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Memorandum

To	George Meservey, Director of Planning & Community Development
CC	James Begley, LSP, MT Environmental AECOM PRB Team
Subject	**Town of Orleans, MA** **Water Quality and Wastewater Planning** **Task Number 14.1.B.3** **Technical Memorandum: Permeable Reactive Barriers (PRB)** **Full-Scale Watershed Planning Investigation**
Project Number	60476644
From	Thomas Parece, P.E., AECOM Project Manager
Date	January 30, 2023

1. Introduction

This Technical Memorandum has been prepared as part of the ongoing effort to identify and confirm potential full-scale Permeable Reactive Barrier (PRB) locations for implementation in accordance with the overall objectives of the Town of Orleans Amended Comprehensive Wastewater Management Plan (ACWMP). The current Memorandum documents the results of field subsurface investigations completed to assess four selected potential full-scale PRB locations in the Pleasant Bay Watershed. These four locations were selected for investigation following a PRB feasibility assessment and planning process documented in the Final Technical Memorandum: Permeable Reactive Barriers (PRB) Full-Scale Watershed Planning (AECOM 2021) included in Appendix A and further consultation with the Town of Orleans.

2. Background

A PRB is an innovative/alternative technology to traditional municipal wastewater collection, treatment, and discharge of treated effluent. PRBs are a decentralized passive treatment technology, designed to intercept and treat nitrate migrating in groundwater from diffuse sources and protecting downgradient salt ponds and embayments from nutrient overload. The PRB removes nitrate through denitrification, a biological process mediated by naturally occurring bacteria in groundwater before the groundwater reaches downgradient surface waters. Refer to **Figure A - Permeable Reactive Barrier**. A PRB is installed in the saturated zone below the water table where amendments, a food substrate for the bacteria, are added by injection to form the PRB. A population of denitrifying bacteria develops in the vicinity of the food substrate and utilizes that substrate over a long period of time. In the biological process, nitrate is converted to inert nitrogen gas. PRBs are typically oriented perpendicular to the direction of groundwater flow as shown in the diagram below and rely on the natural groundwater gradient and flow to carry nitrate to the PRB for removal.

The Town of Orleans implemented a successful multi-year pilot demonstration of the PRB technology. The Eldredge Park Way Demonstration Test PRB was installed in the parking lot area southwest of the Nauset Middle School in November 2016. Groundwater monitoring conducted before and after implantation has shown effective removal of nitrate from groundwater. That removal has continued though the most recent monitoring event in June 2022 and has been documented in quarterly reports provided to the Town.

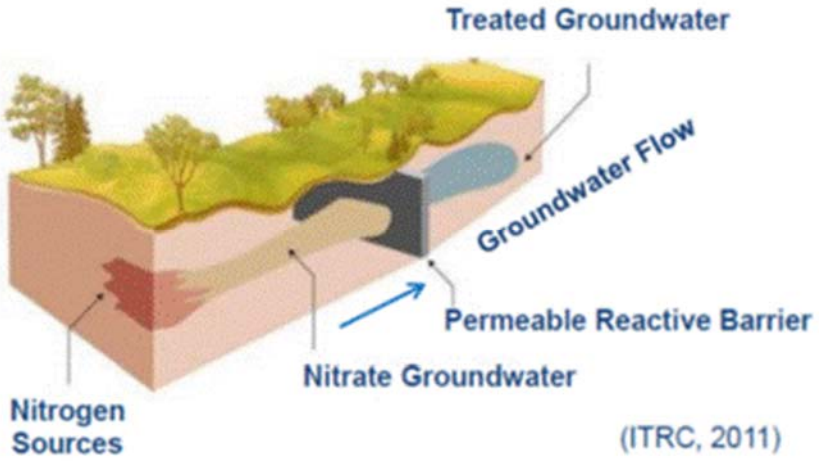


Figure A - Permeable Reactive Barrier

Demonstration test monitoring objectives included:

A. Assessing the potential reduction in nitrate concentrations in groundwater compared to baseline samples and/or wells upgradient of the PRB,

B. Identifying distance traveled by Emulsified Vegetable Oil (EVO) substrate and Dissolved Organic Carbon (DOC),

C. Identifying the extent of PRB generated nitrate reducing conditions,

D. Evaluating the potential for decrease in aquifer permeability because of EVO application, and

E. Evaluating the persistence of EVO and anaerobic conditions favorable for denitrifying bacteria after PRB injection.

Pilot PRB performance demonstrated that the PRB was effective at reducing significant nitrate concentrations, up to 39 mg/L in upgradient groundwater, to low concentrations or to below the detection limits of 0.03 mg/L immediately downgradient of the PRB.

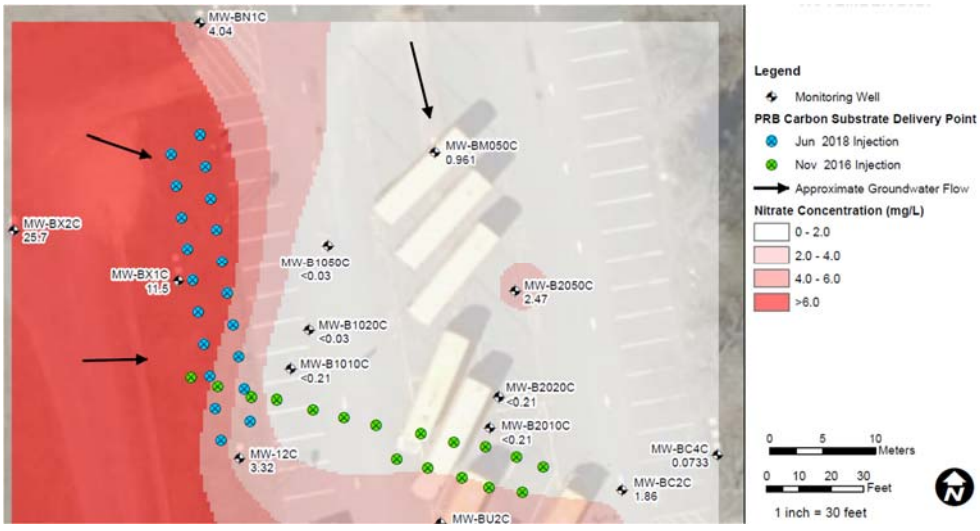


Figure B - Nitrate Removal at Eldredge Park Way Demonstration Test Site

No significant adverse effects of PRB implementation were identified in the assessment. The high nitrate concentration upgradient of the PRB is likely from the septic system serving the Nauset Regional Middle School. This represents a worst-case scenario for complete cut-off of nitrate flux, yet the PRB continues to remain effective; typical PRB applications would be for significantly lower groundwater nitrate concentrations from diffuse sources.

