



Real-Time Water Quality Deployment Report

Paddy's Pond at Outlet

July 20, 2022 to September 16, 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 QA/QC 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 July 20 and September 16, 2022 are summarized in Table 2.

Table 2: Qualitative QA/QC comparison rankings for Paddy's Pond at outlet station July 20, 2022 through September 16, 2022.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Paddy's Pond at Outlet	2022-07-20	Deployment	Excellent	Excellent	Good	Excellent	Excellent
	2022-07-20	Grab Sample #2021-1723-00-SI-SP	N/A	Excellent	Excellent	N/A	Good
	2022-09-16	Removal	Excellent	Good	Good	Excellent	Excellent

- On July 20, 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 59 days and was removed on September 16, 2022.
- Upon deployment, sensors ranked 'Excellent' against the calibrated QA/QC sonde with exception to Conductivity, which ranked 'Good'.
- Upon deployment, the measured field grab sample parameters, pH and Conductivity, ranked 'Excellent', and Turbidity ranked 'Good' against the field sonde.
- At removal of the instrument, parameter rankings varied between 'Excellent' and 'Good' against the QA/QC sonde.

DATA INTERPRETATION

The following graphs and discussion illustrate water quality data obtained hourly from July 20, 2022 through September 16, 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 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.

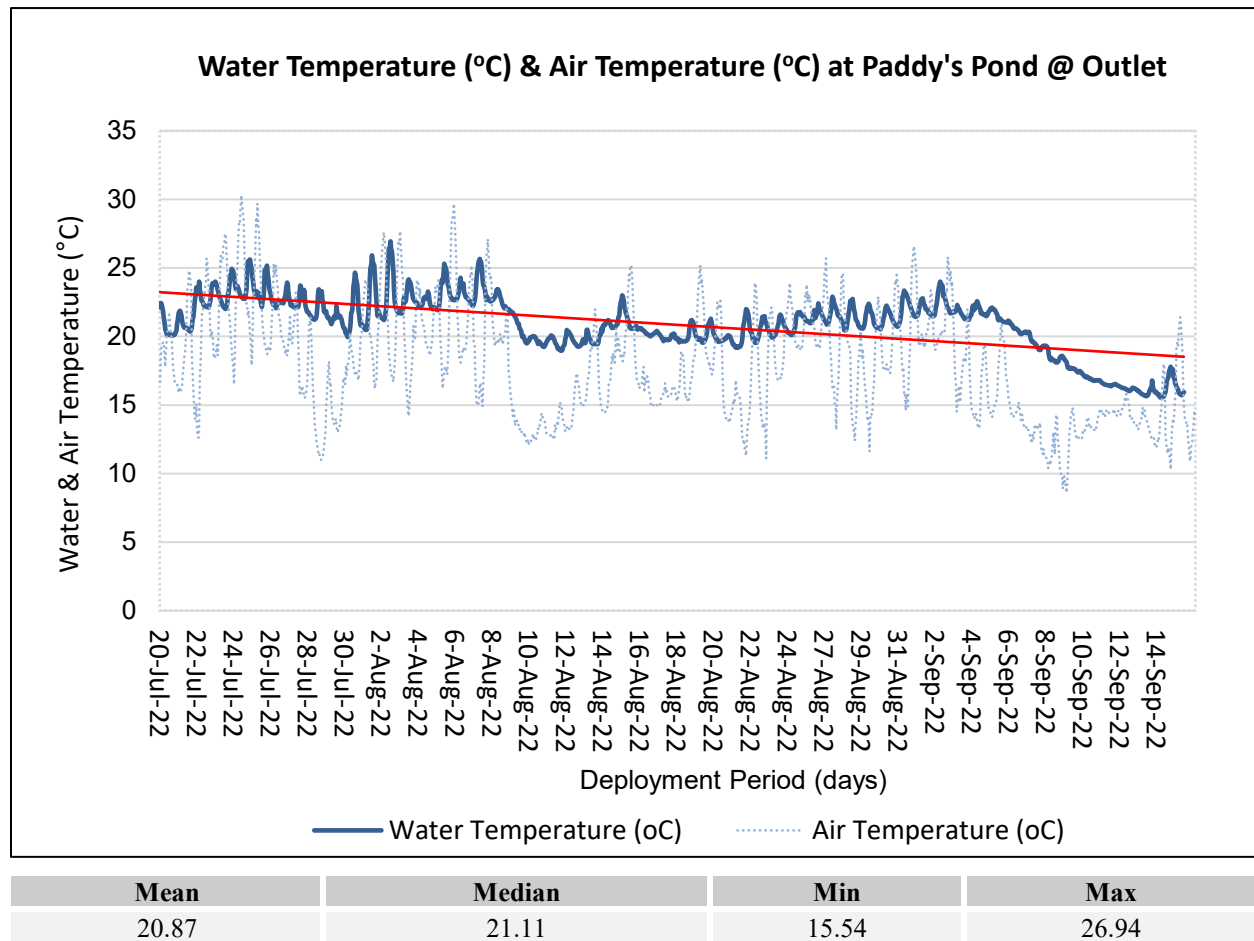


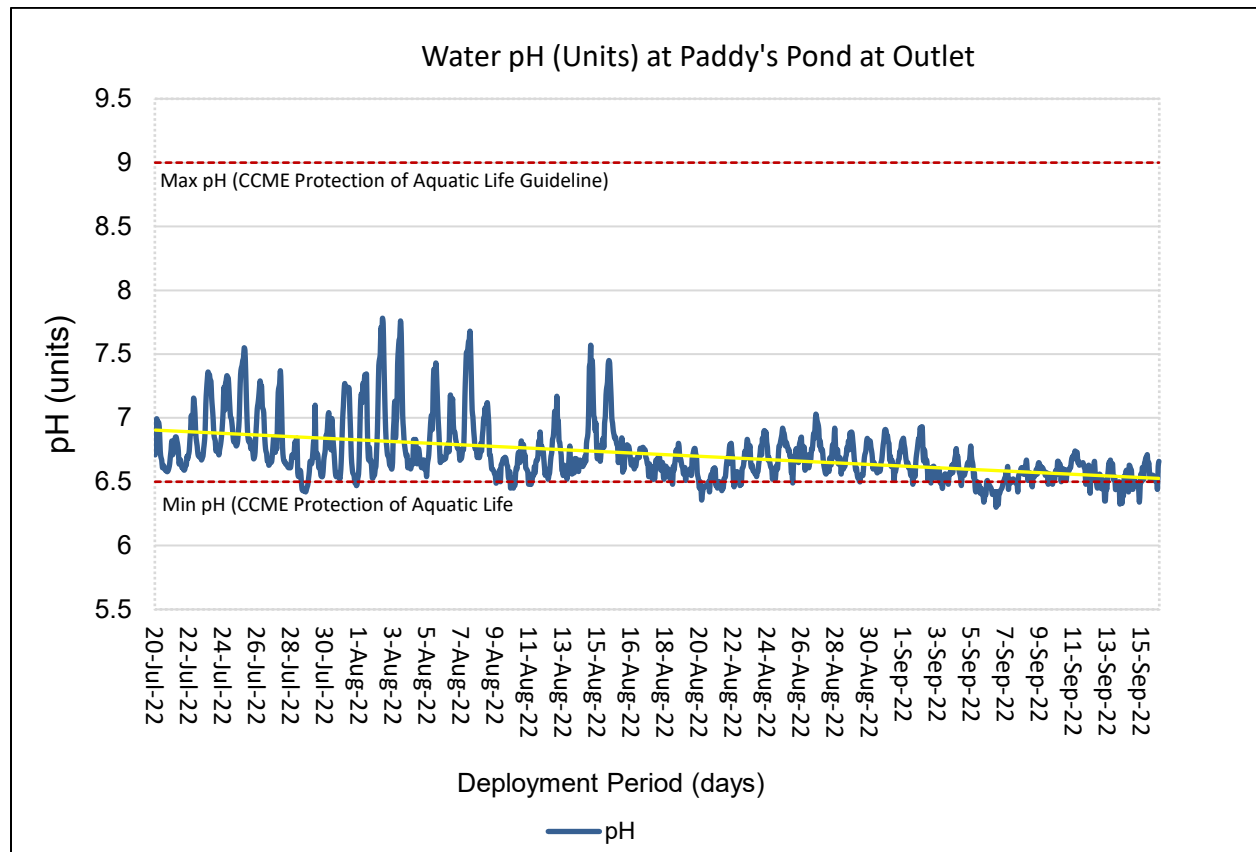
Figure 2: Water temperature (°C) values at Paddy's Pond at Outlet.

- Over the 59-day deployment period, water temperature fluctuated naturally in correlation to air temperature, decreasing into the fall. The mean temperature was 20.87°C with a median of 21.11°C.
- Minimum water temperature of 15.54°C was observed on September 15, 2022 and a maximum water temperature of 26.94°C was observed on August 2, 2022 (Figure 2).
- Water temperature was relatively stable from July 20, 2022 to August 8, 2022. A sudden decrease in water temperature was observed on August 9, 2022 as a result of a precipitation event and correlated decrease in air temperature. Water temperature then began to gradually increase until September 3, 2022 when air temperature dropped and a significant precipitation event (September 10-12, 2022) occurred, adding cooler water to Paddys Pond (See Figure 7- Appendix A).

