Real-Time Water Quality Deployment Report

Paddy's Pond at Outlet

June 3, 2024, to July 17, 2024

Newfoundland Labrador

Government of Newfoundland & Labrador
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CONTENTS

General

The Department of Environment and Climate Change, Water Resources Management Division staff monitor water quality in real-time at Paddy's Pond at the outlet to Three Arm Pond (47.488129N, 52.893809W).

Data compilation and analysis for this report includes the dates between June 3, 2024, to July 17, 2024.

Figure 1: Paddy's Pond at Outlet Real-Time Water Quality Station location.

Maintenance and Calibration of Instrument

As part of the Quality Assurance and Quality Control protocol (QAQC), 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.

Upon deployment, a QA/QC Sonde is temporarily deployed *in situ*, adjacent to the Field Sonde. Depending on the degree of difference between each parameter from the Field and QA/QC sondes, a qualitative rank is assigned (See Table). The possible ranks, from most to least desirable, are Excellent, Good, Fair, Marginal, and Poor. A grab sample is also taken for additional confirmation of conditions at deployment and to allow for future modelling studies.

Table 1: 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

At the end of a deployment period, a freshly cleaned and calibrated QA/QC Sonde is placed *in situ*, adjacent to the Field Sonde. Deployment and removal comparison rankings for the station at Paddy's Pond deployed from June 03, 2024, to July 17, 2024, are summarized in Table 2.

Table 2: Qualitative QA/QC comparison rankings for Paddy's Pond at outlet station June 03, 2024, to July 17, 2024.

Station	**Date**	**Action**	**Comparison Ranking**				
			Temperature	**pH**	**Conductivity**	**Dissolved Oxygen**	**Turbidity**
Paddy's Pond at Outlet	2024-06-03	Deployment	Excellent	Excellent	Poor	Excellent	Excellent
	2024-06-03	Grab Sample #2024-1708-00-SI-SP	N/A	Excellent	Poor	N/A	Excellent
	2024-07-17	Removal	Excellent	Excellent	Good	Excellent	Excellent

On June 03, a real-time water quality monitoring instrument was deployed at the station Paddy's Pond at Outlet. The instrument was deployed for a period of 45 days and was removed on July 17, 2024.

Comparison rankings between the Quality Assurance/Quality Control (QAQC) instrument and the field instrument at Paddy's Pond outlet on June 03, 2024, reveal alignment in some parameters but discrepancies in others. Both instruments agree on temperature, pH, dissolved oxygen and turbidity, ranking them as 'Excellent', indicating accurate and reliable measurements. However, there are disparities in conductivity rankings, with the field instrument showing a 'Poor' ranking for conductivity. Given the 'Poor' comparison ranking for conductivity between the grab sample (#2024-1708-00-SI-SP) and the field sonde, it is likely sediment was stirred up around the sonde and where the grab sample was taken. Grab sample comparison rankings were also provided for pH and turbidity as 'Excellent'.

Upon removing the instrument on July 17, 2024, the conductivity ranking had improved from 'Poor' to 'Good', likely due to sediment not being disturbed in the area. Temperature, pH, dissolved oxygen, and turbidity retained their rankings of 'Excellent'.

DATA INTERPRETATION

The following graphs and discussion illustrate water quality data obtained hourly from June 03, 2024, to July 17, 2024, at Paddy's Pond at outlet to Three Arm Pond, St. John's, NL.