3. Full-Scale PRB Planning and Location Selection

Full scale PRB selection was conducted through a process that considered:

- Overall nitrogen remediation objectives,
- Environmental conditions and proximity to impacted sub-embayments,
- Land use, downgradient water use, and topography,
- Wastewater nitrogen load upgradient within the capture zone of the PRB, and
- Practical limitations like access and PRB installation depths for cost effective implementation of the technology.

The 2021 Full-Scale PRB Watershed Planning Memorandum documented the process including:

- Review of non-traditional technology objectives on a watershed and sub-watershed basis,
- Development of screening criteria, and screening of potential PRBs,
- Assessment of feasibility of implementation,
  - Life Cycle Cost Assessment (LCCA) - Comparing PRBs and Traditional system
  - Evaluation of pros and cons of full-scale PRBs as an alternative to traditional systems
- Determining optimal PRB dimensions,
- Modeling groundwater flow to define upgradient PRB Capture Zones (source area of groundwater flowing through PRBs),
- Assessing the density of wastewater sources in capture zones and potential nitrogen flux based on Massachusetts Estuary Program (MEP) defined source characteristics, and
- Comparing relative PRB efficiency and comparison of PRBs to traditional technology cost and nitrogen load reduction.

The outcome of this planning process for each of the three major Orleans watersheds was as follows:

- Pleasant Bay
  - Identification of 14 potentially viable PRBs,
  - Cumulative nitrogen removal of 2,115 kg/yr. of target 4,996 kg/yr.,
  - 13 recommended for further field assessment,
- Nauset Estuary
  - Identification of 3 potentially viable PRBs,
  - Cumulative nitrogen removal of 866 kg/yr. exceeding 566 kg/yr. target,
  - 2 recommended for further field assessment,
- Rock Harbor
  - Identification of 1 potentially viable PRB,
  - Nitrogen removal of 305 kg/yr. of target 634 kg/yr.,
  - Not recommended for further field assessment.

Further consultation with the Town of Orleans led to a focus on the Pleasant Bay Watershed for follow-on field assessment activities in the near term. The full list of potential Pleasant Bay Watershed PRBs is included in the PRB Screening Matrix included in Appendix B. It was decided to initially proceed with a subset of the full list of potential PRBs to focus and refine the field investigation process. Of the 14 potentially viable PRBs in the watershed, 9 were excluded from further investigation in the current effort due to their location on private roadways where private ownership was considered a short-term impediment to access for installation of monitoring wells and potentially the PRBs. Access to these locations require legal and administrative processes that will need to be addressed prior to proceeding with these locations. The 14 potential PRBs in the Pleasant Bay Watershed are included in Figure 1 along with other potential PRB locations in the watersheds to Rock Harbor and the Nauset Estuary. The locations of PRBs along roadways are shown in red and the capture zone of the PRBs is shown with blue lines tracing the groundwater flow path. The flow paths define the Capture Zone of the PRB and indicate the geographic source area for nitrate to be treated. Particle track modeling was used to trace back from the deepest installation depth of the PRB to the upgradient extent of the PRB capture zone. Groundwater flowing from upgradient of the Capture Zone would flow under the PRB as groundwater generally moves deeper with distance traveled.

Of the remaining five potential PRB locations in the Pleasant Bay watershed after eliminating PRBs located on private roads, four locations were selected for field subsurface investigations. These included PRBs on:

- Duck Hole Road,
- Briar Spring Road,
- Ridgewood Road (Ridge), and
- Namequoit Road.

These four PRB locations are indicated in boxes shown on Figure 1. The 5th location on Monument Road was eliminated due to the potential low-cost benefit rating of the location for a PRB and limited locations for safely installing monitoring wells along Monument Road.

4. Description of PRBs Selected for Investigation

Siting criteria specified locating PRBs along roadways that are cross-gradient to the regional groundwater flow direction and relatively close to impacted embayments. Roadway settings are important for access and facilitate installation.

- **Duck Hole PRB:** The Duck Hole PRB extends north to south along Highview Lane, Old Duck Hole Road, and Lovells Lane with a length of approximately 4,100 feet. The planned PRB was estimated to extend 30 feet into the saturated zone and would reduce nitrogen loading from the Pochet Neck Watershed to Pochet Neck Stream. The full Duck Hole PRB is shown on Figure 2. North and south sections of the PRB are shown on Figure 3 and Figure 4, respectively. Green highlighted parcels in these figures are properties within the capture zone of the PRB and are sources of wastewater nitrogen load.
- **Briar Spring PRB:** Briar Spring PRB extends approximately 2,900 feet northeast to southwest along Briar Spring Road. The planned PRB was estimated to extend 30 feet into the groundwater saturated zone and would reduce nitrogen loading the Pleasant Bay Watershed in the vicinity of Pochet Inlet. The full Briar Spring PRB is shown on Figure 5. The north and south sections of the PRB are shown on Figure 6 and Figure 7, respectively.
- **Namequoit and Ridge PRBs**: Due to proximity the Namequoit and Ridge PRBs were evaluated together. The Namequoit PRB is located along Namequoit Road extending approximately 1,000 feet west from Little Marsh Lane. The Ridge PRB extends north to south on Ridgewood Road and is approximately 460 feet in length. The combined length for evaluation is 1,460 feet. Both PRBs would extend 30 feet into the saturated zone and would reduce nitrogen loading to the Namequoit River. The Namequoit and Ridge PRBs are shown on Figure 8 and Figure 9.

5. Investigation Objectives and Assessment Approach

The investigation was designed to determine the local hydrologic and water quality conditions at the potential PRB site gathering the following information:

A. Depth to groundwater at each location,

B. Direction and velocity of groundwater flow,

C. Soil stratigraphy and hydraulic conductivity in the target vertical extent of the PRB or profile,

D. Maximum feasible depth of direct push injection, and

E. Groundwater chemistry and nitrate concentration in the target profile.

This information was used to assess the feasibility of PRB installation, develop specifications for PRB design, and estimate the potential nitrogen load reduction in kilograms of nitrogen removed per year.

