



Real-Time Water Quality Deployment Report

Paddy's Pond at Outlet

May 5, 2022 to June 7, 2022



Government of Newfoundland & Labrador
Department of Environment and Climate Change
Water Resources Management Division
St. John's, NL, A1B 4J6 Canada

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General

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



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 QAQC sondes a qualitative rank is assigned (See Table 1). 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

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

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 between May 5 and June 7, 2022 are summarized in Table 2.

Table 2: Qualitative QA/QC comparison rankings for Paddy's Pond at outlet station May 5, 2022 through June 7, 2022.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Paddy's Pond at Outlet	2022-05-05	Deployment	Fair	Excellent	Good	Good	Fair
	2022-05-05	Grab Sample #2021-1704-00-SI-SP	N/A	Excellent	Fair	N/A	Excellent
	2022-06-07	Removal	Excellent	Fair	Good	Excellent	Excellent

- On May 5, 2022, 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 34 days and was removed on June 7, 2022.
- Upon deployment, all sensors ranked 'Excellent', 'Good' and 'Fair' against the calibrated QA/QC sonde. Potential causes for less than excellent QA/QC rankings to be obtained include: the placement of the QA/QC sonde in relation to the field sonde, the amount of time each sonde was given to stabilize before readings were recorded; and deteriorating performance of one of the sensors.
- Upon deployment, the measured field grab sample parameter sensors ranked 'Excellent', and 'Fair' against the field sonde. Upon review of the lab sample analysis report it was determined that the grab sample temperature was lower (7.6°C) than that of the initial ambient water temperature at the time of sampling (10.26°C) and as a result may have influenced temperature dependant parameters such as conductivity.

- At removal of the instrument, parameter rankings varied between 'Excellent', 'Good' and 'Fair' against the QA/QC sonde.

DATA INTERPRETATION

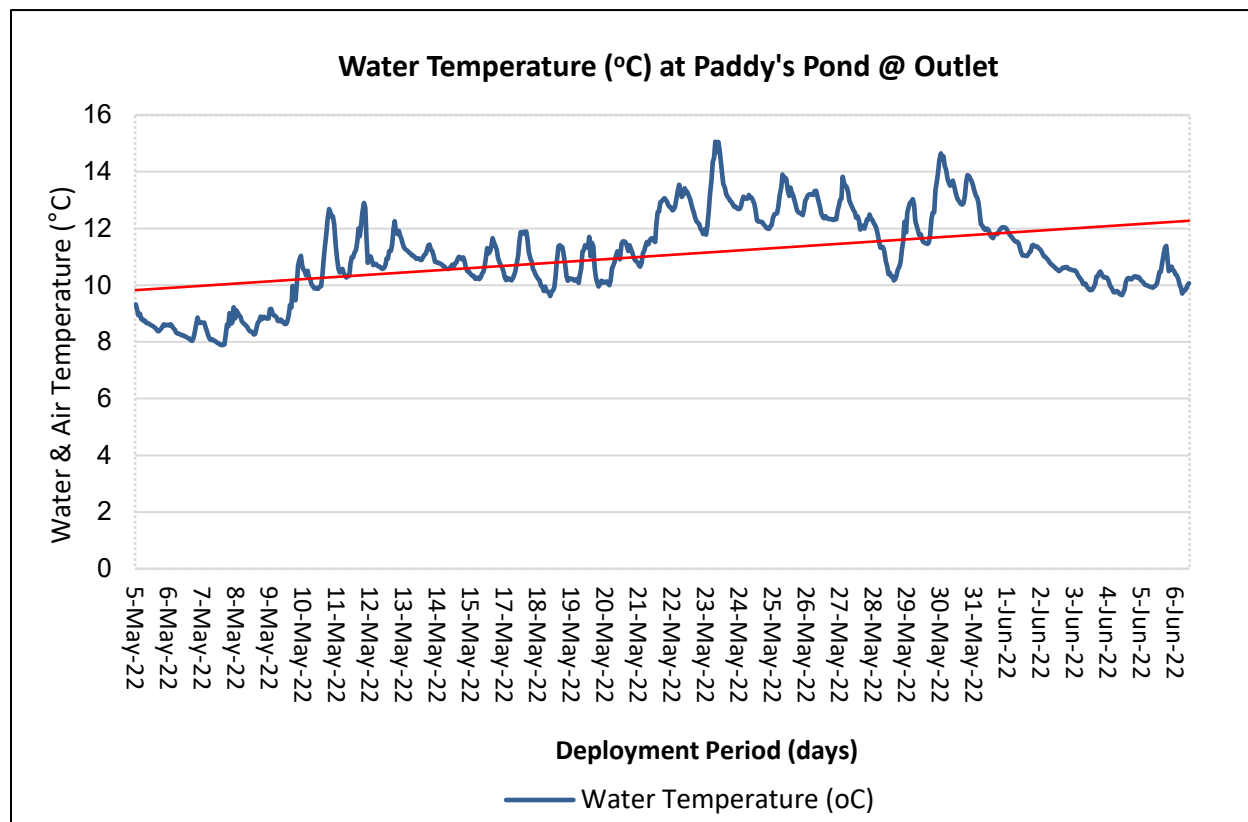
The following graphs and discussion illustrate water quality data obtained hourly from May 5, 2022 through June 7, 2022 at Paddy's Pond at outlet to Three Arm Pond, St. John's, NL.

