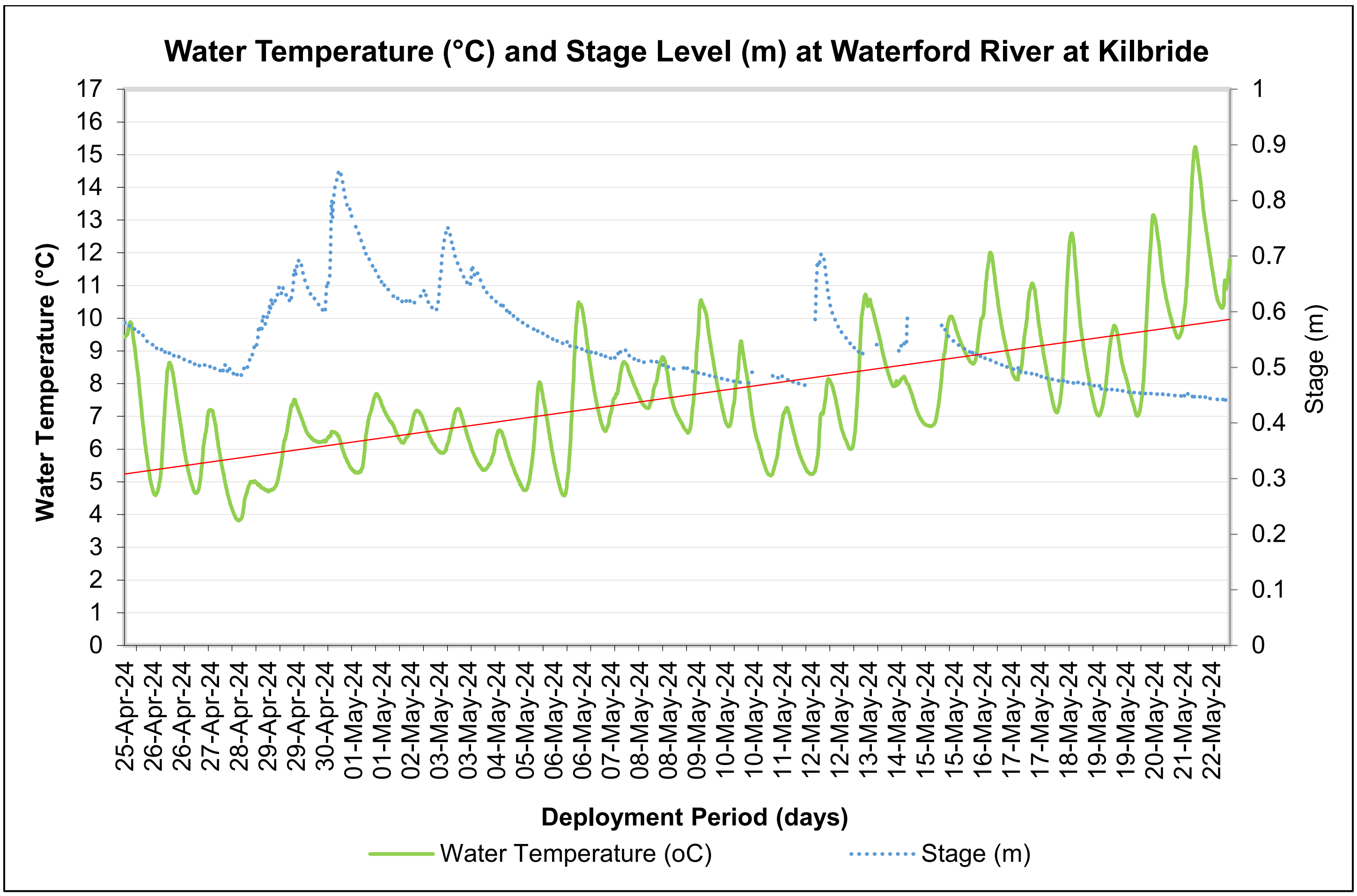
On April 25, 2025, during the field sonde deployment, all parameters were rated as "Excellent” in comparison to the QaQc sonde. The grab sample # 2024-1702-00-SI-SP showed excellent performance in pH, conductivity, and turbidity. On May 22, 2024, during removal, the rankings varied. Temperature, pH, conductivity and dissolved oxygen were “Fair” to “Good”, while turbidity remained “Excellent”. This suggests that the monitoring instrument performed well during deployment but may have experienced some drift or biofouling over time.

DATA INTERPRETATION

Water Temperature

Water Temperature is a major factor used to describe water quality. Temperature has major implications on both the ecology and chemistry of a water body, governing processes such as the metabolic rate of aquatic plants and animals and the degree of dissolved oxygen saturation. Variations in water temperature can influence biological processes, aquatic habitats, and water chemistry, making it a crucial parameter to monitor in understanding ecosystem dynamics. Additionally, tracking temperature trends over time can provide valuable information for assessing the impacts of climate change, seasonal variations, and anthropogenic influences on aquatic ecosystems.

It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependent, temperature compensated and temperature independent. As the temperature sensor is not isolated from the rest of the sonde, the entire sonde 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.