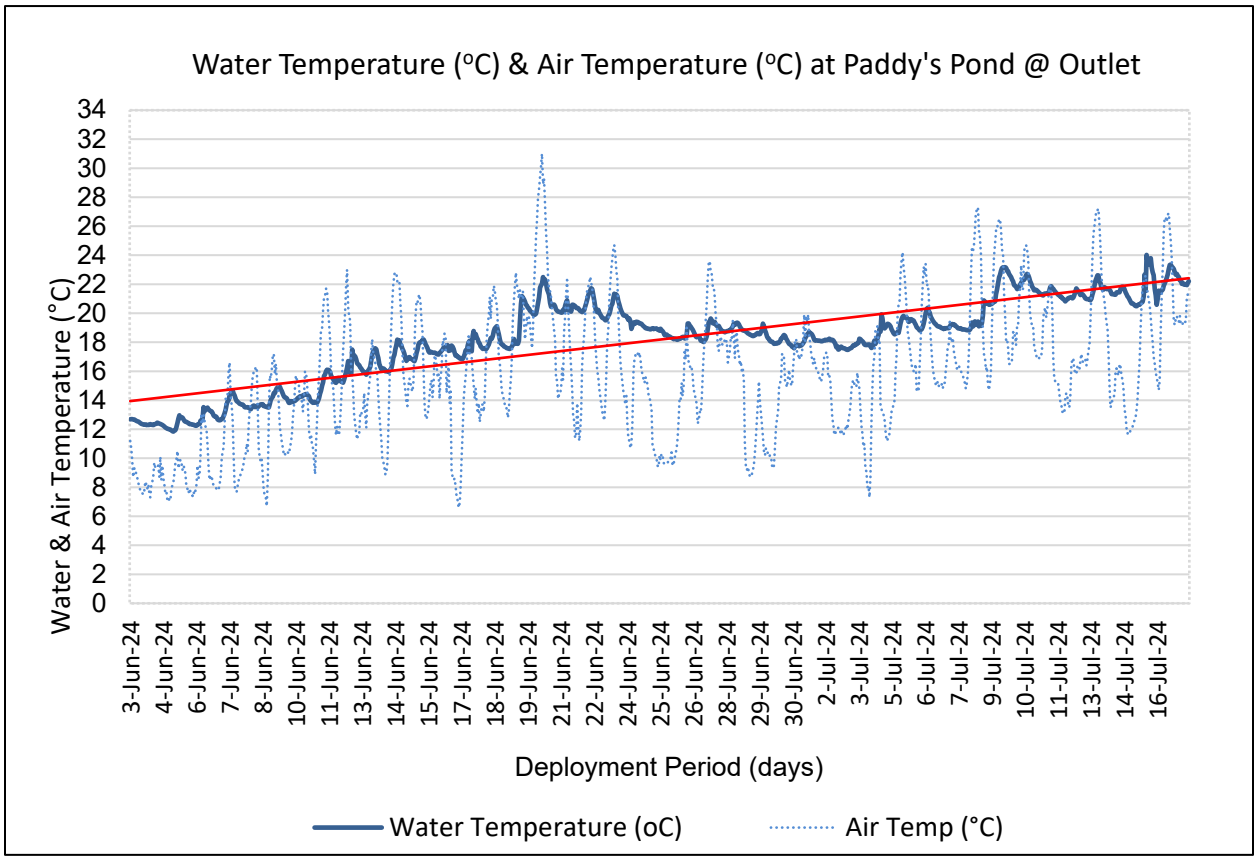
Stage is not monitored at this station and as such cannot be discussed with respect to other monitored water quality parameters. All data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol.

Mean daily temperature and total precipitation data was obtained from the Department of Environment and Climate Change Canada (ECCC) historical weather data at https://climate.weather.gc.ca/historical_data/search_historic_data_e.html and can be found illustrated in Appendix A. Gaps in available daily data were removed for graphing purposes.

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.

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.



Water Temp	Mean	Median	Min	Max
Hourly	18.18	18.52	11.84	24.02

Figure 2: Water temperature (°C) values at Paddy's Pond at Outlet.

The daily temperature for Paddy's Pond at Outlet Station over a 45-day period are depicted in Figure 2, spanning from June 03, 2024, to July 17, 2024. Temperature fluctuations ranged from a minimum of 11.84°C to a maximum of 24.02°C, with a median of 18.52°C and a mean of 18.18°C. These variations likely reflect seasonal changes from late spring to mid-summer.