- A natural diurnal pattern, with temperatures increasing during the day and decreasing overnight was observed. The magnitude of variation was influenced by daily air temperature fluctuations as well as precipitation events.

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.



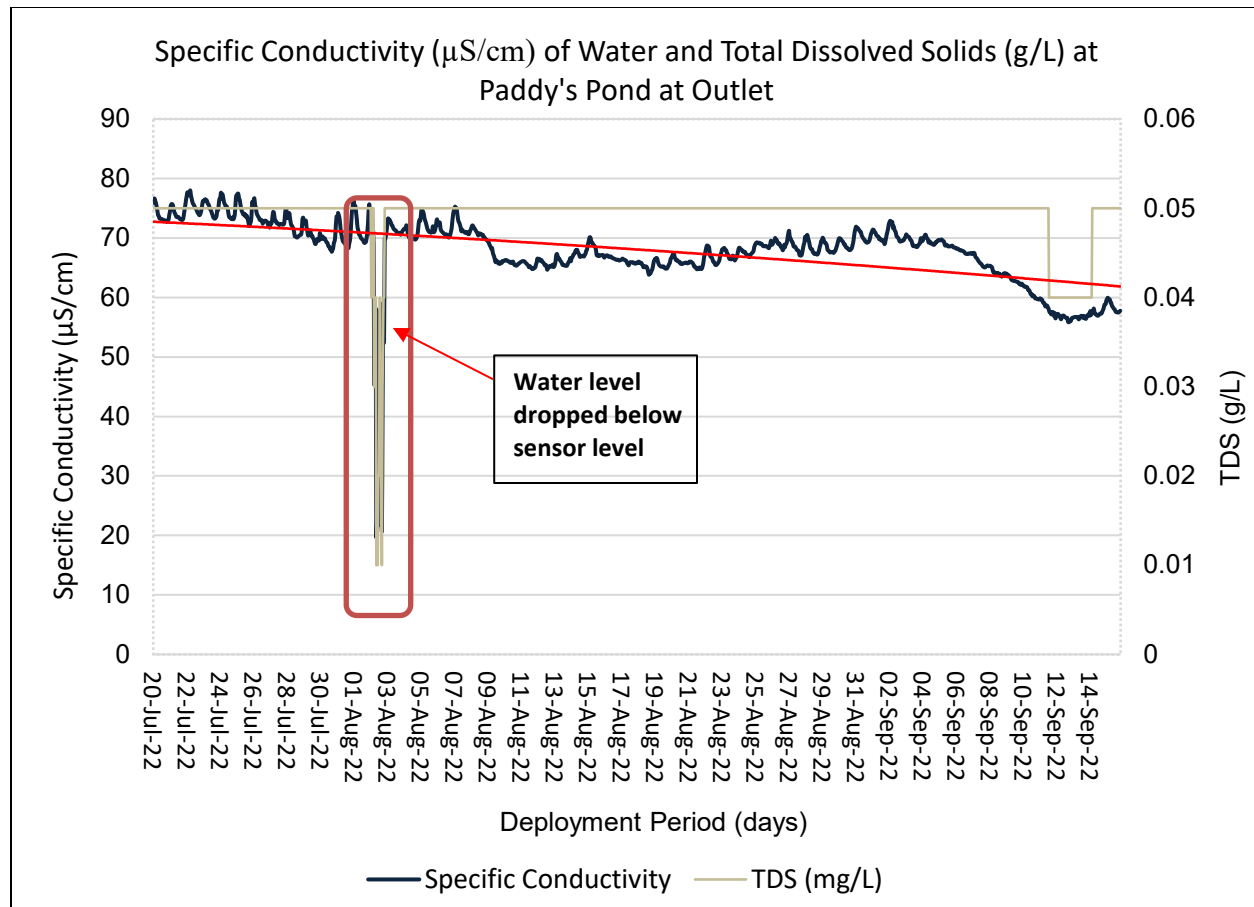
Mean	Median	Min	Max
6.78	6.74	6.42	7.78

Figure 3: pH (pH units) at Paddy's Pond at outlet from July 20, 2022 through September 16, 2022.

- Throughout the deployment period, pH values were within 6.42 to 7.78 pH units, with a mean unit value of 7.78 and median of 6.74 units (Figure 3).
- A gradual decrease in pH (Figure 2) was observed over the duration of the deployment period as air and water temperatures decreased.
- 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. This guideline provides a basis for the overall health of the waterbody. Paddy's Pond at Outlet pH values decreased slightly below the minimum guideline on a number of occasions throughout the deployment period. This may be the result of a decrease in photosynthesis and respiration by aquatic organisms expected at this time of the year, as well as the addition of more acidic water during precipitation events such as observed on July 27, 2022, August 9, 2022, September 7, 2022 and on September 10-12, 2022 (See Figure 7 – Appendix 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.