6. Summary of Field Investigations

The field investigation generally followed the methodology described in the U.S. Geological Survey report *Hydrologic site assessment for passive treatment of groundwater nitrogen with permeable reactive barriers*, *Cape Cod, Massachusetts* (Barbero, et al. 2019). The field investigation proceeded in a two phased approach to optimize data collection and included installation of deep soil borings and monitoring wells on the edge of public roadways.

The selected soil boring and monitoring well locations were spatially positioned to form a triangle at each PRB or within segments of each large PRB so that the local groundwater flow direction could be estimated with groundwater elevation surveys and triangulation.

Each triangulation of monitoring wells (i.e., DU-1-37. DU-2-26, DU-3-51, Figure 2) was designed to include a cluster of monitoring wells screened at up to three elevations: (1) shallow; (2) intermediate; and (3) deep with a maximum target installation depth of 100 feet below ground surface.

Soil boring logs were recorded for the deepest soil boring/monitoring well location to document subsurface soil characteristics. The triangulation of monitoring wells was located a sufficient distance apart to estimate the direction of groundwater flow and groundwater gradient based on relative water table elevations. Each soil boring/monitoring well location was identified and adjusted as necessary following field reconnaissance and subsurface utility location. All wells were constructed from two-inch diameter PVC riser and were completed with ten-foot screen intervals.

The first phase of investigation was completed in the Fall of 2021 and included installation of the deepest soil boring at each location, preparing and evaluating soil boring logs to define stratigraphy, soil sample collection to determine soil characteristics, and installing the deepest of the three planned monitoring wells (shallow, intermediate, and deep wells) at each location. Boring logs are included in Appendix C.

The installation of the deepest monitoring wells was followed by:

- Monitoring well elevation and location survey,
- Water level measurement,
- Field water quality parameter measurement, and
- Water quality sampling and analysis.

Deep Soil borings were completed using a Roto-Sonic drilling rig (Refer to **Figure C – Roto-Sonic Rig Completing Deep Soil Boring**) at 17 locations distributed across the 4 PRB locations. The Roto-Sonic drilling method produced high quality soil cores for observations of soil stratigraphy and can quickly penetrate to deeper depths. A Geoprobe direct push rig was also deployed to these soil boring locations to conduct penetration tests to verify the ability of the direct push rig to rapidly penetrate the subsurface soils up to 100 feet at each location. The direct push tests successfully verified the drilling methods ability to quickly drill and inject substrate during future PRB construction.



Figure C – Roto-Sonic Rig Completing Deep Soil Boring

The first phase of field work was followed by a period of data review and evaluation. The soil borings were reviewed to determine the vertical extent of soil suitable for PRB installation. Groundwater elevations were used to triangulate and estimate the direction of groundwater flow at the water table and verify the depth to groundwater. Groundwater monitoring and analytical results were used for an initial assessment of groundwater chemistry and nitrogen compound concentration.

The second phase of field investigation was completed in December 2021 and January 2022 and included installation of intermediate depth and shallow water table monitoring wells by the direct push method as necessary to complete each monitoring well location. This phase included additional groundwater gauging and sample collection.

The full set of monitoring wells in the completed network is as follows:

- **Duck Hole PRB**: 6 monitoring well clusters, with 3 monitoring wells in each cluster. Well identification code **DU - location number - depth of bottom of the 10-foot monitoring well screen** (e.g., BR-1-100),
- **Briar Spring PRB:** 6 clusters of monitoring wells with 3 wells at each location. Well identification code **BR - location number - depth of bottom of 10-foot screen**,
- **Namequoit PRB:** 2 clusters of monitoring well, one with 2 wells, one with 3 wells. Well identification code **NA - location number - depth of bottom of 10-foot screen**,
- **Ridge PRB:** 3 monitoring well clusters, one with 1 monitoring well, two with 2 wells. Well identification code **RI - location number - depth of bottom of 10-foot screen**.

A total of 17 monitoring well locations with a total of 46 monitoring wells were installed in the combined field efforts. Monitoring well construction details are included in Table 1. Each monitoring well was surveyed for location and top of casing elevation.

7. Groundwater Monitoring

Groundwater monitoring was conducted to test water quality and characterize groundwater geochemistry. The results of analyses provide data for a detailed evaluation of the feasibility of PRB installation, potential nitrogen load reduction, and PRB design.

Completed monitoring wells were sampled during two events including: (1) following installation November 2021 to February 2022; and (2) in May 2022. Depth to groundwater measurements were completed prior to groundwater sampling. Groundwater monitoring was conducted with peristaltic, or Whale submersible pump connected to a YSI meter with a flow through cell to measure field parameters. Groundwater samples were collected once field parameters stabilized on the water quality meter.

Monitoring events included:

- Groundwater elevation gauging
- Measurement of field groundwater parameters:
  - pH (SU)
  - Temperature (°C)
  - Dissolved Oxygen (DO, mg/L)
  - Redox Potential (ORP; mV)
  - Specific Conductivity (µS/cm)
  - Turbidity (NTU)
- Sample collection for laboratory analyses of:
  - Nitrate as N (mg/L)
  - Nitrite as N (mg/L)
  - Total Kjeldahl Nitrogen (TKN) (mg/L)
  - Total Nitrogen (mg/L)
  - Dissolved Organic Carbon (DOC)(mg/L)
  - Dissolved Iron (mg/L)
  - Dissolved Manganese (mg/L)

Laboratory samples were sent to ESS Laboratory for analysis.

8. Water Levels and Groundwater Flow

Measured groundwater elevations from three water table wells at each PRB or section of PRB were used to assess groundwater gradients and find the slope of the water table. Refer to **Figure D - Groundwater Gradient Illustration**. The groundwater gradient (i) was determined by finding the difference between upgradient and downgradient groundwater elevations and then dividing that difference by the distance between the monitoring wells. Groundwater flow direction was determined by evaluating water table elevations at the three points of each of triangle of monitoring wells.