Temperature (oC)	Mean	Median	Min	Max
Hourly	7.59	7.21	3.82	15.24

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

The water temperature data in Figure 2, provides valuable insights into the thermal characteristics of the aquatic environment under consideration. With a mean temperature of 7.59°C and a median of 7.21°C, the dataset indicates relatively consistent temperatures across the observations, suggesting stability in thermal conditions over the measured period. The minimum temperature recorded at 3.82° (April 28), represents cold conditions, possibly associated with freezing or near-freezing temperatures, and expected for this time of year. The maximum temperature of 15.24°C was reached on May 21. This upward trend suggests a gradual warming of the river water, likely influenced by seasonal changes due to increased sun hours as spring begins.

The water temperature dynamics observed reveal a stable diurnal pattern characterized by temperature increases during the day and decreases overnight. This pattern highlights the river's responsiveness to external influences, particularly daily air temperature fluctuations and precipitation events. Warmer air temperatures during the day contribute to elevated water temperatures, while cooler nighttime temperatures lead to declines. Precipitation events, such as rainfall and snowmelt, also play a significant role, introducing cooler water into the river and contributing to fluctuations in temperature. Additionally, the changing length of days, with increasing daylight hours as spring progresses, likely influences the river's thermal patterns, affecting the duration and intensity of temperature fluctuations.

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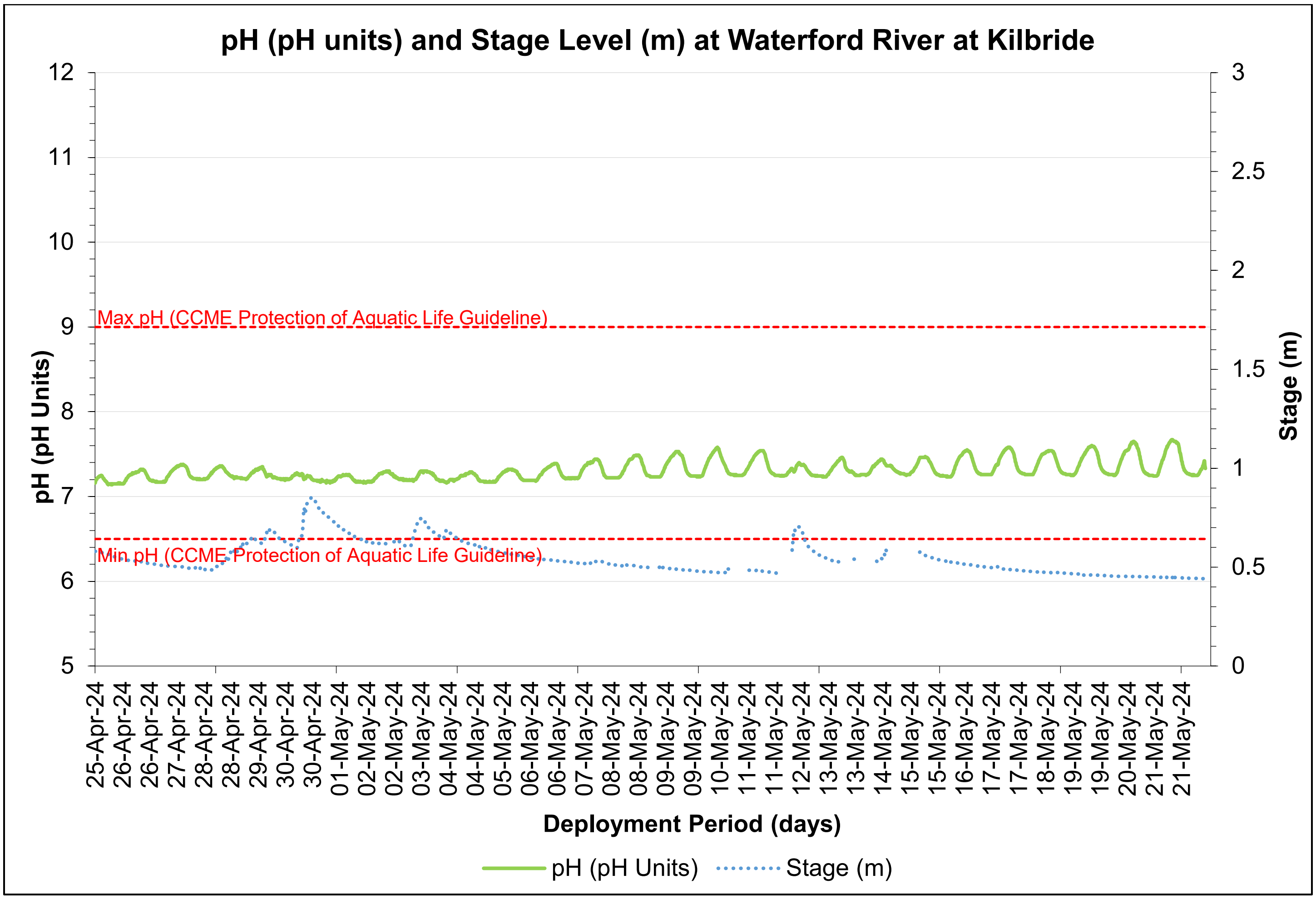
pH

pH is used to give an indication of the acidity or basicity of a solution. A pH of seven (7) denotes a neutral solution while lower values are acidic and higher values are basic. Technically, the pH of a solution indicates the availability of protons to react with molecules dissolved in water. Such reactions can affect how molecules function chemically and metabolically.