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
68.1	68.6	55.8	78.0

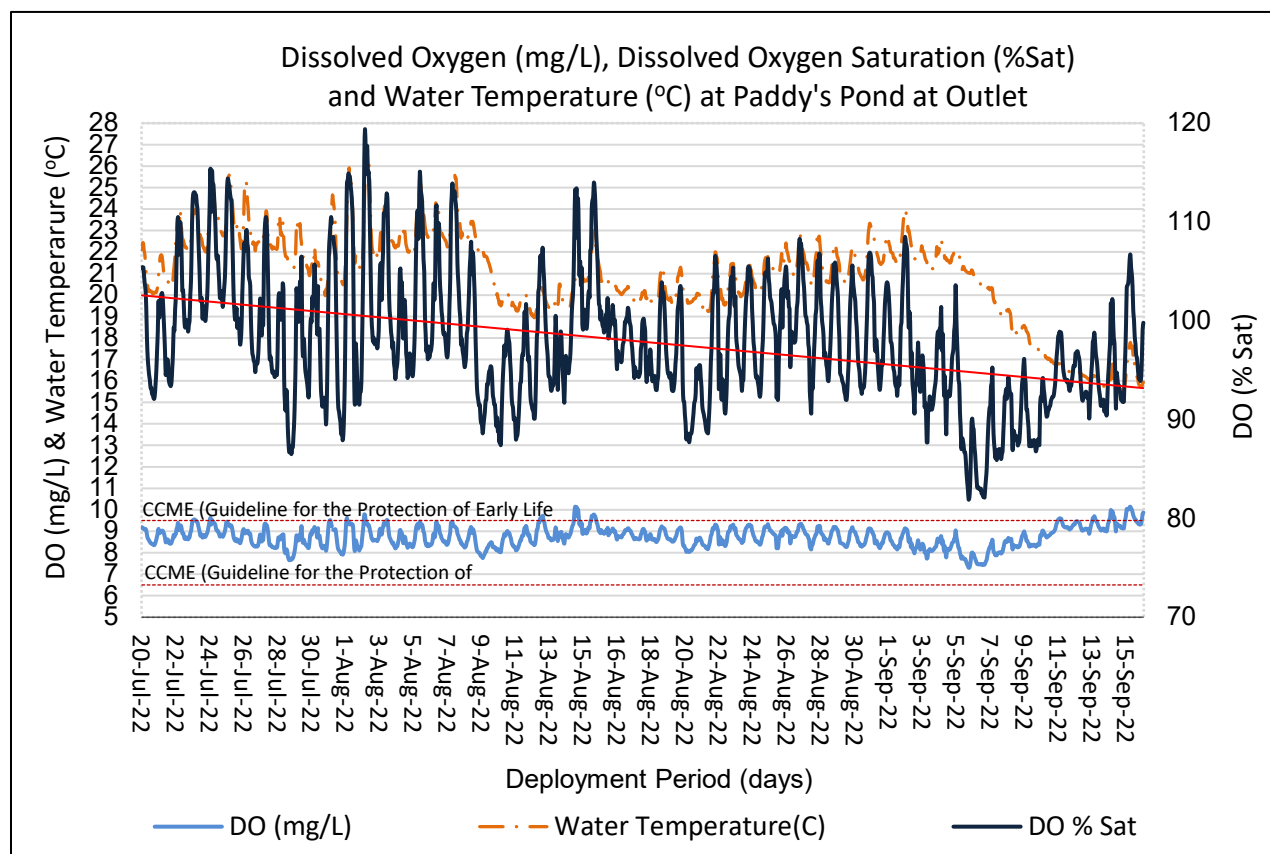
Figure 4: Specific conductivity ($\mu\text{S}/\text{cm}$) values at Paddy's Pond at Outlet.

- Specific conductivity values gradually decreased throughout the deployment period with a slight increase through late August into early September. On August 3, 2022, a significant drop in conductivity was observed due to a decrease in stage below the level of the sensor. The sonde was relocated to an area of deeper water for the remainder of the deployment period. Please note that this data was removed for statistical analysis.
- A maximum conductivity value of 78.0 $\mu\text{S}/\text{cm}$ and a minimum value of 55.8 $\mu\text{S}/\text{cm}$ (Figure 4) were observed. Mean conductivity was 68.1 $\mu\text{S}/\text{cm}$ with a median conductivity value of 68.6 $\mu\text{S}/\text{cm}$.
- 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) value stable at 0.05 g/L throughout the deployment period with exception to a temporary decrease to 0.04 g/L on September 12-14, 2022.