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 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.



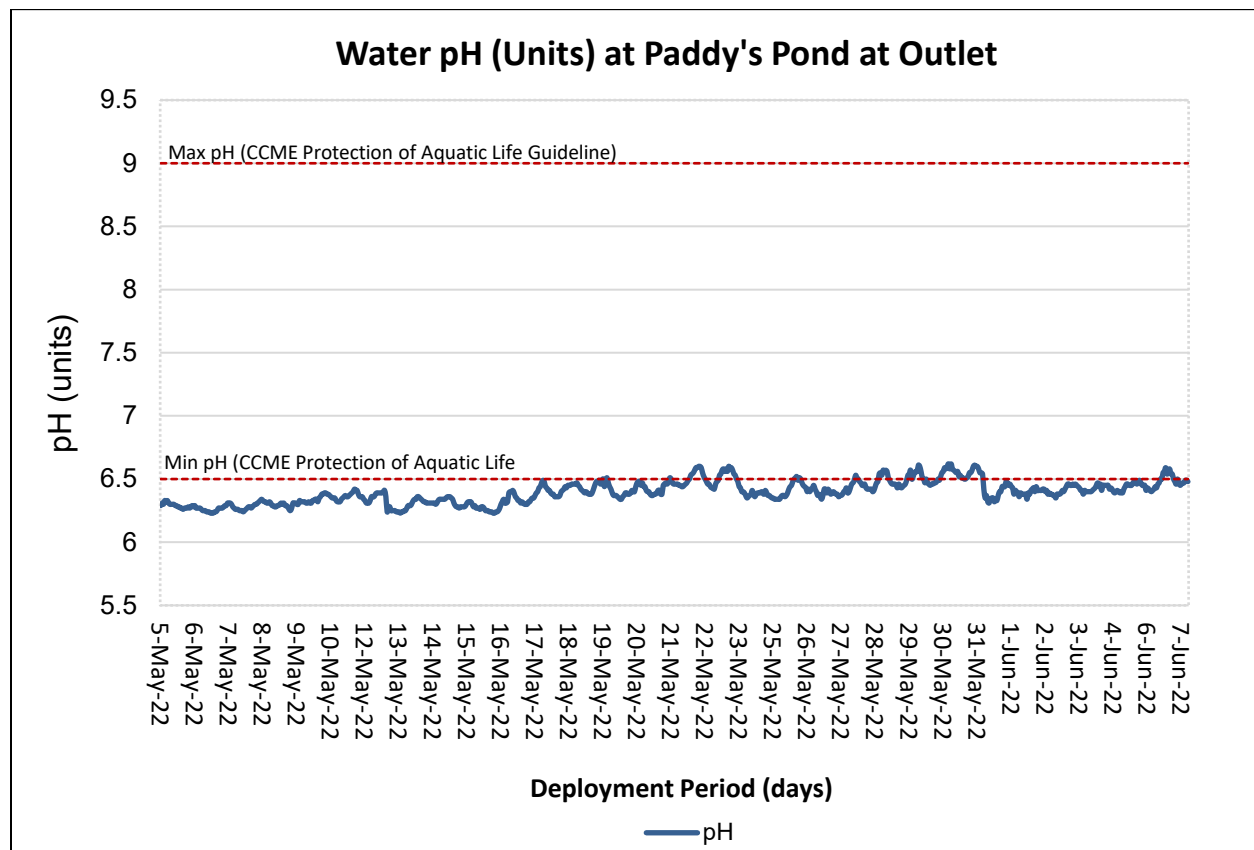
Mean	Median	Min	Max
11.05	10.97	7.89	15.06

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

- Over the 34-day deployment period, water temperature fluctuated naturally in correspondence to air temperature, increasing into the summer. The mean temperature was 11.05°C with a median of 10.97°C.
- Minimum water temperature of 7.89°C was observed on May 5, 2022 and a maximum water temperature of 15.06 °C was observed on May 23, 2022 (Figure 2).
- More significant decreases in water temperature observed below the trend, can be associated with precipitation events and the addition of cool water as seen on May 28, 2022 (See Figure 7- Appendix A).
- A natural diurnal temperature pattern with temperatures increasing during the day and decreasing overnight was observed.