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.



Temperature (oC)	Mean	Median	Min	Max
Hourly	7.31	7.27	7.14	7.67

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

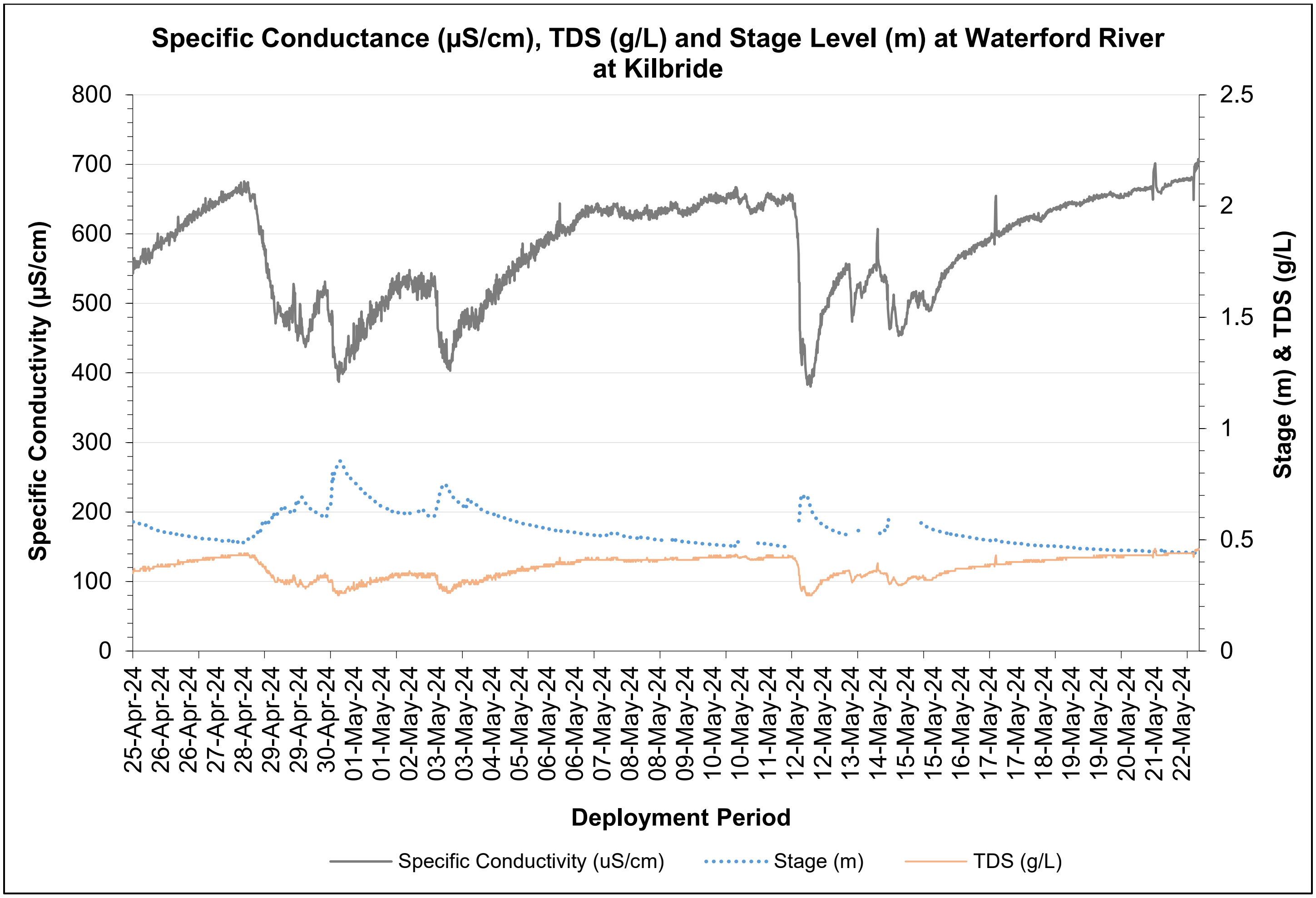
The water pH statistics for the Waterford River provide valuable insight into the acidity or alkalinity levels of the river water during the monitoring period. The mean pH of 7.31 indicates a slightly alkaline nature on average, suggesting that the water tends to be slightly basic overall. Similarly, the median pH of 7.27 reinforces this trend, indicating that most pH measurements clustered around this value. The minimum pH recorded at 7.14 represents the lowest acidity level observed, suggesting occasional fluctuations towards neutrality. On the other hand, the maximum pH of 7.67 indicates the highest alkalinity level recorded (Figure 3).

The data shows relatively stable pH levels throughout, with minor fluctuations within a narrow range. These variations may be influenced by factors such as natural fluctuations in water chemistry, input from surrounding environments, and changes in weather conditions. Despite these minor fluctuations, the average pH values suggest that the Waterford River maintains a relatively stable alkaline environment throughout the monitoring period.