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.



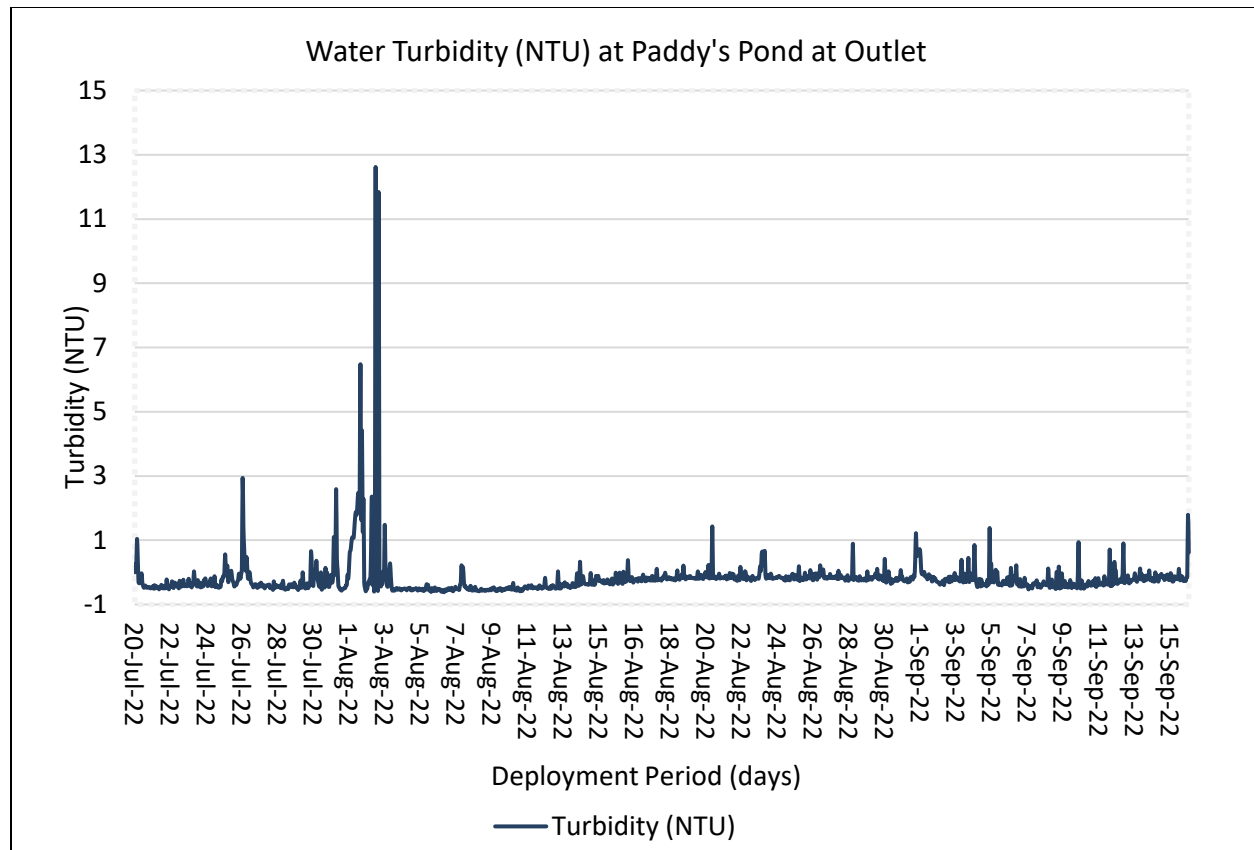
Parameter	Mean	Median	Min	Max
DO (mg/L)	100.2	99.4	86.5	119.4
DO (% Sat)	8.78	8.78	7.65	10.14

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

- Dissolved Oxygen (DO) concentrations (mg/L) were stable throughout the deployment period until early September when a gradual increase was observed in correlation to a decrease in water temperature. A maximum DO of 10.14 mg/L (119.4 % Sat) to a minimum DO of 7.65 mg/L (86.5 % Sat) were observed.
- 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.
- Significant diurnal variations were observed throughout the deployment period due to temperature ranges from day to night. Variations can be influenced by water depth during deployment as shallow water temperatures will change more rapidly.
- The dissolved oxygen values were predominantly below the CCME Guideline for the Protection of Early Life Stages (9.5 mg/L) but remained above the CCME Guideline for the Protection of Other Life Stages (6.5mg/L). This is expected for the time of the year as most aquatic organisms have developed beyond sensitivities.

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.



Mean	Median	Min	Max
-0.3	-0.4	-0.6	6.5

Figure 6: Water turbidity (NTU) values at Paddy's Pond at Outlet during deployment period July 20, 2022 through September 16, 2022.