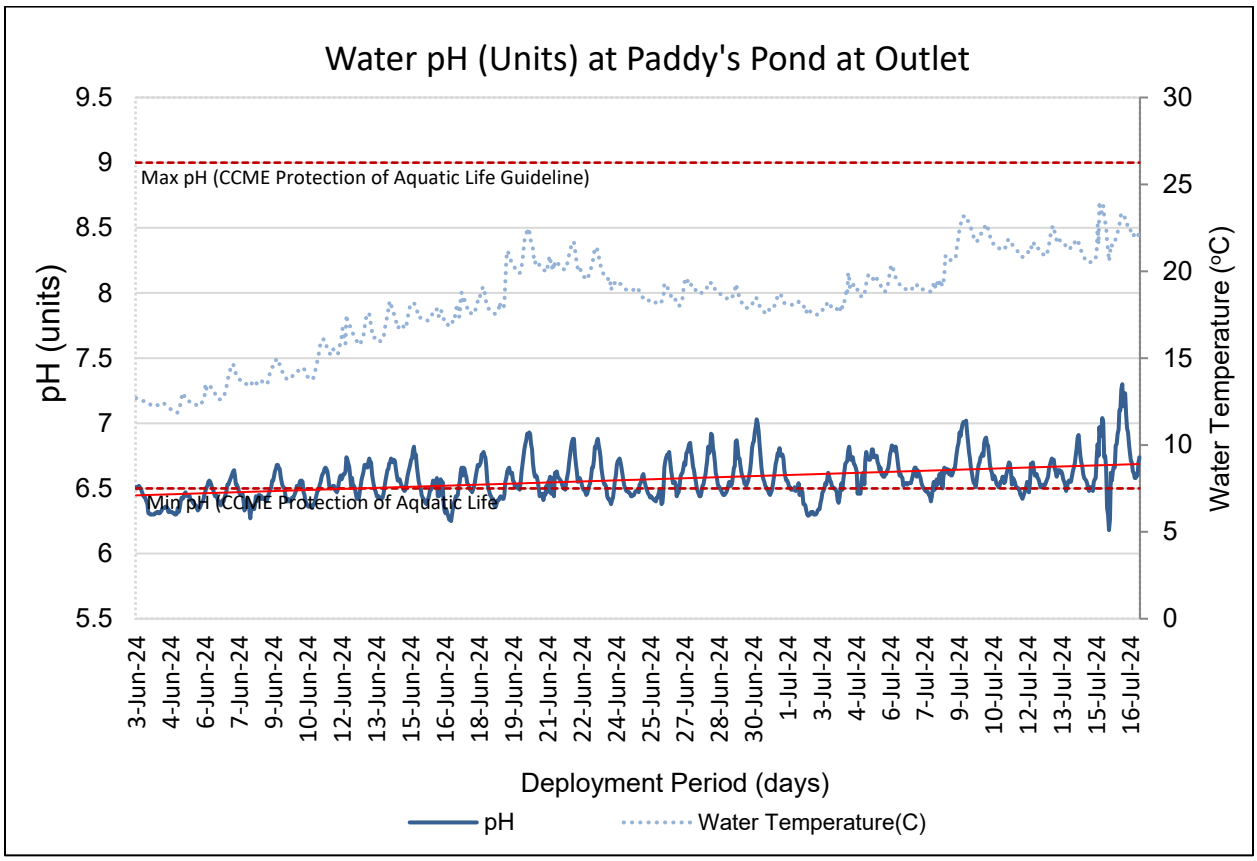
Throughout this period, there are noticeable fluctuations in water temperature, likely influenced by daily weather variations such as changes in air temperature, sunlight exposure, and rainfall. Notably, there is a sharp rise in temperature around June 20, peaking at about 15°C, followed by a slight dip. Early to late July water temperature increases, reaching a maximum temperature on July 15, 2024, with minor fluctuations thereafter.

A diurnal fluctuation pattern was characterized by significant fluctuations between daytime and nighttime temperatures, as expected during this time of the year. Daytime temperatures typically rise due to solar radiation and warm air temperatures, while nighttime temperatures tended to decrease as heat dissipated into the atmosphere. These diurnal variations reflect the dynamic interplay between solar heating, atmospheric conditions, and water body characteristics, contributing to the overall thermal dynamics of the aquatic environment.

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.



pH	Mean	Median	Min	Max
Hourly	6.57	6.55	6.18	7.3

Figure 3: pH (pH units) at Paddy's Pond at outlet from June 03, 2024, through July 17, 2024.