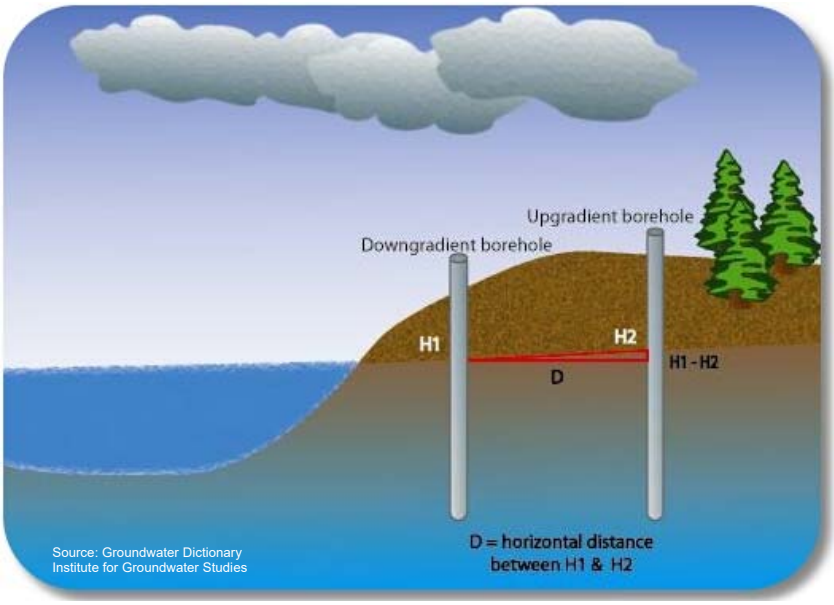


Figure D - Groundwater Gradient Illustration

Identified groundwater flow directions are included as blue arrows on PRB figures. Generally measured groundwater elevations and resulting groundwater flow directions matched the directions predicted by particle track modeling completed in the previous phase of PRB planning and supported the proposed orientations of PRBs. Groundwater gauging data and water table elevations/piezometric head levels for both sampling events are included in Table 2.

The groundwater velocity was calculated with the Darcy's Law equation:

V= ki/n where:

V = Groundwater velocity (ft/day)

K = hydraulic conductivity (ft/day)

i = groundwater gradient (unitless)

n = effective porosity of sand (unitless)

Soil samples were taken from continuous core samples collected during deep soil borings completed with the Roto-Sonic drilling rig. The subsurface materials were characterized to assess the variability of aquifer material for estimates of hydraulic conductivity. Based on the subsurface materials observed at each PRB a representative hydraulic conductivity for the sandy material was estimated at 150 feet/day.

9. Investigation Results

A summary of groundwater gradient, velocity, and flow directions determined in the assessment for each PRB is provided in **Table A – PRB Summary of Groundwater Gradient, Velocity, and Flow Directions**.

Table A – PRB Summary of Groundwater Gradient, Velocity, and Flow Directions

PRB Location	Groundwater Gradient (unitless)	Groundwater Velocity (feet/day)	Flow Direction
Duck Hole	0.001	0.5	East to Southeast
Briar Spring	0.001	0.5	Southeast
Namequoit/Ridge	0.001	0.5	Northeast

The groundwater velocity (0.5 feet per day) was found to be the same at each PRB location and is typical for groundwater velocity on Cape Cod. Vertical hydraulic gradients at well clusters were qualitatively assessed based on piezometric head measurements from the shallow, intermediate, and deep monitoring wells. Generally, this assessment showed flow was vertically upward, typical for locations near the coast where groundwater eventually discharges to surface water. Some locations had little vertical gradient and some indicated conflicting results, potentially associated with flow up or down to more permeable strata.

10. Hydrogeologic Assessment and Subsurface Geology

Investigation Objectives related to subsurface geology included:

- Depth to groundwater at each location,
- Direction and velocity of groundwater flow.
- Soil stratigraphy and hydraulic conductivity in the target profile,
- Maximum feasible depth of direct push injection and potential target PRB depth, and
- Findings for each PRB are presented below.

A. Duck Hole PRB

1) **Depth to Groundwater:** The water table was encountered at an elevation of approximately 3 feet of elevation (NAVD 88), 11 feet below ground surface at DU-2 and 37 feet below ground surface at DU-3 due to hilly topography.

2) **Groundwater Flow Direction:** Based on recorded water table elevations the groundwater flow direction at the Duck Hole PRB is to the southeast or east as shown with blue arrows on Figure 3 and Figure 4.

3) **Soil Stratigraphy:** Cross sections of the geologic strata were developed at two locations along the Duck Hole PRB. The location of geologic cross section line A to A' from monitoring location DU-3 to DU-2 is shown for the northern section of the PRB on Figure 3 and the cross-section is shown in Figure 10. Soil strata encountered in the saturated zone below the water table was found to be fine to coarse sand down to elevation -45 feet. Silty sand was encountered at approximate elevation -45 feet extending down to -55 feet with fine sand observed below from -55 feet to elevation -85 feet.

   Figure 4 shows the geologic cross section line B to B' for the southern section of the Duck Hole PRB between DU-5 and DU-6 and cross section B to B' is shown on Figure 11. Soil strata encountered in the saturated zone below the water table was found to be fine to coarse sand with a trace of gravel down to elevation -65 feet. Sand with a trace of silt and clay were found below the -65 feet elevation.

4) **Feasible Target PRB Depth:** Duck Hole subsurface material appears hydraulically suitable for PRB installation from the water table down to elevation -80 feet. Direct push tests indicated it took approximately 25 minutes for the Geoprobe Rig to push to 90 feet below ground surface at locations DU-2 (elevation -76 feet) and DU-5 (elevation -69 feet).

B. Briar Spring PRB

1) **Depth to Groundwater:** The water table was encountered at approximately 2 feet of elevation along Briar Springs Road and Gilman Lane. The depth to groundwater ranged from 21 feet at BR-2 to 42 feet below land surface at BR-3.

2) **Groundwater Flow Direction:** Based on recorded water table elevations the groundwater flow direction at the Briar Spring PRB was generally to the south southeast as shown with blue arrows on Figure 6 and Figure 7.

3) **Soil Stratigraphy:** Geologic cross section line C to C' is shown for the northern section of the Briar Spring PRB along Briar Spring Road between BR-2 to BR-3 on Figure 6 and the cross-section is shown in Figure 12. The southern section of the PRB on Gilman Lane is shown on Figure 7 along with the location of cross section D to D' between BR-5 and BR-6. Cross section D to D' is shown in Figure 13.