- Turbidity measurements throughout the deployment period indicated very low turbidity including negative values. This situation is most likely to happen when measuring low-level turbidity. Natural variations in all measurements, instrument and non-instrument related, can lead to a negative result. Some other turbidimeters are designed to round up a negative number to 0.00 NTU, since a result of less than 0.00 NTU is theoretically impossible. However, in practice, these results are actually quite meaningful. The problem could be operator technique or sonde error. It could also indicate a problem with the low turbidity/turbidity-free water used for a blank or a problem with the calibration. If the meter rounds the negative result to 0.00 NTU, the user will not be alerted to a potential problem.
- The turbidity spikes seen on August 3rd, 2022 (12.62 NTU) were the result of the low water levels near or below the level of the turbidity sensor. Turbidity data from August 2, 2022 (PM) to August 3, 2022 (AM) was removed for statistical analysis.
- Turbidity values range from -0.6 to 6.5 NTU, with a mean of -0.3 NTU and a median value of -0.4 NTU (Figure 6).

- Turbidity levels were low during the deployment period; however, events above baseline levels did occur, as seen on July 26, 2022 (2.94 NTU) and on July 31, 2022 (2.59 NTU) are likely influenced by debris, suspended algae, siltation due to wave action and precipitation events.

APPENDIX A : MEAN DAILY TEMPERATURE AND TOTAL PRECIPITATION

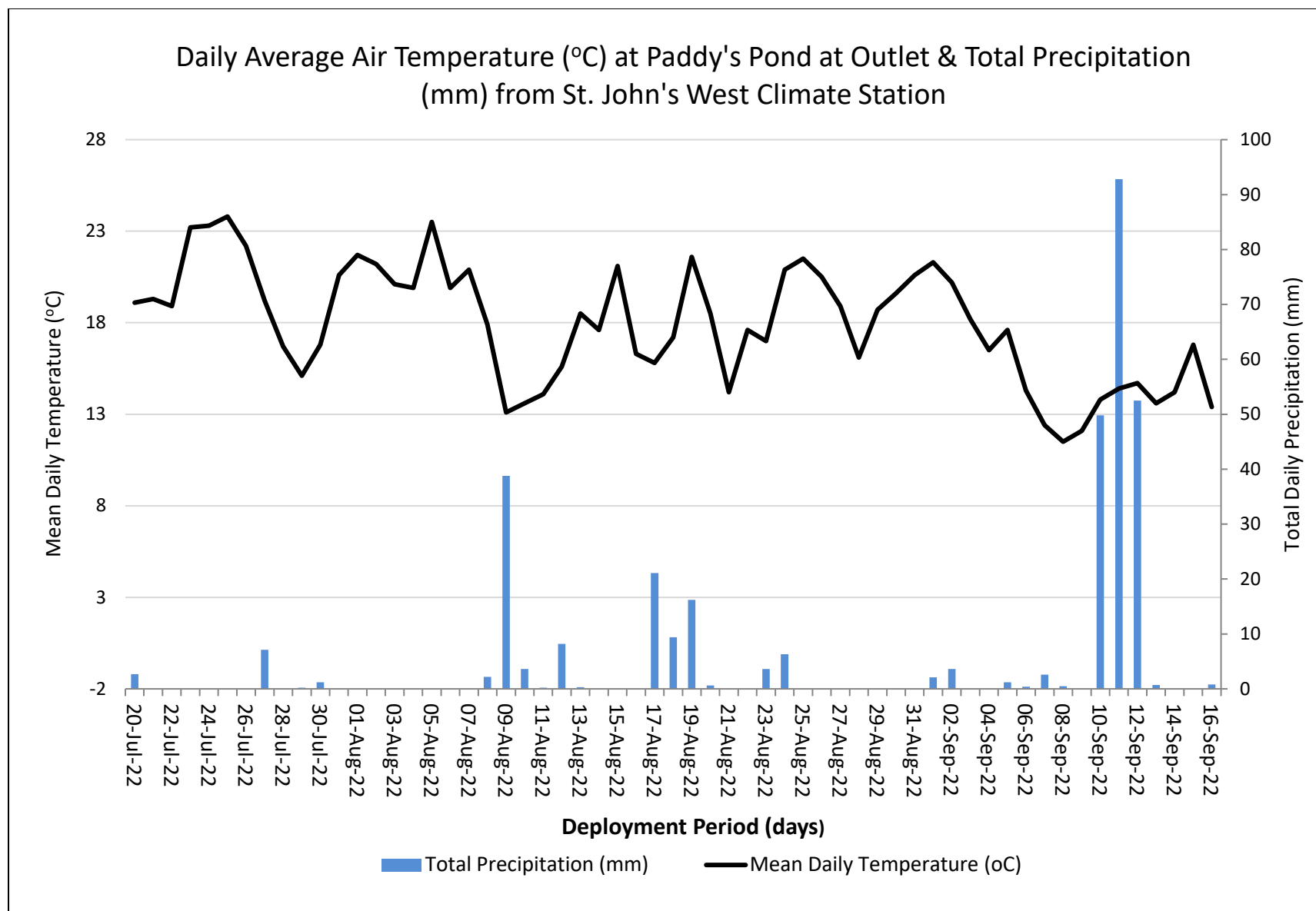


Figure 7: Mean daily air temperature and total precipitation at St. John's West near Paddy's Pond July 20, 2022 to September 16, 2022.

APPENDIX B : QA/QC GRAB SAMPLE FIELD RESULTS



Your P.O. #: 220028978-6
 Site Location: PADDY'S POND @ OUTLET
 Your C.O.C. #: 2022-1725-00-SI-SP

Attention: Robert Richard Harvey

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

Report Date: 2022/10/26
 Report #: R7357975
 Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2R7801

Received: 2022/09/22, 09:13

Sample Matrix: Water