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.



Mean	Median	Min	Max
6.39	6.38	6.23	6.62

Figure 3: pH (pH units) at Paddy's Pond at outlet from May 5, 2022 through June 7, 2022.

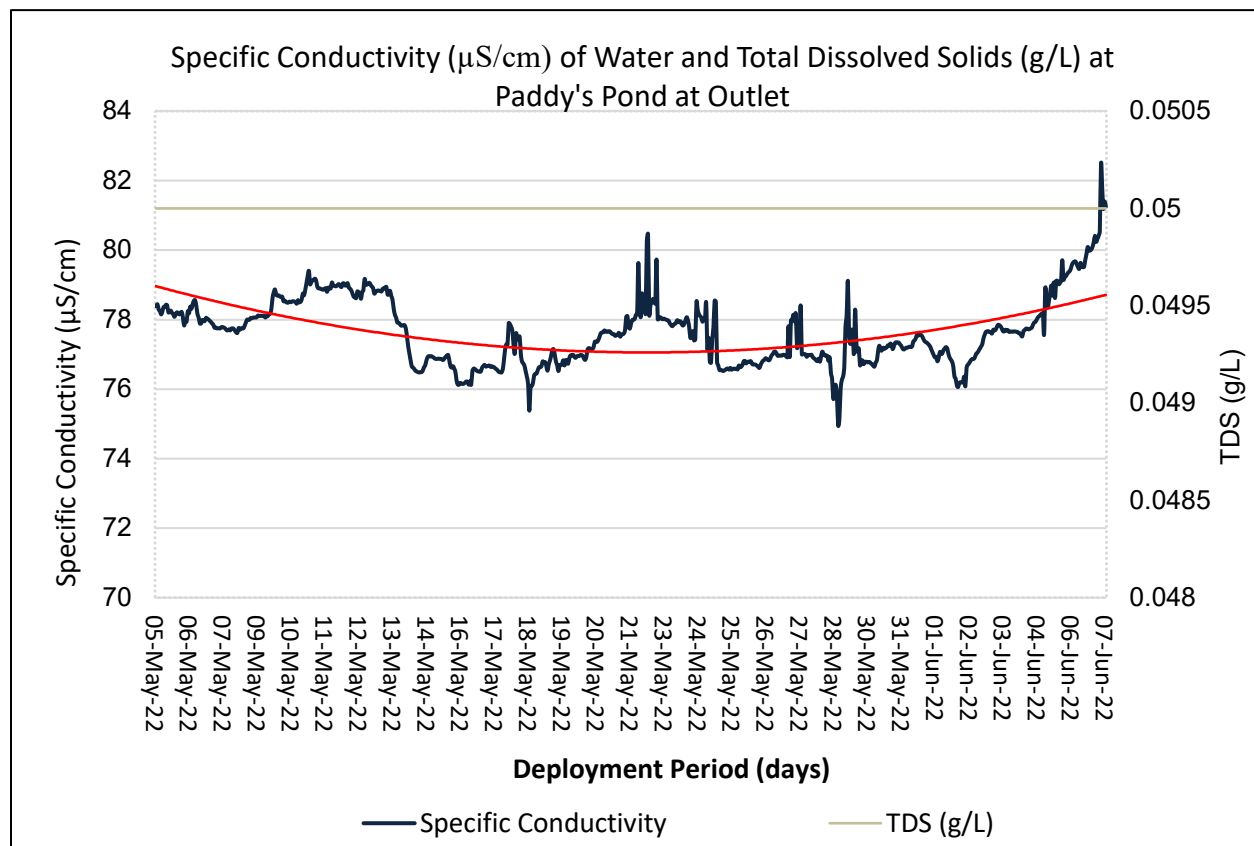
- Throughout the deployment period, pH values remained stable with a range from 6.23 to 6.62 pH units, with a mean unit value of 6.39 and median of 6.38 units (Figure 3).
- A slight decrease in pH (Figure 2) was observed near the end of the deployment period and is correlated to precipitation events May 31 to June 3 (Appendix A).
- 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. 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 due to the influence of significant rainfall.