The diurnal fluctuation in water pH is temperature dependent and rises during the day followed by nighttime decreases. This pattern emphasizes the river's sensitivity to external factors, especially daily shifts in air temperature and precipitation. When temperatures warm up during the day, the water's pH tends to rise, whereas cooler nights correspond to a decline in pH levels. Thus, due to the expected increase in seasonal temperature range, the pH diurnal pattern increased in early May to the end of the deployment period.

Specific Conductivity & Total Dissolved Solids

Conductivity relates to the ease of passing an electric charge – or resistance – through a solution. Conductivity is highly influenced by the concentration of dissolved ions in solution: distilled water has zero conductivity (infinite resistance) while salty solutions have high conductivity (low resistance). Specific Conductivity is corrected to 25°C to allow comparison across variable temperatures. Monitoring specific conductivity is crucial for assessing water quality, identifying potential sources of contamination, and ensuring the health of aquatic ecosystems. Deviations from expected conductivity levels may signal the need for further investigation and management actions to maintain water quality and ecosystem integrity.



Parameter		Mean	Median	Min	Max
Specific Conductivity (µS/cm)	Hourly	576.8	598.4	380.4	701.4
TDS (mg/L)	Hourly	0.3748	0.3900	0.2500	0.4600

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

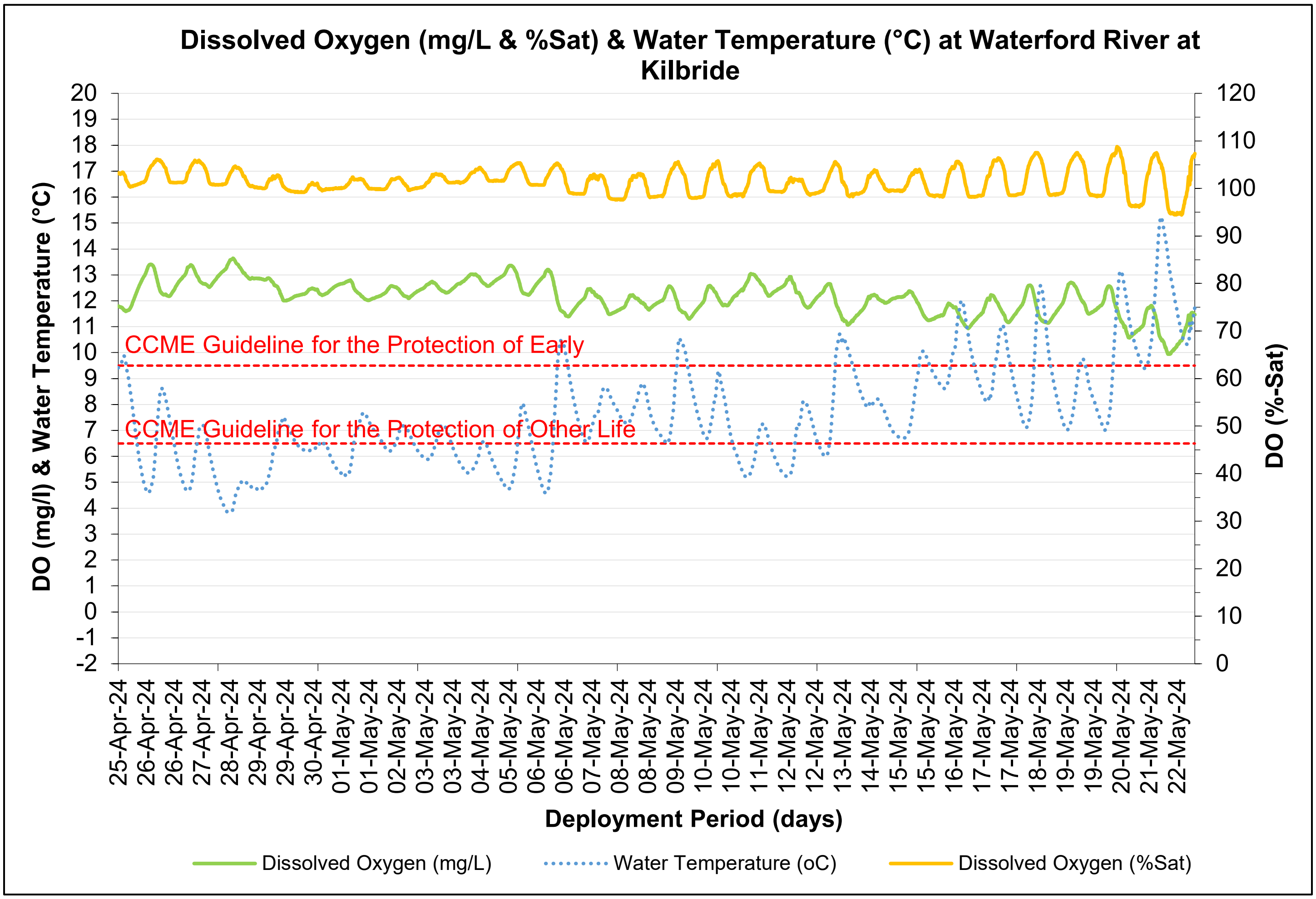
The specific conductivity and total dissolved solids (TDS) data (Figure 4) for the Waterford River provide essential insights into its chemical composition and overall water quality. The data shows a varied pattern over the observed period, starting at 556.78 µS/cm on April 25th and gradually increasing until reaching its peak at 701.4 µS/cm on May 22nd. Notable fluctuations are observed throughout, with occasional spikes and dips in conductivity levels. For instance, there's a significant increase in conductivity from April 26th to April 28th, followed by a decrease on April 29th and April 30th. Subsequently, conductivity levels rise again, showing an overall increasing trend until May 22nd.