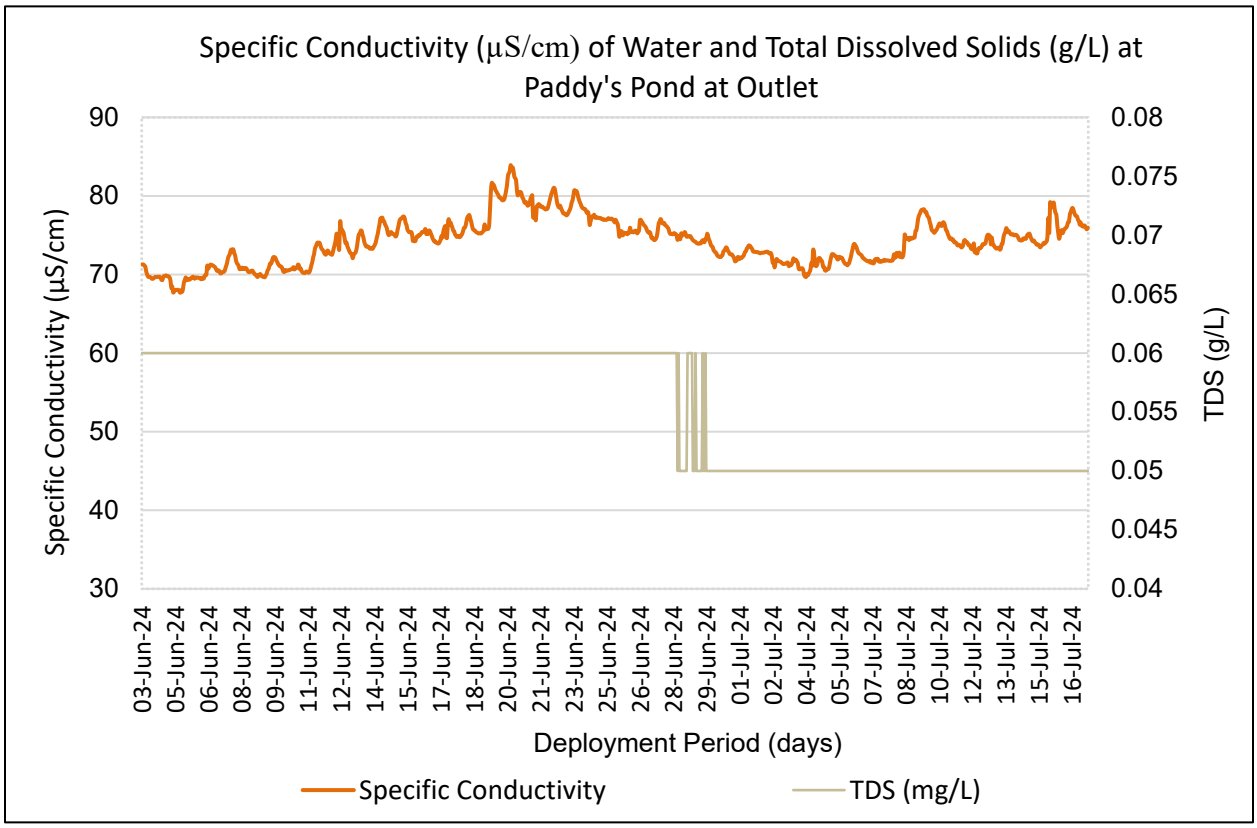
The pH of Paddy's Pond in the specified period ranged from 6.18 to 7.3 pH units, with a median of 6.55 and mean of 6.57 pH units. Although relatively stable throughout the deployment period, a slight increasing trend from the beginning (6.51) of the deployment until the end (6.74) was observed. This upward trend suggests that the water was becoming less acidic, possibly due to reduced runoff, changes in temperature, or decreased organic decay.

Most pH values were at or slightly above the CCME Protection of Aquatic Life minimum pH guideline of 6.5 units and below the maximum pH CCME Protection of Aquatic Life guideline (horizontal dashed lines). It must be noted that these are national guidelines and do not reflect the peculiarities of Newfoundland geology. This guideline provides a basis for the overall health of the waterbody. Paddy's Pond at Outlet pH values were slightly below the minimum guideline but historically typical for this waterbody. Other pH reducing influences include lower water temperatures and the addition of more acidic rainwater and/or snowmelt runoff during precipitation events. (See Figure 7 – Appendix A).

Diurnal variation pattern was visible as the magnitude of variation correlates to daily water temperature range, length of days and fluctuations in photosynthesis and respiration rates. Inconsistencies to the diurnal variation pattern, as seen on June 15-16, 2024, July 1-3, 2024, and July 7, 2024, are likely the result of an increase in precipitation events as seen in Appendix A - Figure 7. The addition of cool precipitation can decrease water temperature, lowering the concentration of dissolved ions and specific conductivity.

Specific Conductivity

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.



Parameter	Mean	Median	Min	Max
Sp. Conductivity	74.14	74.10	67.68	83.92
TDS	0.0560	0.0600	0.0500	0.0600

Figure 4: Specific Conductivity (µS/cm) & TDS values at Paddy's Pond at Outlet.

Specific conductivity measurements recorded hourly from June 3 to July 17, 2024, depicted in Figure 4, indicate a minimum and maximum range of 67.78 to 83.92 µS/cm respectively, a mean of 74.14 µS/cm and median of 74.10 µS/cm. These close mean and median values suggest a fairly symmetrical distribution of the data.