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

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.



Mean	Median	Min	Max
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77.7	77.6	75.0	80.5
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Figure 4: Specific conductivity ($\mu\text{S}/\text{cm}$) values at Paddy's Pond at Outlet.

- Specific conductivity values varied throughout the deployment period with a slight decrease throughout May and increase near the end of the deployment period. A maximum conductivity value of $80.5 \mu\text{S}/\text{cm}$ and a minimum value of $75.0 \mu\text{S}/\text{cm}$ (Figure 4) were observed. Mean conductivity was $77.7 \mu\text{S}/\text{cm}$ with a median conductivity value of $77.6 \mu\text{S}/\text{cm}$. This trend (indicated in red in Figure 4) of decreasing ion concentrations is likely due to dilution from precipitation events.
- Variability in specific conductivity values throughout the deployment period is likely the result of temperature variations and precipitation events (Appendix A – Figure 7). A reduction in conductivity can be expected after rainfall, as the amount of water increases, solids concentration is reduced, decreasing conductivity.
- Given the isolated station location, sources of disturbances that may affect conductivity are considered minimal.
- The calculated Total Dissolved Solids (TDS) values remained stable throughout the deployment period at $0.05 \text{ g}/\text{L}$.

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.

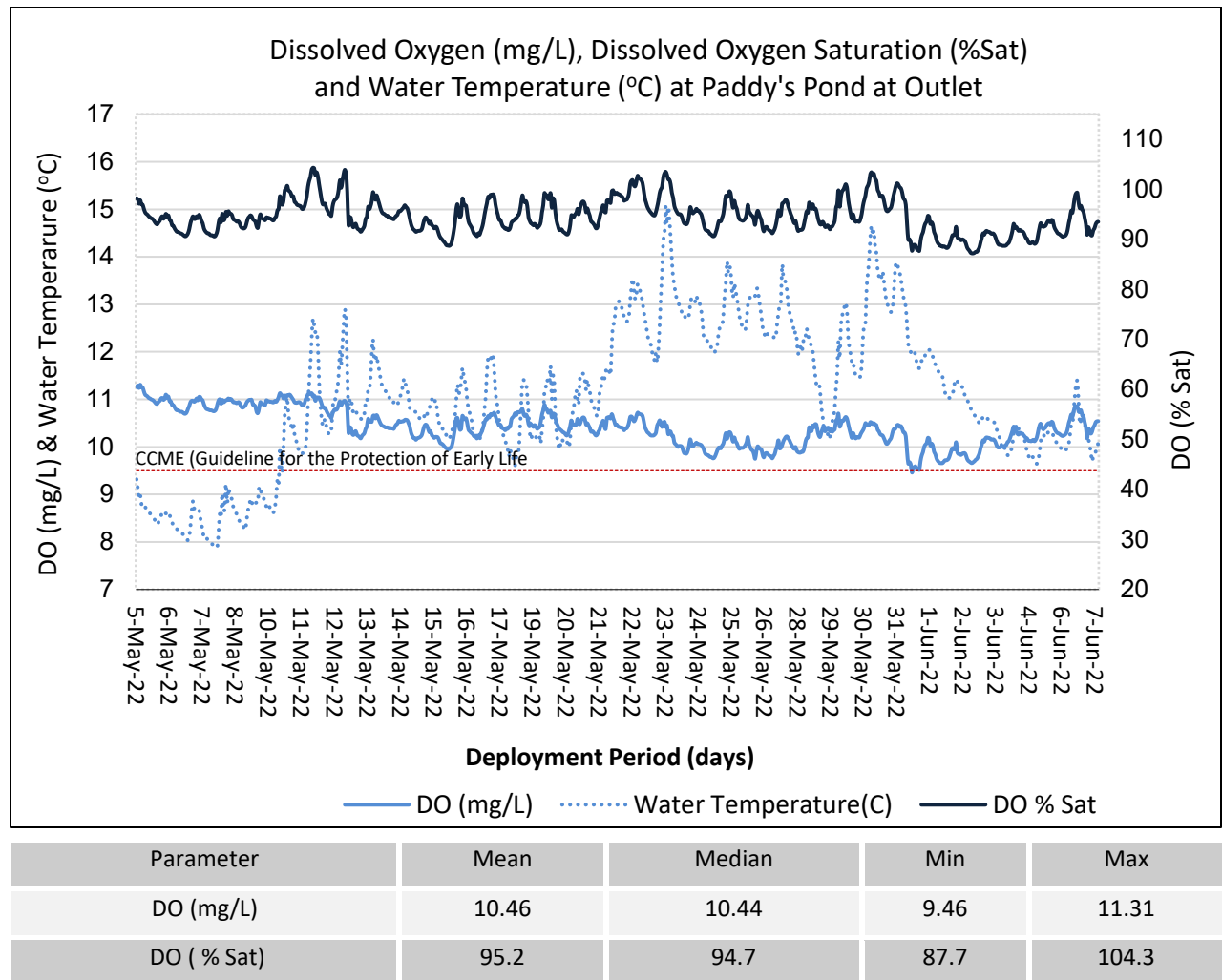


Figure 5: Dissolved Oxygen (mg/L & Percent (%) Saturation) values at Paddy's Pond at Outlet.

- Dissolved Oxygen (DO) concentrations decreased slightly over the deployment period with a maximum DO of 11.31 mg/L (104.3% Sat) to a minimum DO of 9.46 mg/L (87.7 % Sat). This is an expected natural trend due to the seasonal increase in water temperature.
- Diurnal variations were observed throughout the deployment period due to temperature ranges from day to night. Diurnal variation can be influenced by water depth during deployment as well as number of sunlight hours.
- 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) with exception to a concentration of 9.46 mg/L observed on May 31, 2022.

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.

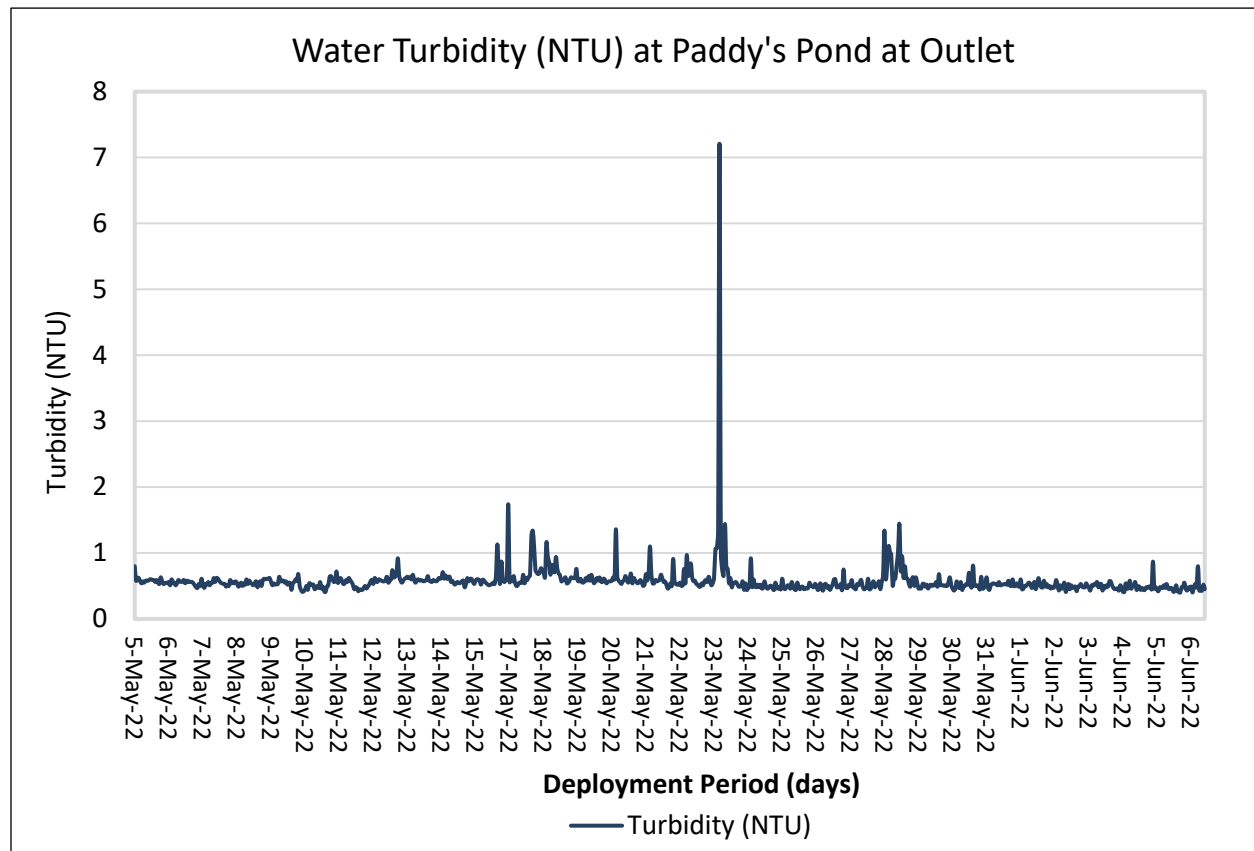


Figure 6: Water turbidity (NTU) values at Paddy's Pond at Outlet during deployment period May 5, 2022 through June 7, 2022.