   Soil strata encountered in the saturated zone varies significantly along the Briar Spring PRB. The soil boring at BR-3 in the northern section along cross section C to C' encountered permeable fine to coarse sand from the water table elevation down to elevation -35 feet, where lower permeability sand and silt with some bands of clay were encountered. The sand with silt and clay extended down to elevation -50 where fine to coarse sand was encountered before the boring was terminated at elevation -57 feet (100 feet below land surface). At the far end of the C to C' cross section at BR-2, saturated zone soil was mainly fine to medium sand with some gravel with limited bands of fine sand with silt.

   Along the southern cross section D to D' soils were mainly fine to coarse sand with a trace of gravel and intermittent silty sand layers with some clay.

4) **Feasible Target PRB Depth:** Briar Spring PRB subsurface material appears hydraulically suitable for PRB installation from the water table down to elevation -70 feet. Direct push tests indicated it took 25 minutes for the Geoprobe Rig to push to 90 feet below ground surface at location BR-2 and 30 minutes to push to 80 feet below land surface at BR-5.

C. Namequoit PRB and Ridge PRB

1) **Groundwater Flow Direction:** The location of the Namequoit PRB and Ridge PRB is shown on Figure 8. Based on recorded water table elevations the groundwater flow direction at the Namequoit and Ridge PRB was generally to the northeast toward the Namequoit River as shown with blue arrows on Figure 9. A large topographically low wetland area east of Ridgewood Road may affect the direction of groundwater flow locally.

2) **Depth to Groundwater:** The land surface elevation varies widely in the vicinity of these PRBs. Surface elevation ranges from 11 feet at the eastern end of the Namequoit PRB at Little Marsh Lane up to 56 feet near the western end. The depth to groundwater ranges from 9 feet at NA-2 on the corner of Little Marsh Lane (groundwater elevation 5.3 feet) to approximately 46 feet below land surface on the western end of the Namequoit PRB near Heritage Drive. The depth to groundwater at the western end of the PRB on Namequoit Road was estimated based on land surface elevation and the 65-foot depth to groundwater at nearby monitoring location NA-1 on Heritage Drive (groundwater elevation 9.4 feet).

   Ridgewood Road located off Heritage Drive is also located in a hilly area. The depth to groundwater ranged from 28 feet below land surface at RI-2 (groundwater elevation 8 feet) to 61 feet below land surface at RI-3 (groundwater elevation 5.7 feet).

3) **Soil Stratigraphy:** Geologic cross section line E to E' runs between NA-1 on Heritage Drive extending approximately 1,100 feet east to NA-2 on Namequoit Road (see Figure 9 and Figure 14). The soil boring at NA-1 was terminated at elevation -25 feet due to the 65-foot depth to groundwater at this drilling location. Strata encountered in the saturated zone at NA-1 was mainly fine to coarse sand with a 3-foot layer of dense silt at elevation -14 to -17 (89 to 92 feet below land surface) with fine to coarse sand below. On the east end of cross section E to E' at NA-2, fine to coarse sand with a trace of gravel extended from the water table to approximately elevation -40 where fine sand and silt with thin bands of dense silt and clay were encountered.

   The Ridge PRB geologic cross section F to F' location between monitoring wells at RI-3 and RI-2 is shown on Figure 9 and the cross section is shown on Figure 15. Fine to coarse sand with a trace of gravel was found down to elevation -20 at R-3 and to -25 feet at RI-2. Fine sand with some silt was found below -25 feet down to elevation -65 feet.

4) **Feasible Target PRB Depth:** Subsurface material at the Namequoit and Ridge PRBs generally appear hydraulically suitable for PRB installation from the water table down to elevation -65 feet elevation. Direct push tests indicated it took 28 minutes for the Geoprobe Rig to push to 78 feet below ground surface (-64 feet elevation) at location NA-2 with penetration beyond 70 feet slower than shallower sections.

11. Assessment of Groundwater Chemistry

Investigation objectives also included data collection for evaluation of groundwater chemistry in the vicinity of proposed PRBs. This assessment included collecting nitrogen data for evaluation of flux and information related to groundwater Redox conditions that affect nitrogen chemistry.

Groundwater with sufficient dissolved oxygen (DO) for aerobic biological processes is considered oxic. Generally lower dissolved DO and oxidation-reduction potential (ORP) (low Redox conditions) or anoxic were observed in groundwater from the deeper monitoring wells compared to shallow monitoring wells. Groundwater is considered anoxic if the DO is < 1 mg/L or the ORP is less than +50 mV. Oxygen is often difficult to measure in groundwater with as oxygen can be increased while sampling. This evaluation was supported by a secondary line of evidence of that indicates anoxic conditions based on elevated dissolved iron and manganese levels. Iron and manganese are present in subsurface geologic material and are dissolved in groundwater at higher concentrations under low Redox conditions.

Observed anoxic conditions generally corresponded to low nitrate concentrations or non-detectable nitrate concentrations. Field parameters and laboratory results for each sampling event are included in Table 3. Charts showing the variation of oxygen and nitrate with depth at each monitoring location are included in Appendix D and laboratory reports are included in Appendix E.

A. Duck Hole PRB

1) **Redox Conditions:** A review of data collected for the Duck Hole PRB location indicated that one of six deep monitoring wells, DU-2-100, consistently showed anoxic groundwater conditions. One monitoring well DU-1-100, showed anoxic conditions in the first round of testing and aerobic conditions in the second round. The rest of the deep monitoring wells showed aerobic conditions with some being only marginally aerobic. Shallow and intermediate depth monitoring wells all showed aerobic groundwater conditions.

2) **Nitrogen Concentrations:** Groundwater nitrogen was mainly in the form of nitrate as indicated by similar concentrations of nitrate and total nitrogen. Concentrations of nitrate were not consistent between sampling rounds. The nitrate concentration decreased between the 1st and 2nd round at shallow monitoring well DU-6-33. Nitrate concentrations in Duck Hole deep monitoring wells increased at the second round in May 2022, with higher concentrations at all deep locations. The average and range of nitrate concentrations in Duck Hole monitoring wells are presented in **Table B – Duck Hole PRB - Summary of Nitrate Concentrations and Range at MW Depths**.