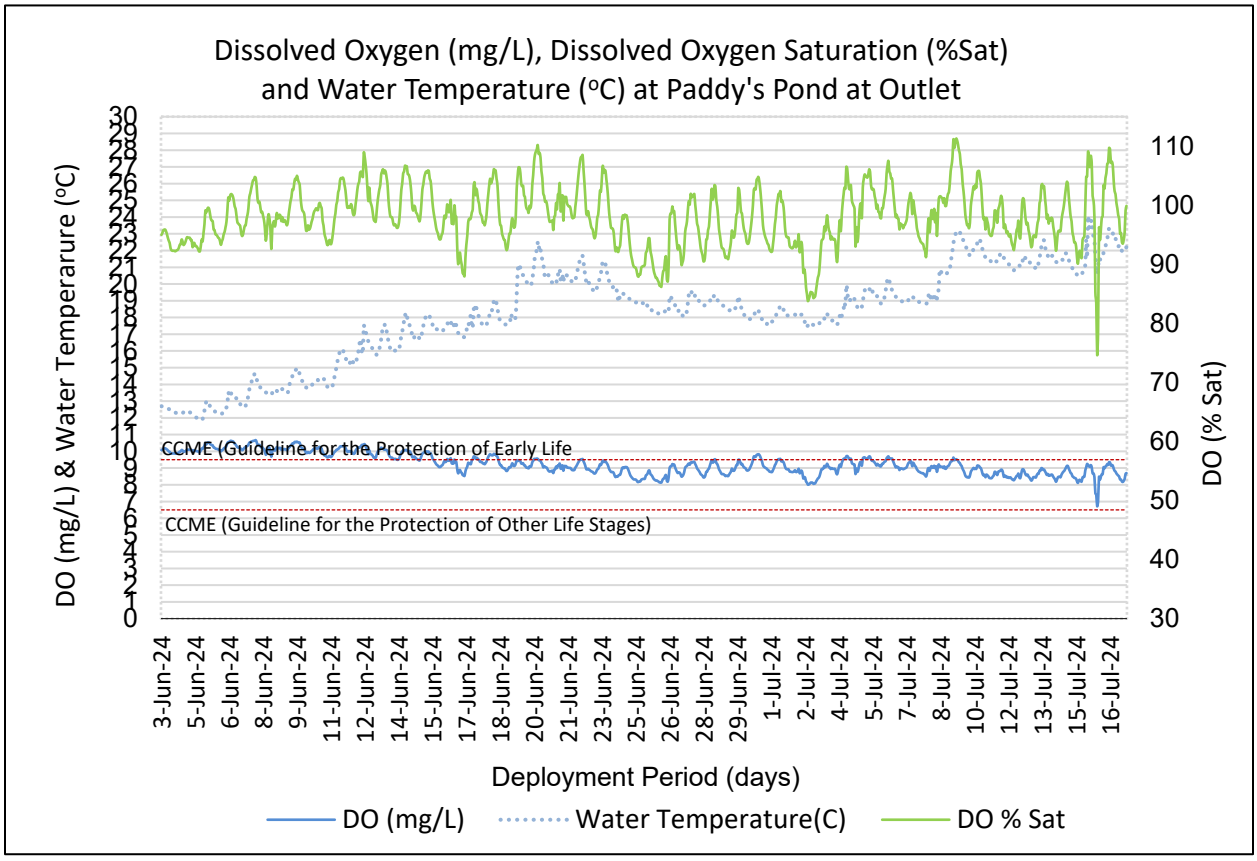
Conductivity initially decreased from 71.28 µS/cm to 67.68 µS/cm in early June, likely due to cooler temperatures or rainfall dilution. From June 5 onwards, conductivity stabilized and then rose steadily, reaching 71.26 µS/cm by June 10. Peaks around June 14 and June 20, reaching up to 83.92 µS/cm, may be the result of runoff or low stage conditions. From mid-June to early July, conductivity decreased steadily as near daily precipitation events occurred. From early to

mid-July, conductivity began to increase again, often exceeding 75 µS/cm, and ending at 78.52 µS/cm. Higher temperatures likely contributed to increased ion dissolution.

Total dissolved solids (TDS), which measure the combined content of all inorganic and organic substances dissolved in the water, have a calculated mean value of 0.0.056 g/L and a median of 0.0600 g/L over the deployment period. The close values of the mean and median values suggest a relatively balanced distribution. The minimum TDS recorded is 0.0500 g/L, while the maximum is 0.0600 g/L. This range of TDS values indicates fluctuations in the concentration of dissolved substances, likely correlating with changes in specific conductivity.