The mean specific conductivity of 576.8 µS/cm indicates a moderately high level of ion concentration, reflecting the presence of dissolved salts, minerals, and other conductive substances. This suggests that the river contains a notable amount of dissolved solids, potentially influenced by factors like urban runoff, or natural geological processes. The median conductivity (598.4 µS/cm) closely aligns with the mean, indicating consistent conductivity levels across the dataset. The minimum conductivity value of 380.4 µS/cm suggests areas with lower ion concentration, while the maximum conductivity of 701.4 µS/cm signifies elevated ion levels, likely influenced by. These fluctuations may be influenced by various anthropogenic and natural factors such as variations in precipitation, runoff from surrounding areas, and changes in water flow.

In terms of the calculated TDS, the mean value of 0.3748 mg/L indicates a low concentration of dissolved solids, which is generally favorable for freshwater ecosystems. The median TDS of 0.3900 mg/L suggests consistent dissolved solids levels throughout the dataset. Instances of exceptionally low TDS content, represented by the minimum value of 0.2500 mg/L, may occur in areas with minimal anthropogenic influence or pristine environmental conditions. Conversely, the maximum TDS of 0.4600 mg/L indicates higher concentrations of dissolved solids, potentially influenced by agricultural runoff, urban pollution, or natural geological processes.

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.



Dissolved Oxygen		Mean	Median	Min	Max
DO (%Sat)	Hourly	101.4	101.2	94.4	108.8
DO (mg/L)	Hourly	12.13	12.20	9.94	13.64

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

The statistical data for dissolved oxygen (DO) concentrations (mg/L) and percent saturation (% Sat) offers valuable insights into the water quality dynamics of each freshwater river within the monitoring period (Figure 5). The mean DO saturation percentage of 101.4% suggests that, on average, the water is fully saturated with oxygen, which is optimal for aquatic organisms' respiration and survival. This high mean value indicates that the river generally maintains healthy oxygen levels throughout the recorded period. The median DO saturation percentage is consistent with the mean, further confirming the overall stability of oxygen saturation levels.

Waterford River at Kilbride, Newfoundland and Labrador

Examining the minimum and maximum DO saturation percentages provides additional insights into the range of oxygen levels experienced in the river. The minimum value of 94.4% indicates a slight decrease in oxygen saturation, likely influenced by factors such as temperature fluctuations, organic matter decomposition, or reduced water flow. Conversely, the maximum value of 108.8% suggests instances of oxygen supersaturation, which could be caused by factors like increased photosynthetic activity, enhanced aeration, or lower water temperatures.

Considering dissolved oxygen concentrations in milligrams per liter (mg/L), the mean DO concentration of 12.13 mg/L aligns well with the saturation percentage data, indicating adequate oxygen levels to support aquatic life. The median DO concentration (12.20 mg/L) is also consistent with the mean, reflecting the stability of dissolved oxygen levels throughout the dataset. The minimum DO concentration of 9.94 mg/L represents a temporary decrease in oxygen levels, likely influenced by environmental factors impacting oxygen solubility or biological oxygen demand. The maximum DO concentration of 13.64 mg/L indicates periods of elevated oxygen levels, which can be beneficial for supporting sensitive aquatic species and promoting overall ecosystem resilience. Together, these metrics provide a comprehensive understanding of dissolved oxygen dynamics in the Waterford River, highlighting its capacity to sustain diverse aquatic communities and ecosystem functions.