Table B – Duck Hole PRB - Summary of Nitrate Concentrations and Range at MW Depths

Sampling Round	MW Depth	Average Nitrate Concentration (mg/L)	Nitrate Concentration Range (mg/L)
First	Shallow	2.5	0.81 - 8.72
	Intermediate	2.08	0.78- 5.2
	Deep	0.68	0.11 - 1.12
Second	Shallow	1.91	0.25 - 4.15
	Intermediate	2.0	1.73 - 3.66
	Deep	1.68	0.23 - 3.46

B. Briar Spring PRB

1) **Redox Conditions:** At the Briar Spring PRB location five of six deep monitoring wells indicated groundwater conditions were anoxic. All shallow and intermediate monitoring wells showed aerobic conditions.

2) **Nitrogen Concentrations:** Groundwater nitrogen was mainly in the form of nitrate. Concentrations of nitrate were consistent between sampling rounds except for deep screen results for monitoring well BR-4-100, where the nitrate concentration increased in the second round in May 2022. The average concentration and range of nitrate concentrations in Briar Spring monitoring wells are presented in **Table C - Briar Spring PRB - Summary of Nitrate Concentrations and Range at MW Depths**.

Table C - Briar Spring PRB - Summary of Nitrate Concentrations and Range at MW Depths

Sampling Round	MW Depth	Average Nitrate Concentration (mg/L)	Nitrate Concentration Range (mg/L)
First	Shallow	0.97	0.44 - 1.09
	Intermediate	1.31	0.62 - 2.6
	Deep	0.18	0.03 - 0.16
Second	Shallow	0.88	0.44 - 1.35
	Intermediate	1.49	0.83 - 2.21
	Deep	0.37	0.03 - 1.79

C. Namequoit PRB and Ridge PRB

1) **Redox Conditions:** A review of data collected for the Namequoit PRB location indicated aerobic conditions at the NA-1 location at the two deepest monitoring wells installed (NA-1-78 and NA-1-98). Only two wells were installed at this location due to the significant depth to groundwater (approximately 64 feet). All three wells installed at the NA-2 location, including NA-2-22, NA-2-55, and NA-2-88 showed anoxic conditions. Data collected for the Ridge PRB location indicated anoxic conditions at the intermediate depth RI-2-58 monitoring well.

2) **Nitrogen Concentrations:** The concentration of nitrate was low, < 1 mg/L or not detected at Namequoit PRB monitoring wells except for NA-1-78 where 1.71 and 1.83 mg/L were detected in the 1st and 2nd sampling events respectively. Total nitrogen concentrations were less than 1 mg/L. Ridge PRB monitoring wells showed generally low concentrations with some variation higher or lower between sampling rounds. The average concentration and range of nitrate concentrations in Namequoit PRB and Ridge PRB monitoring wells are presented in **Table D - Namequoit PRB - Summary of Nitrate Concentrations and Range at MW Depths** and **Table E - Ridge PRB - Summary of Nitrate Concentrations and Range at MW Depths**.

Table D - Namequoit PRB - Summary of Nitrate Concentrations and Range at MW Depths

Sampling Round	MW Depth	Average Nitrate Concentration (mg/L)	Nitrate Concentration Range (mg/L)
First	Shallow	0.03	0.03
	Intermediate	0.87	0.03 - 1.71
	Deep	0.29	0.03 -0.55
Second	Shallow	0.03	0.03
	Intermediate	0.93	0.03 - 1.83
	Deep	0.38	0.03 - 0.74

Table E - Ridge PRB - Summary of Nitrate Concentrations and Range at MW Depths

Sampling Round	MW Depth	Average Nitrate Concentration (mg/L)	Nitrate Concentration Range (mg/L)
First	Shallow	1.34	1.34
	Intermediate	0.75	0.36 - 1.14
	Deep	0.47	0..45-0.49
Second	Shallow	1.13	1.13
	Intermediate	0.47	0.45 - 0.48
	Deep	1.01	0.43- 1.58

12. PRB Nitrate Flux Evaluation

An evaluation of nitrate mass flux was used to compare the nitrate flux estimated in the previous phase of work based on wastewater source characterization to a mass flux determined with concentration and groundwater flow data from this investigation.

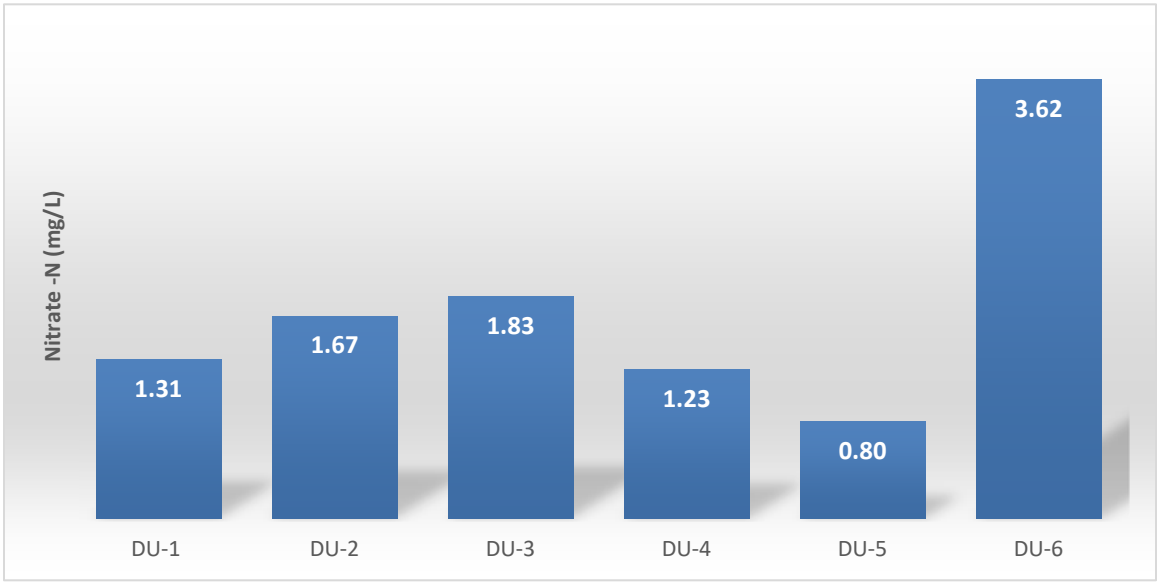
The source characterization method was reported in the Final Technical Memorandum: Permeable Reactive Barriers (PRB) Full-Scale Watershed Planning (AECOM 2021) included in Appendix A. The density of septic system wastewater nitrogen sources was assessed by estimating the number of parcels within the capture zone or area of groundwater intercepted by the PRBs assuming the PRBs would extend down 30 feet into the saturated zone. The associated nitrogen load generated in that area was calculated with specified assumptions including water use and source strength characteristics used by the MEP in estimating nitrogen loading to the estuary. For planning purposes PRBs were assumed to remove 80 percent of the nitrogen load as groundwater passes through.