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.



Parameter	Mean	Median	Min	Max
DO (mg/L)	9.26	9.17	6.71	10.67
DO (% Sat)	97.9	97.9	74.6	111.3

Figure 5: Dissolved Oxygen (mg/L & Percent (%) Saturation) values at Paddy's Pond at Outlet.

Statistical analysis of dissolved oxygen (DO) levels in a Paddy's Pond, detailing both concentrations measured in (mg/L) and percent saturation (% Sat) were calculated and mean and median values for DO concentration were determined to be around 9.26 mg/L and 9.17 respectively, indicating some stability within this range. However, fluctuations are evident, with instances of lower concentrations (minimum value of 6.71 mg/L) and higher concentrations (maximum value of 10.67 mg/L) observed across sampling period. Similarly, the mean and

median values for DO saturation percentage indicate a generally high level of oxygen saturation at around 97.9%. Overall, a decreasing trend was observed from the start to the end of the deployment period.

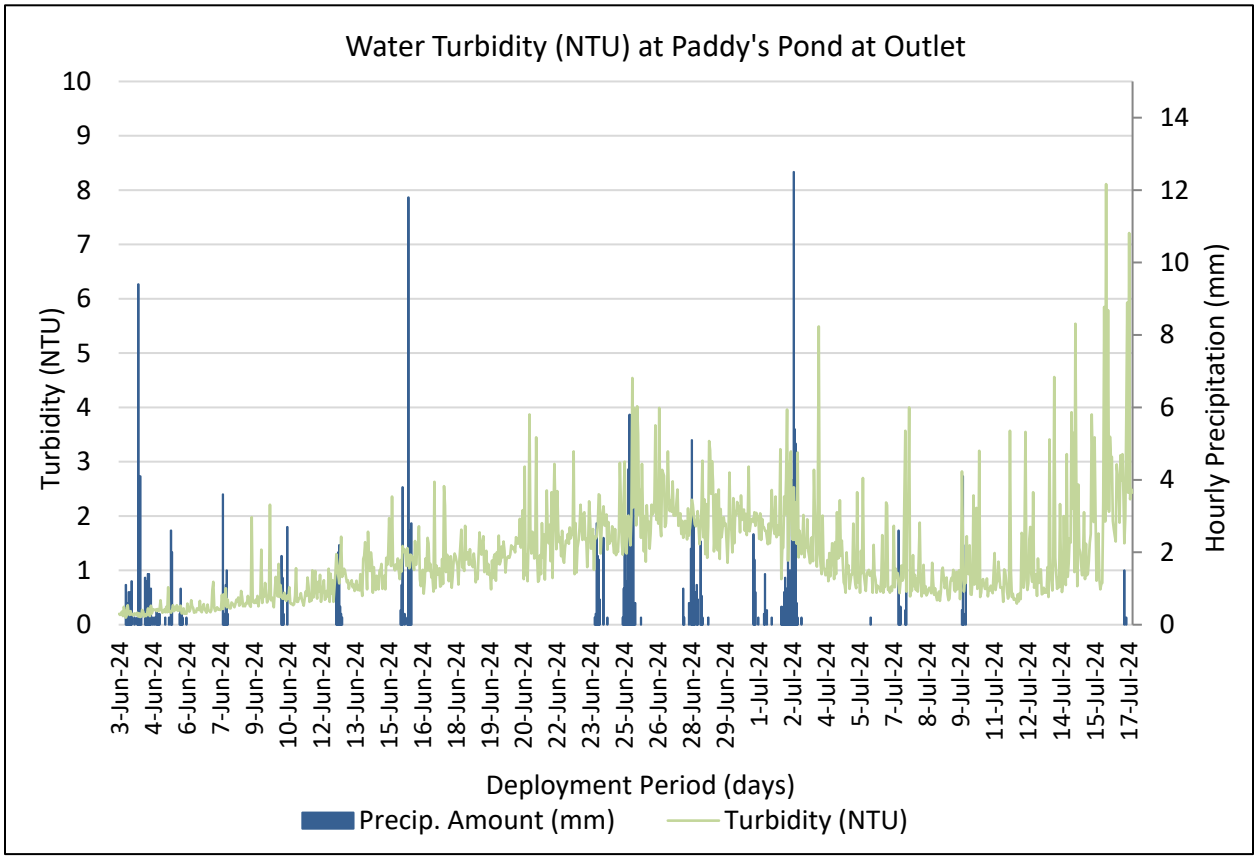
The DO% range between the minimum (74.6%) and maximum (111.3%) values indicates notable variability. Low concentrations indicate possible instances where the water may be relatively undersaturated with oxygen. This could potentially be a cause for concern as it indicates a lower-than-ideal oxygen level for aquatic organisms. The maximum value of 111.3% is somewhat high and could indicate either an error in measurement or some exceptional environmental conditions, such as super-saturation due to rapid aeration or photosynthesis. 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.