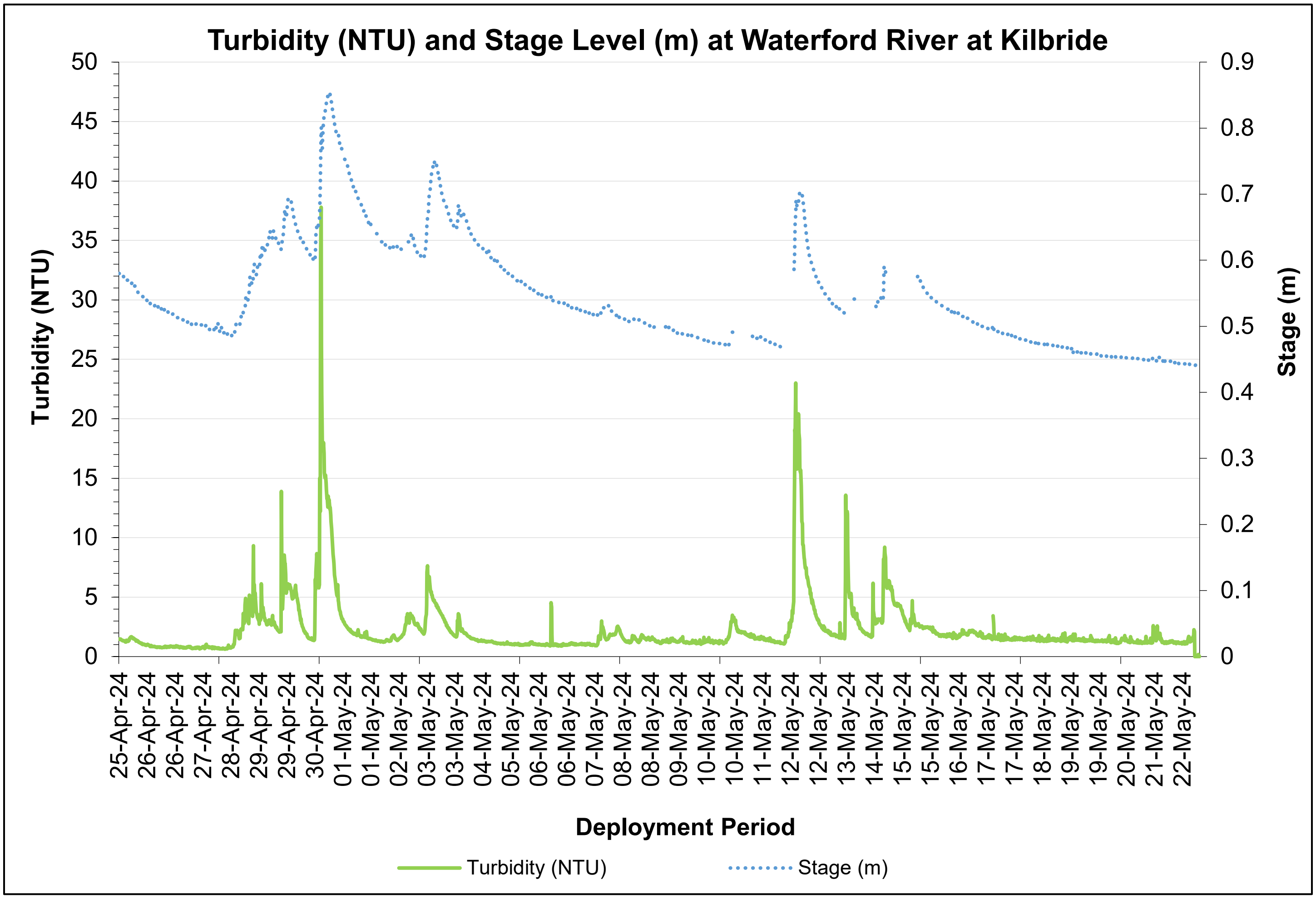
Notably, there's a decrease in both DO and %SAT values from May 15th to May 22nd, suggesting a decline in water quality and oxygen availability during this period. This decline could be attributed to various factors, including increased water temperature, reduced flow rates, and potential pollution events.

Overall, dissolved oxygen level remained consistently above the Canadian Council of Ministers of the Environment (CCME) Guideline for the Protection of the Other Life (6.5 mg/L), and at or above the CCME guideline of 9.5 mg/l for the protection of early life stage cold water biota for most of the deployment period.

A diurnal variation pattern was evident. The extent of this variation is linked to the daily range of water temperature, duration of daylight, and fluctuations in rates of photosynthesis and respiration. Consequently, the observed attenuation of the diurnal pattern is expected (early May to end of deployment period), given the increase in aquatic biotic activity, and broadening daily temperature ranges during the winter to spring season.

Turbidity

Water turbidity is characterized by the cloudiness or haziness caused by suspended particles and can significantly impact water quality. High turbidity reduces light penetration, hindering photosynthesis and affecting aquatic vegetation growth and habitat suitability. It can lead to temperature fluctuations, oxygen depletion from microbial decomposition of organic matter, and sedimentation, smothering benthic habitats and compromising biodiversity. Turbidity can also transport nutrients and pollutants, contributing to eutrophication, algal blooms, and contamination of drinking water sources. Furthermore, it highlights the significance of monitoring and managing turbidity levels to uphold the health and functionality of aquatic ecosystems.



Turbidity (NTU)	Mean	Median	Min	Max
Hourly	2.3	1.5	0.6	37.8

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

The turbidity levels in the Waterford River at Kilbride from April 25 to May 22, 2024, provide insights into the water's clarity or cloudiness caused by suspended particles. The data illustrates fluctuations in turbidity over the observed period. With a mean turbidity of 2.3 NTU, the average clarity suggests moderately clear water conditions with some suspended particles or sediment present. The median turbidity value of 1.5 NTU closely aligns with the mean, indicating relatively consistent clarity across the dataset, albeit with some variability. The minimum turbidity value of 0.6 NTU represents periods of relatively clear water, indicating good visibility within the river. However, the maximum turbidity recorded at 37.8 NTU signifies instances of significantly elevated cloudiness, likely caused by factors such as sediment runoff, increased turbidity from rainfall events, or other environmental disturbances.

Notably, there's a significant spike in turbidity on April 30, where it reaches 37.8 NTU, indicating a sudden decrease in water clarity, possibly due to increased sedimentation or runoff events. Subsequently, turbidity levels gradually decrease but remain relatively elevated compared to the earlier part of the observed period.

The fluctuations in turbidity could be influenced by various factors, including precipitation events, runoff from surrounding areas, and changes in water flow. Sedimentation, erosion, and human activities such as construction or agricultural practices can also contribute to changes in turbidity levels.