In the current effort a nitrate flux estimate was developed from collected groundwater data and observed hydrogeologic conditions. Estimating nitrogen flux with a limited data set constrains the development of a flux estimate with a high confidence level but provides for a rough estimate or a range of potential flux. The nitrate data from each monitoring location (e.g., DU-1) was used to assess the range of nitrogen concentration for flux estimates. Nitrate concentration data from available shallow, intermediate, and deep monitoring wells, including data from both rounds of sampling were vertically averaged for each monitoring well cluster. This provided a representative concentration for the assessed groundwater vertical profile at the location. The location with the lowest and highest representative concentration were then used, along with site specific groundwater velocity estimates to calculate the range of nitrate flux for each PRB. The flux calculation used a 30-foot vertical extent of PRB to match the 30-foot extent of the PRB used to calculate the flux based on source strength. The actual potential flux and nitrogen reduction by the PRB will depend on the installed depth and may be greater than the flux used for comparison to the source strength estimate (see conclusions section). The results are presented for each PRB below.

A. Duck Hole PRB Nitrate Flux Evaluation

The range of average nitrate concentrations at Duck Hole monitoring locations was 0.80 mg/L to 3.62 mg/L as seen in **Figure E – Duck Hole PRB Average Nitrate Concentrations**. Four of the six monitoring locations had an average between 1 and 2 mg/L of nitrate. The highest average concentration was observed at location DU-6 where the shallow monitoring well showed a significantly higher concentration in the first round of testing than the subsequent round.

Figure E – Duck Hole PRB Average Nitrate Concentrations



A nitrate flux range was calculated using the low and high average concentrations, a groundwater velocity of 0.5 feet/day, PRB dimensions of 4,100 feet of length, and a 30-foot vertical treatment zone to match the assumed 30-foot PRB used for the source load estimate. The vertical profile of monitoring data varied from location to location due to site specific variables including depth to groundwater, soil characteristics, and depth of the monitoring wells. The resulting nitrate flux range is compared to the estimated flux based on the modeled septic system load for the capture zone is presented in **Table F - Duck Hole PRB Flux Range**.

Table F - Duck Hole PRB Flux Range

Description	Nitrate (mg/L)	Nitrate Flux (kg/yr.)
Low Concentration	0.80	178
High Concentration	3.62	805
Estimated sewer load based on source strength	---	370

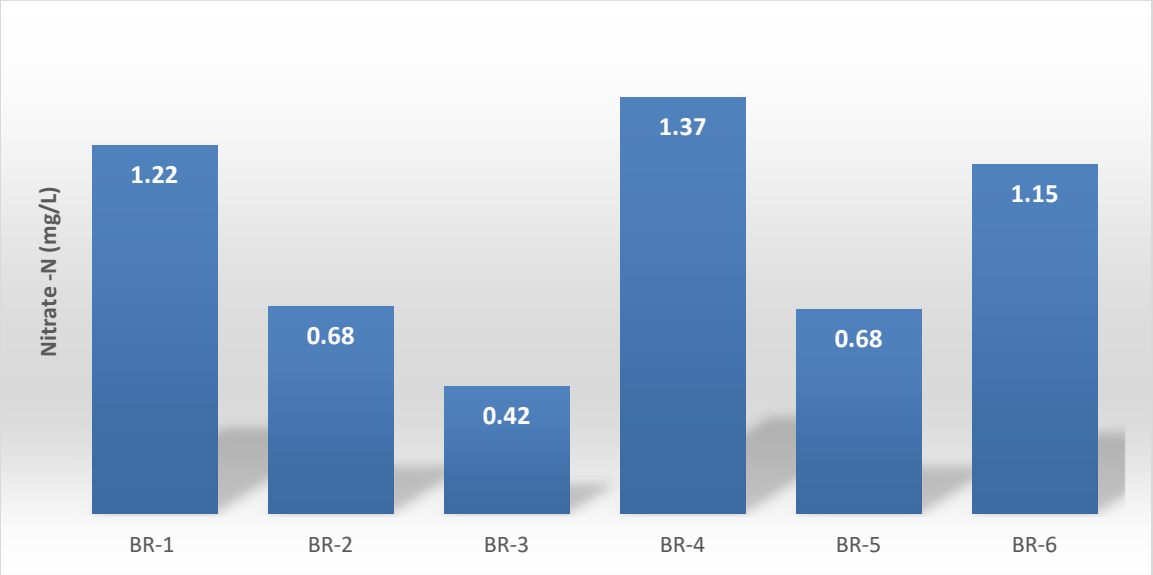
Note: Assumes a 30-foot vertical extent of the PRB.

The estimated nitrogen load based on wastewater source strength falls within the range of observed vertically averaged nitrate concentration.

B. Briar Spring PRB Nitrate Flux Evaluation

The range of average nitrate concentrations at Briar Spring monitoring locations was 0.42 mg/L to 1.37 mg/L as seen in **Figure F – Briar Spring PRB Average Nitrate Concentrations**.

Figure F – Briar Spring PRB Average Nitrate Concentrations



The nitrate flux range was calculated using the low and high average concentrations, a groundwater velocity of 0.5 feet/day, PRB dimensions of 2,900 feet of length, and a 30-foot vertical treatment zone. The resulting nitrate flux range is compared to the estimated flux based on the septic system load from the capture zone is presented in

Table G - Briar Spring PRB Flux Range.