Diurnal variation pattern was visible throughout the deployment period due to longer sun hours and the correlation between water temperature and air temperature. Variations can be influenced by water depth during deployment as shallow water temperatures will change more rapidly, especially in a lake environment such as Paddy's Pond. As well as linked to the daily range of water temperature, duration of daylight, precipitation (as seen on June 15-16, 2024, June 25, 2024, and July 2, 2024) and fluctuations in rates of photosynthesis and respiration.

The dissolved oxygen values were above or near the CCME Guideline for the Protection of Early Life Stages (9.5 mg/L) and remained above the CCME Guideline for the Protection of Other Life Stages (6.5mg/L) for the entire deployment period.

Turbidity

Turbidity is typically caused by fine suspended solids such as silt, clay, or organic material. Consistently high levels of turbidity tend to block sunlight penetration into a waterbody, discouraging plant growth. High turbidity can also damage the delicate respiratory organs of aquatic animals and cover spawning areas.



Turbidity	Mean	Median	Min	Max
Hourly	1.26	0.06	0.13	8.11

Figure 6: Water turbidity (NTU) values at Paddy's Pond at Outlet

The turbidity data collected from June 3 to July 17, 2024, reveals a consistent pattern. With a mean turbidity of 1.26 NTU, the average clarity suggests generally clear water conditions with minimal suspended particles or sediment. The median turbidity of 0.6 NTU does not align significantly with the mean, indicating some variability across the dataset, albeit minimally. The minimum turbidity value of 0.13 NTU represents exceptionally clear water, highlighting periods of excellent visibility within the pond. However, the maximum turbidity of 8.11 NTU signifies instances of slightly elevated cloudiness, likely attributed to environmental factors such as sediment runoff or wave action.