- Turbidity values range from 0.4 to 7.2 NTU, with a mean of 0.6 and a median value of 0.6 NTU (Figure 6). Turbidity measurements over the deployment period indicated low turbidity values with a slight decreasing trend.
- Turbidity levels were low during this deployment period, however events above baseline levels do occur, as seen in mid-to-late May, and are likely influenced by debris, suspended algae, siltation due to wave action and precipitation events. Specifically, the precipitation event seen on May 23, 2022 and the associated turbidity spike of 7.2 NTU.

APPENDIX A : MEAN DAILY TEMPERATURE AND TOTAL PRECIPITATION

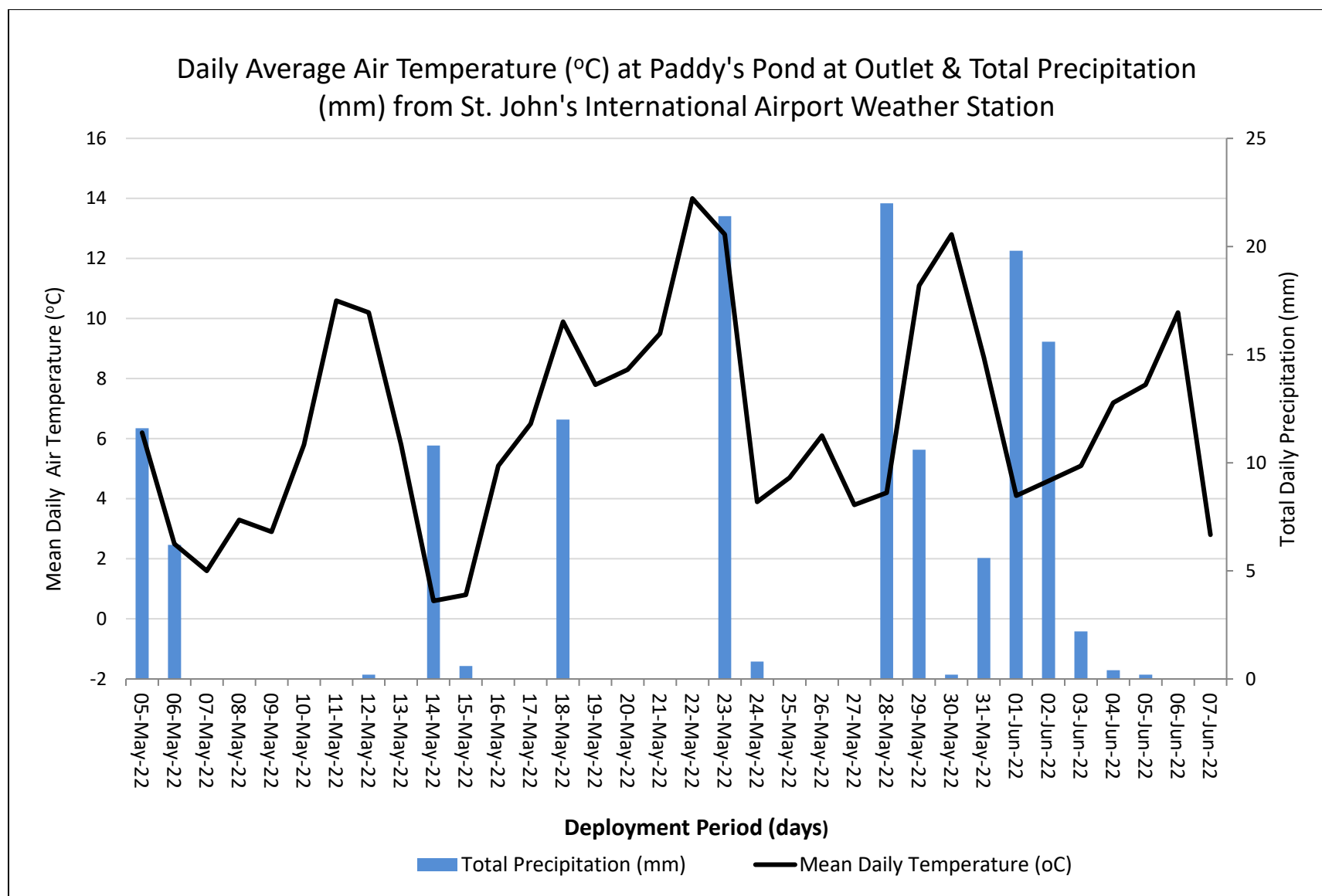


Figure 7: Mean daily air temperature and total precipitation at St. John's West near Paddy's Pond between April 5, 2022 to May 5, 2022.