Stage and Precipitation

Stage values are determined by a vertical reference and serves as an approximation of the water level at the monitoring station. In addition, stage plays a vital role in understanding various environmental parameters like specific conductivity, dissolved oxygen (DO), and turbidity. It typically rises in response to rainfall events, reflecting the influx of water into the river system. However, during snowfall, the increase in stage may not be as pronounced due to factors such as snow accumulation, which takes time to melt and contribute significantly to the water level. By tracking stage variations, we gain valuable insights into the impact of precipitation on river dynamics, helping us assess water quantity, quality, and potential environmental implications.

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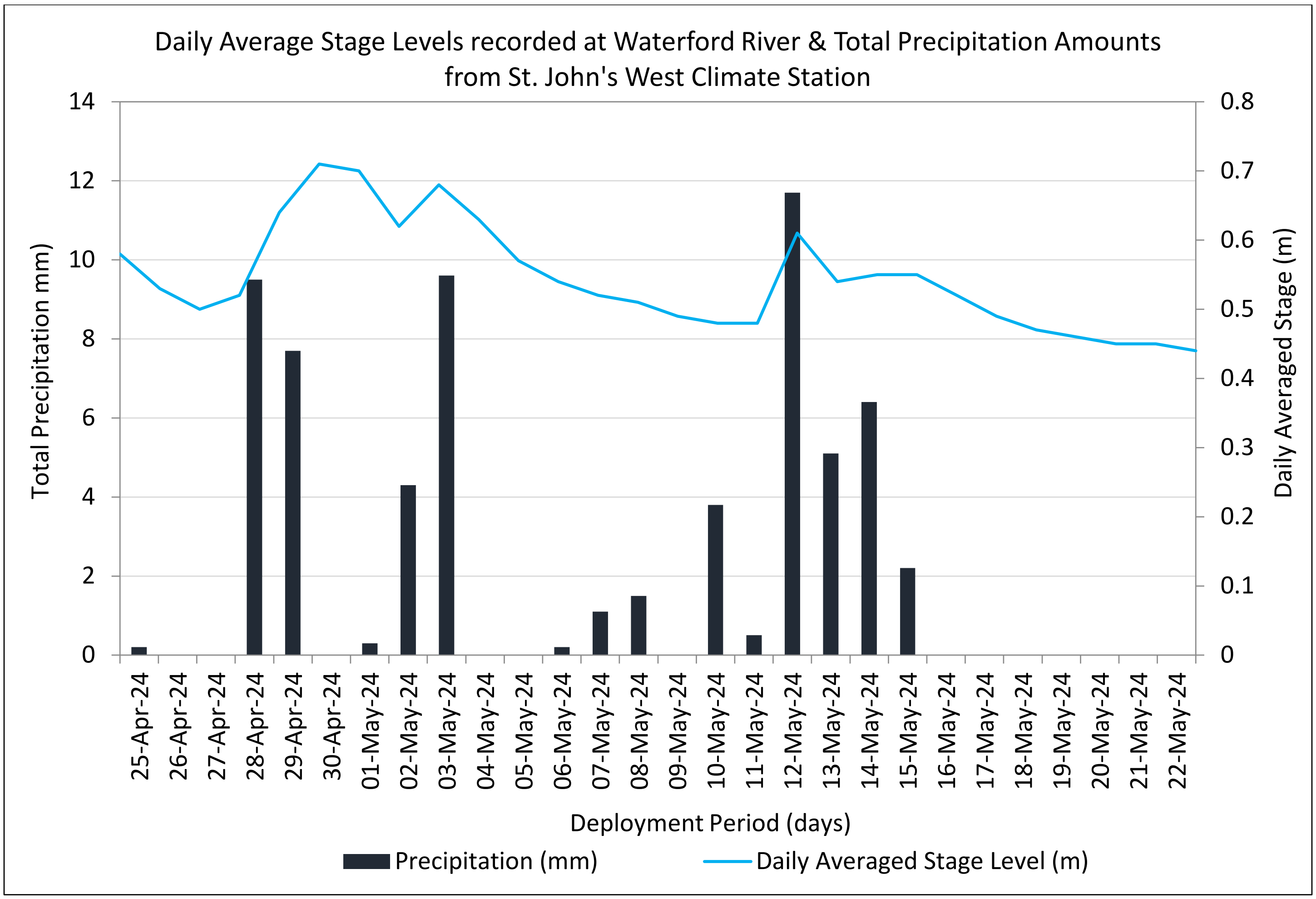


Stage (m)	Mean	Median	Min	Max
Daily Average	0.54	0.53	0.44	0.74

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.