APPENDIX A: MEAN DAILY TEMPERATURE AND TOTAL PRECIPITATION

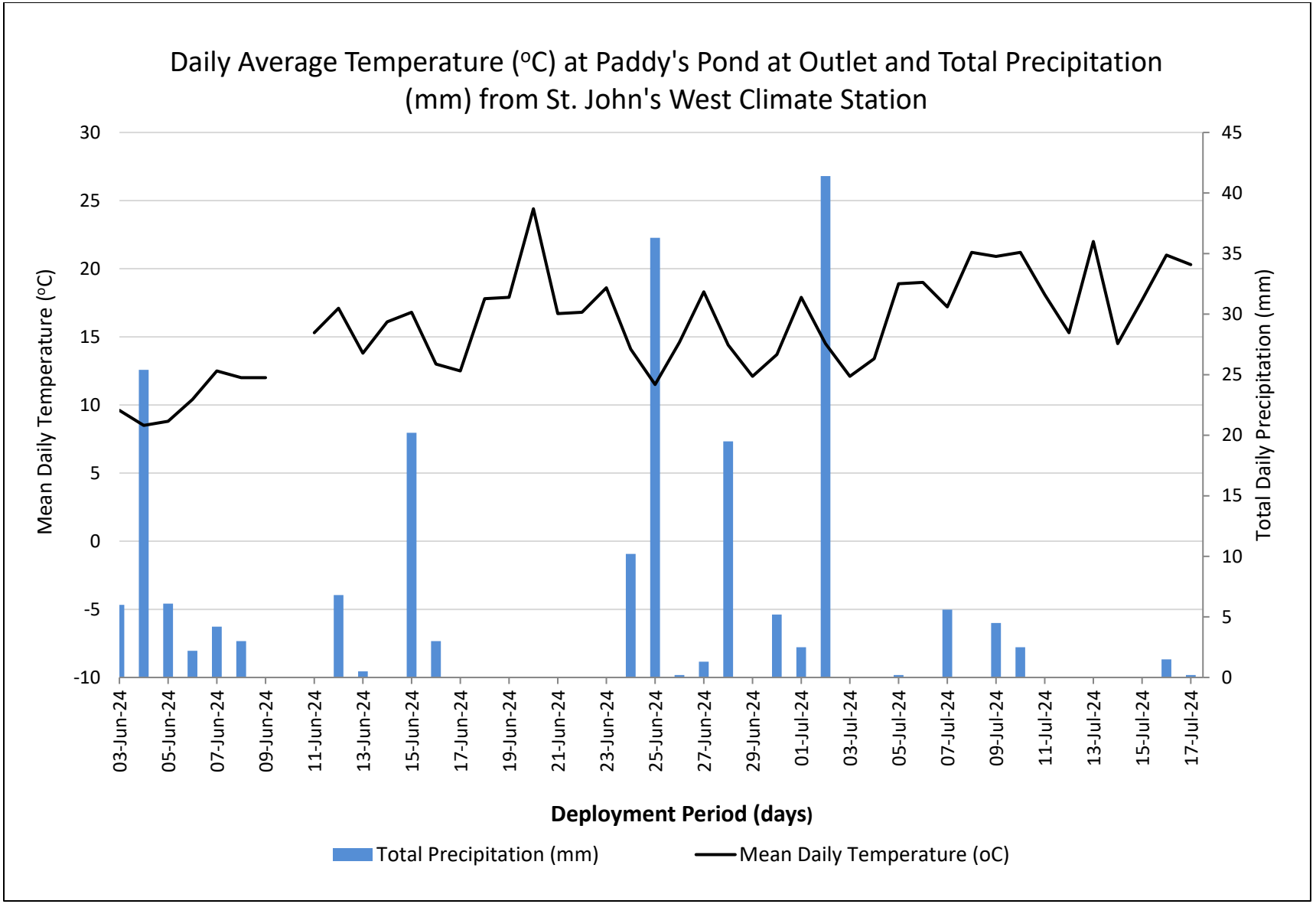


Figure 7: Mean daily air temperature and total precipitation at St. John's West near Paddy's Pond June 2, 2024, to July 17, 2024.

APPENDIX B: Water Parameter Description

Dissolved Oxygen - The amount of Dissolved Oxygen (DO) (mg/l) in the water is vital to aquatic organisms for their survival. The concentration of DO is affected by such things as water temperature, water depth and flow (e.g., aeration by rapids, riffles etc.), consumption by aerobic organisms, consumption by inorganic chemical reactions, consumption by plants during darkness, and production by plants during the daylight (Allan 2010).

pH - pH is the measure of hydrogen ion activity and affects: (i) the availability of nutrients to aquatic life; (ii) the concentration of biochemical substances dissolved in water; (iii) the efficiency of hemoglobin in the blood of vertebrates; and (iv) the toxicity of pollutants. Changes in pH can be attributed to industrial effluence, saline inflows or aquatic organisms involved in the photosynthetic cycling of CO_2 (Allan 2010).

Specific conductivity - Specific conductivity (µS/cm) is a measure of water's ability to conduct electricity, with values normalized to a water temperature of 25ºC. Specific conductance indicates the concentration of dissolved solids (such as salts) in the water, which can affect the growth and reproduction of aquatic life. Specific conductivity is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

Stage – Stage (m) is the elevation of the water surface and is often used as a surrogate for the more difficult to measure flow.

Temperature - Essential to the measurement of most water quality parameters, temperature (^oC) controls most processes and dynamics of limnology. Water temperature is influenced by such things as ambient air temperature, solar radiation, meteorological events, industrial effluence, wastewater, inflowing tributaries, as well as water body size and depth (Allan 2010; Hach 2006).

Total Dissolved Solids - Total Dissolved Solids (TDS) (g/l) is a measure of alkaline salts dissolved in water or in fine suspension and can affect the growth and reproduction of aquatic life. It is affected by rainfall events, the composition of inflowing tributaries and their associated geology, saline inflow (e.g., road salt), agricultural run-off and industrial inputs (Allan 2010; Swanson and Baldwin 1965).

Turbidity - Turbidity (NTU) is a measure of the translucence of water and indicates the amount of suspended material in the water. Turbidity is caused by any substance that makes water cloudy (e.g., soil erosion, micro-organisms, vegetation, chemicals, etc.) and can correspond to precipitation events, high stage, and floating debris near the sensor (Allan 2010; Hach 2006; Swanson and Baldwin 1965.

APPENDIX C: QA/QC GRAB SAMPLE FIELD RESULTS