 # Samples Received: 1

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Alkalinity	1	N/A	2022/10/04	ATL SOP 00142	SM 23 2320 B
Anions (1)	1	N/A	2022/09/30	CAM SOP-00435	SM 23 4110 B m
Colour	1	N/A	2022/10/11	ATL SOP 00020	SM 23 2120C m
Organic carbon - Diss (DOC) (2)	1	N/A	2022/10/13	ATL SOP 00203	SM 23 5310B m
Conductance - water	1	N/A	2022/10/04	ATL SOP 00004	SM 23 2510B m
Fluoride	1	N/A	2022/10/04	ATL SOP 00043	SM 23 4500-F- C m
Hardness (calculated as CaCO3)	1	N/A	2022/10/03	ATL SOP 00048	Auto Calc
Mercury - Total (CVAA,LL)	1	2022/10/03	2022/10/03	ATL SOP 00026	EPA 245.1 R3 m
Metals Water Total MS	1	2022/09/30	2022/10/03	ATL SOP 00058	EPA 6020B R2 m
Nitrogen Ammonia - water	1	N/A	2022/10/21	ATL SOP 00015	EPA 350.1 R2 m
Nitrogen - Nitrate + Nitrite	1	N/A	2022/10/12	ATL SOP 00016	USGS I-2547-11m
Nitrogen - Nitrite	1	N/A	2022/10/05	ATL SOP 00017	SM 23 4500-NO2- B m
Nitrogen - Nitrate (as N)	1	N/A	2022/10/12	ATL SOP 00018	ASTM D3867-16
pH (3)	1	N/A	2022/10/04	ATL SOP 00003	SM 23 4500-H+ B m
Calculated TDS (DW Pkg)	1	N/A	2022/10/05	N/A	Auto Calc
Total Kjeldahl Nitrogen in Water (1)	1	2022/10/13	2022/10/13	CAM SOP-00938	OMOE E3516 m
Organic carbon - Total (TOC) (2)	1	N/A	2022/10/04	ATL SOP 00203	SM 23 5310B m
Total Phosphorus (Colourimetric) (1)	1	2022/09/29	2022/09/29	CAM SOP-00407	SM 23 4500-P I
Total Suspended Solids	1	2022/09/27	2022/09/30	ATL SOP 00007	SM 23 2540D m
Turbidity	1	N/A	2022/10/04	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 requires 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. #: 220028978-6
Site Location: PADDY'S POND @ OUTLET
Your C.O.C. #: 2022-1725-00-SI-SP

Attention: Robert Richard Harvey

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

Report Date: 2022/10/26
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Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C2R7801
Received: 2022/09/22, 09:13

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:
Maryann Comeau, Customer Experience Supervisor/PM
Email: Maryann.COMEAU@bureauveritas.com
Phone# (902)420-0203 Ext:298

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Bureau Veritas Job #: C2R7801
Report Date: 2022/10/26