APPENDIX B : QA/QC GRAB SAMPLE FIELD RESULTS



Your P.O. #: 220028978-5
 Site Location: PADDY'S POND @ OUTLET
 Your C.O.C. #: N/A, 2022-1704-00-SI-SP

Attention: Janice McCarthy

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

Report Date: 2022/05/17
 Report #: R7128763
 Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2C4824

Received: 2022/05/06, 10:09

Sample Matrix: Water
 # Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Alkalinity	1	N/A	2022/05/13	ATL SOP 00142	SM 23 2320 B
Anions (1)	1	N/A	2022/05/13	CAM SOP-00435	SM 23 4110 B m
Colour	1	N/A	2022/05/16	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (2)	1	N/A	2022/05/16	ATL SOP 00203	SM 23 5310B m
Conductance - water	1	N/A	2022/05/13	ATL SOP 00004	SM 23 2510B m
Fluoride	1	N/A	2022/05/13	ATL SOP 00043	SM 23 4500-F- C m
Hardness (calculated as CaCO3)	1	N/A	2022/05/12	ATL SOP 00048	Auto Calc
Mercury - Total (CVAA,LL)	1	2022/05/16	2022/05/16	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Total MS	1	2022/05/10	2022/05/11	ATL SOP 00058	EPA 6020B R2 m
Nitrogen Ammonia - water	1	N/A	2022/05/16	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	1	N/A	2022/05/16	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	1	N/A	2022/05/16	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	1	N/A	2022/05/17	ATL SOP 00018	ASTM D3867-16
pH (3)	1	N/A	2022/05/13	ATL SOP 00003	SM 23 4500-H+ B m
Calculated TDS (DW Pkg)	1	N/A	2022/05/13	N/A	Auto Calc
Total Kjeldahl Nitrogen in Water (1)	1	2022/05/13	2022/05/16	CAM SOP-00938	OMOE E3516 m
Organic carbon - Total (TOC) (2)	1	N/A	2022/05/16	ATL SOP 00203	SM 23 5310B m
Total Phosphorus (Colourimetric) (1)	1	2022/05/13	2022/05/16	CAM SOP-00407	SM 23 4500 P B H m
Total Suspended Solids	1	2022/05/10	2022/05/11	ATL SOP 00007	SM 23 2540D m
Turbidity	1	N/A	2022/05/13	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, 6740 Campobello Rd , Mississauga, ON, L5N 2L8

(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
Site Location: PADDY'S POND @ OUTLET
Your C.O.C. #: N/A, 2022-1704-00-SI-SP

Attention: Janice McCarthy

NL Department of Environment, Climate Change and Municipalities
Water Resources
PO Box 8700
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CANADA A1B 4J6

Report Date: 2022/05/17
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CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2C4824

Received: 2022/05/06, 10:09

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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BUREAU
VERITAS