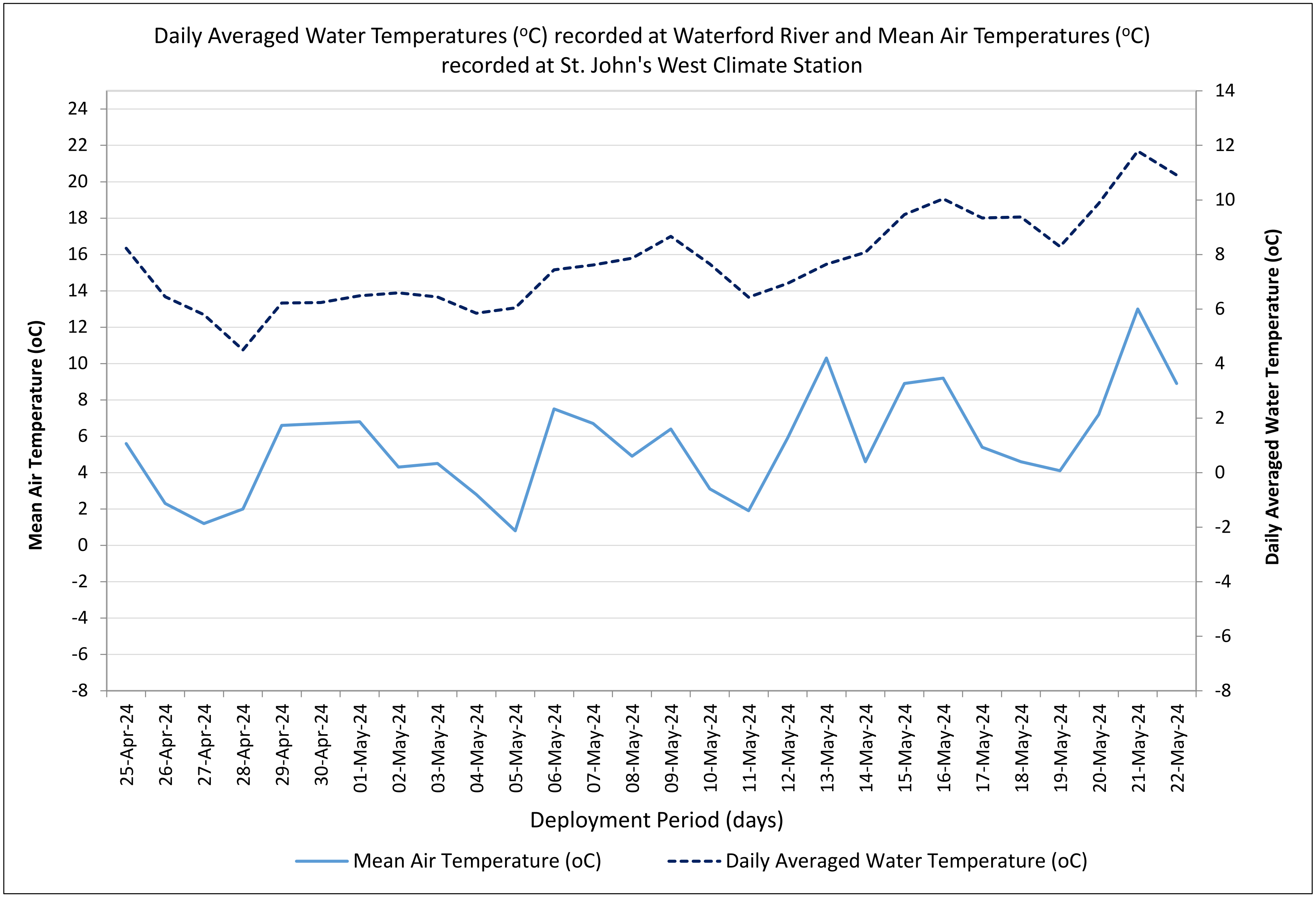
Comparing total precipitation against average daily stage and daily average flow provides insight into the relationship between rainfall and water levels in the Waterford River at Kilbride from April 25th to May 22nd, 2024. With a mean stage of 0.54 m, the average level of the river during this time frame, serves as a central reference point for observation of change. The median stage of 0.53 m, closely aligned with the mean, suggests a relatively symmetrical distribution. However, the range from the minimum stage of 0.44 units to the maximum stage of 0.74 units signifies some variability in river levels (Figure 7).

On days with precipitation, there tends to be an observable increase in average daily stage, indicating a direct response of the river to rainfall events. For example, on April 28, there was a total precipitation of 9.5 mm, corresponding to an increase in average daily stage to 0.52 m. Similarly, on May 12, with a substantial precipitation of 11.7 mm, there's a noticeable spike in stage, reaching 0.61 m.

However, there are instances where rainfall does not directly lead to increased water levels. For example, on April 25, despite a precipitation event of 0.2 mm, there's a slight increase in average daily stage and flow, but it's relatively minor compared to days with higher precipitation levels. Additionally, there are days with zero precipitation where stage and flow remain relatively stable or even decrease slightly.

These discrepancies highlight the complex interactions between precipitation and stage. Factors such as current soil moisture levels, land use, and basin characteristics can influence how much precipitation infiltrates the soil, runs off into the river, or evaporates.

APPENDIX A: MEAN DAILY AIR TEMPERATURE AND AVERAGE WATER TEMPERATURE


Daily Averaged Water Temperatures (°C) recorded at Waterford River and Mean Air Temperatures (°C) recorded at St. John's West Climate Station
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
14
12
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-8
25-Apr-24
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10-May-24
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14-May-24
15-May-24
16-May-24
17-May-24
18-May-24
19-May-24
20-May-24
21-May-24
22-May-24
Deployment Period (days)
Mean Air Temperature (oC)
Daily Averaged Water Temperature (oC)

APPENDIX B: QA/QC GRAB SAMPLE FIELD RESULTS