NL Department of Environment, Climate Change and
Municipalities

Site Location: PADDY'S POND @ OUTLET

Your P.O. #: 220028978-6

Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TVL407 PADDY'S POND @ OUTLET								
Sampling Date		2022/09/20 09:38						
Matrix		W						
Sample #		2022-1725-00-SI-SP						
Registration #		WS-S-0000						
RESULTS OF ANALYSES OF WATER								
Calculated Parameters								
Hardness (CaCO3)	-	8.5	1.0	mg/L	N/A	2022/10/03		8247885
Nitrate (N)	-	0.16	0.050	mg/L	N/A	2022/10/12		8247888
Total dissolved solids (calc., EC)	-	40	1.0	mg/L	N/A	2022/10/05		8247646
Inorganics								
Conductivity	-	72	1.0	uS/cm	N/A	2022/10/04	NGI	8262596
Chloride (Cl-)	-	15	1.0	mg/L	N/A	2022/09/30	LKH	8257594
Bromide (Br-)	-	ND	1.0	mg/L	N/A	2022/09/30	LKH	8257594
Sulphate (SO4)	-	2.5	1.0	mg/L	N/A	2022/09/30	LKH	8257594
Total Alkalinity (Total as CaCO3)	-	4.2	2.0	mg/L	N/A	2022/10/04	NGI	8262629
Colour	-	38	5.0	TCU	N/A	2022/10/11	TGO	8266342
Dissolved Fluoride (F-)	-	ND	0.10	mg/L	N/A	2022/10/04	NGI	8262636
Total Kjeldahl Nitrogen (TKN)	-	0.17	0.10	mg/L	2022/10/13	2022/10/13	RTY	8280544
Nitrate + Nitrite (N)	-	0.16	0.050	mg/L	N/A	2022/10/12	TGO	8268028
Nitrite (N)	-	ND	0.010	mg/L	N/A	2022/10/05	TGO	8268029
Nitrogen (Ammonia Nitrogen)	-	ND	0.050	mg/L	N/A	2022/10/21	TGO	8298448
Dissolved Organic Carbon (C)	-	5.5	0.50	mg/L	N/A	2022/10/13	RSL	8278403
Total Organic Carbon (C)	-	5.9	0.50	mg/L	N/A	2022/10/04	RSL	8260586
pH	-	6.87		pH	N/A	2022/10/04	NGI	8262625
Total Phosphorus	-	0.011	0.004	mg/L	2022/09/29	2022/09/29	SSV	8254459
Total Suspended Solids	-	ND	1.0	mg/L	2022/09/27	2022/09/30	RMK	8249581
Turbidity	-	0.45	0.10	NTU	N/A	2022/10/04	KMC	8263127
MERCURY BY COLD VAPOUR AA (WATER)								
Metals								
Total Mercury (Hg)	-	ND	0.000013	mg/L	2022/10/03	2022/10/03	FJO	8257753
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Aluminum (Al)	-	0.071	0.0050	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Antimony (Sb)	-	ND	0.0010	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Arsenic (As)	-	ND	0.0010	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Barium (Ba)	-	0.0023	0.0010	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Boron (B)	-	ND	0.050	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Cadmium (Cd)	-	ND	0.000010	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Calcium (Ca)	-	2.4	0.10	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Chromium (Cr)	-	ND	0.0010	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Copper (Cu)	-	0.00054	0.00050	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Iron (Fe)	-	0.21	0.050	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Lead (Pb)	-	ND	0.00050	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Magnesium (Mg)	-	0.61	0.10	mg/L	2022/09/30	2022/10/03	JHY	8256899



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Bureau Veritas Job #: C2R7801
Report Date: 2022/10/26

NL Department of Environment, Climate Change and
Municipalities

Site Location: PADDY'S POND @ OUTLET

Your P.O. #: 220028978-6

Sampler Initials: LB

Sample Details/Parameters	A	Result	RDL	UNITS	Extracted	Analyzed	By	Batch
TVL407 PADDY'S POND @ OUTLET								
Sampling Date 2022/09/20 09:38								
Matrix W								
Sample # 2022-1725-00-SI-SP								
Registration # WS-S-0000								
ELEMENTS BY ICP/MS (WATER)								
Metals								
Total Manganese (Mn)	-	0.044	0.0020	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Nickel (Ni)	-	ND	0.0020	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Phosphorus (P)	-	ND	0.10	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Potassium (K)	-	0.44	0.10	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Selenium (Se)	-	ND	0.00050	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Sodium (Na)	-	10	0.10	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Strontium (Sr)	-	0.0073	0.0020	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Uranium (U)	-	ND	0.00010	mg/L	2022/09/30	2022/10/03	JHY	8256899
Total Zinc (Zn)	-	ND	0.0050	mg/L	2022/09/30	2022/10/03	JHY	8256899



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Bureau Veritas Job #: C2R7801
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NL Department of Environment, Climate Change and
Municipalities
Site Location: PADDY'S POND @ OUTLET
Your P.O. #: 220028978-6
Sampler Initials: LB

GENERAL COMMENTS

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

Package 1	10.0°C
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Results relate only to the items tested.



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VALIDATION SIGNATURE PAGE

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

Anastasiya Hamanov, Scientific Specialist

Colleen Acker, B.Sc, Scientific Service Specialist

Janah Rhyno, Metals Supervisor-Bedford

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