Bureau Veritas Job #: C2C4824
Report Date: 2022/05/17

NL Department of Environment, Climate Change and
Municipalities

Site Location: PADDY'S POND @ OUTLET

Your P.O. #: 220028978-5

Sampler Initials: LB

Sample Details/Parameters	MAC	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
SOP507 PADDY'S POND @ OUTLET								
Sampling Date		2022/05/05 13:38						
Matrix		W						
Sample #		2022-1704-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	6.4	1.0	mg/L	N/A	2022/05/12		7985546
Nitrate (N)	10	ND	0.050	mg/L	N/A	2022/05/17		7985554
Total dissolved solids (calc., EC)	-	38	1.0	mg/L	N/A	2022/05/13		7985556
Inorganics								
Conductivity	-	69	1.0	uS/cm	N/A	2022/05/13	SHW	7993258
Chloride (Cl-)	-	17	1.0	mg/L	N/A	2022/05/13	SUR	7994247
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/05/13	SUR	7994247
Sulphate (SO4)	-	2.0	1.0	mg/L	N/A	2022/05/13	SUR	7994247
Total Alkalinity (Total as CaCO3)	-	2.9	2.0	mg/L	N/A	2022/05/13	SHW	7993260
Colour	-	29	5.0	TCU	N/A	2022/05/16	MCN	7993774
Dissolved Fluoride (F-)	1.5	ND	0.10	mg/L	N/A	2022/05/13	SHW	7993261
Total Kjeldahl Nitrogen (TKN)	-	0.17	0.10	mg/L	2022/05/13	2022/05/16	MJ1	7994162
Nitrate + Nitrite (N)	-	ND	0.050	mg/L	N/A	2022/05/16	MCN	7993776
Nitrite (N)	1	ND	0.010	mg/L	N/A	2022/05/16	MCN	7993778
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2022/05/16	MCN	7993658
Dissolved Organic Carbon (C)	-	4.2	0.50	mg/L	N/A	2022/05/16	NGI	7993386
Total Organic Carbon (C)	-	4.1	0.50	mg/L	N/A	2022/05/16	NGI	7996705
pH		6.46		pH	N/A	2022/05/13	SHW	7993259
Total Phosphorus	-	0.011	0.004	mg/L	2022/05/13	2022/05/16	SSV	7994638
Total Suspended Solids	-	1.8	1.0	mg/L	2022/05/10	2022/05/11	RMK	7985693

MAC: Guideline - Summary of Guidelines for Canadian Drinking Water Quality (SGCDWQ), Health Canada, September 2020.

MAC= Maximum Acceptable Concentration (MAC) - established for substances that are known or suspected to cause adverse effects on health.

AO= Aesthetic Objectives (AO) - apply to characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good quality water.

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If Screening Levels (SL) for gross alpha or gross beta are exceeded then concentration of the specific radionuclides of the CWQG should be analyzed.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.

Note 2 Aluminum guideline value of 0.1 mg/L is for treatment plants using aluminum-based coagulants, 0.2mg/L applies to other types of treatment systems.



Sample Details/Parameters	MAC	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
SOP507 PADDY'S POND @ OUTLET								
Sampling Date 2022/05/05 13:38								
Matrix W								
Sample # 2022-1704-00-SI-SP								
Registration # WS-S-0000								
RESULTS OF ANALYSES OF WATER								
Inorganics								
Turbidity	-	1.8	0.10	NTU	N/A	2022/05/13	SHW	7993585
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	0.001	ND	0.000013	mg/L	2022/05/16	2022/05/16	FJO	7991415
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	2.9	0.076	0.0050	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Antimony (Sb)	0.006	ND	0.0010	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Arsenic (As)	0.010	ND	0.0010	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Barium (Ba)	2.0	0.0026	0.0010	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Boron (B)	5	ND	0.050	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Cadmium (Cd)	0.007	ND	0.000010	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Calcium (Ca)	-	1.7	0.10	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Chromium (Cr)	0.05	ND	0.0010	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Copper (Cu)	2	ND	0.00050	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Iron (Fe)	-	0.15	0.050	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Lead (Pb)	0.005	ND	0.00050	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Magnesium (Mg)	-	0.52	0.10	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Manganese (Mn)	0.12	0.023	0.0020	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/05/10	2022/05/11	JHY	7986273

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If Screening Levels (SL) for gross alpha or gross beta are exceeded then concentration of the specific radionuclides of the CWQG should be analyzed.

Note 1 Turbidity guideline value of 0.3 NTU based on conventional treatment system. For slow sand or diatomaceous earth filtration 1.0 NTU and for membrane filtration 0.1 NTU.

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Sample Details/Parameters	MAC	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
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Sampling Date 2022/05/05 13:38								
Matrix W								
Sample # 2022-1704-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Potassium (K)	-	0.33	0.10	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Selenium (Se)	0.05	ND	0.00050	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Sodium (Na)	-	11	0.10	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Strontium (Sr)	7.0	0.0055	0.0020	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Uranium (U)	0.02	ND	0.00010	mg/L	2022/05/10	2022/05/11	JHY	7986273
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/05/10	2022/05/11	JHY	7986273

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Bureau Veritas Job #: C2C4824
Report Date: 2022/05/17

NL Department of Environment, Climate Change and
Municipalities
Site Location: PADDY'S POND @ OUTLET
Your P.O. #: 220028978-5
Sampler Initials: LB

GENERAL COMMENTS

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

Package 1	7.6°C
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Results relate only to the items tested.



VALIDATION SIGNATURE PAGE

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

Anastassia Hamanov, Scientific Specialist

Colleen Acker, B.Sc, Scientific Service Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation please refer to the Validation Signature Page.