Table G - Briar Spring PRB Flux Range

Description	Nitrate (mg/L)	Nitrate Flux (kg/yr.)
Low Concentration	0.42	66
High Concentration	1.37	216
Estimated sewer load based on source strength	---	321

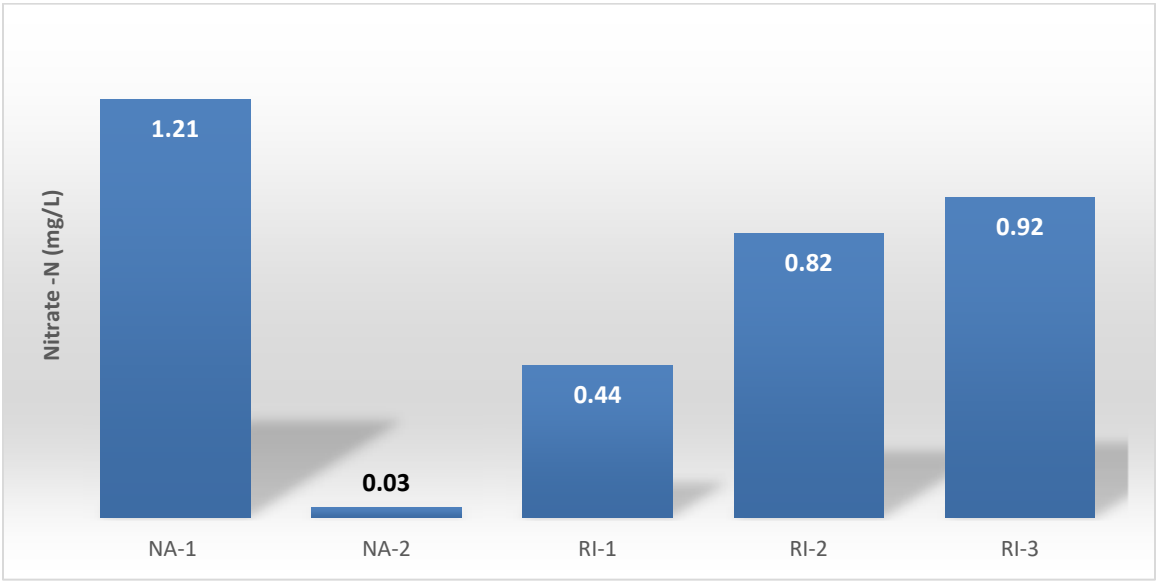
Note: Assumes a 30-foot vertical extent of the PRB.

The estimated nitrogen load based on wastewater source strength is approximately 50 percent higher than the load at the high end of the observed vertically averaged nitrate concentration.

C. Namequoit PRB and Ridge PRB Nitrate Flux Evaluation

The range of average nitrate concentrations for the combined Namequoit and Ridge PRB monitoring locations was from 0.03 mg/L (the detection limit) to 1.21 mg/L as seen in **Figure G – Namequoit PRB and Ridge PRB Average Nitrate** Concentrations.

Figure G – Namequoit PRB and Ridge PRB Average Nitrate Concentrations



The nitrate flux range was calculated using the low and high average concentrations, a groundwater velocity of 0.5 feet/day, a combined PRB length of 1,460 feet, and a 30-foot vertical treatment zone. The resulting nitrate flux range is compared to the estimated flux based on the septic system load from the capture zones is presented in

Table H - Combined Namequoit PRB and Ridge PRB Flux Range.

Table H - Combined Namequoit PRB and Ridge PRB Flux Range

Description	Nitrate (mg/L)	Nitrate Flux (kg/yr.)
Low Concentration	0.03	2
High Concentration	1.21	96
Estimated Sewer Load Namequoit PRB	---	147
Estimated Sewer Load Ridge PRB	---	158
Total Estimated Sewer Load	---	305

Note: Assumes a 30-foot vertical extent of the PRB.

The total estimated nitrogen load based on wastewater source strength is 220 percent higher than the load at the high end of the range based on observed vertically averaged nitrate concentration.

13. Discussion and Conclusions

The number of monitoring wells installed and completion of two sampling events limits the evaluation of nitrate concentration, groundwater flow, and nitrate flux at the assessed locations. The nature and distribution of septic system wastewater sources and the groundwater recharge and transport system conceptually suggests nitrate plumes arising from wastewater discharge will be narrow, undergo limited mixing and potentially have intermittent (seasonal) source strength. Groundwater flow direction may also vary seasonally or in response to changing climatic conditions. However, the investigation results provide a snapshot of existing conditions and sufficient data to achieve project objectives.

A. Observed Groundwater Conditions and Nitrate Flux

In general, groundwater nitrate concentrations were lower than expected. Groundwater chemistry and redox conditions varied between sampling locations. Anoxic conditions were noted in groundwater samples at 11 of the 46 monitoring wells, most being deep monitoring wells. All monitoring wells that showed local anoxic conditions had nitrate concentrations less than 1 mg/L. This observation suggests that denitrification may be occurring naturally under anoxic conditions. Naturally occurring biologically mediated denitrification has been identified by multiple investigators in aquifers including on Cape Cod. Travel time in groundwater from source to discharge is a key factor in the degree of denitrification (Coleman et al. 2004).

Naturally occurring denitrification may be responsible for lower observed nitrogen flux compared to the estimated nitrogen flux based on nitrogen sources. Lower concentrations and anoxic conditions noted in several deep monitoring wells may indicate loss of nitrate from upgradient sources due to long travel times to monitoring locations. Based on this observation, deeper zones in the aquifer may be less beneficial targets for installation of PRBs due to lower nitrate flux associated with naturally occurring denitrification. Deeper zones are also less favorable for PRB installation due to increased costs and the limited feasibility of injecting substrate into deep zones.

B. Feasibility of Implementing PRB Locations and Potential PRB Dimensions

1) Duck Hole PRB (83')

Duck Hole lithologic conditions appear hydraulically suitable for PRB installation from the water table (elevation +3 feet) down to elevation -80 feet (83 feet total) and this depth can be reached in a reasonable period of time (less than 30 minutes drilling) based on penetration tests. The depth to groundwater varies along the PRB and some areas and the vicinity of Wind Swept Lane at a higher land surface elevation that may preclude installation to the maximum depth.

Nitrate was present at concentrations greater than 1 mg/L in at least one of the two sampling rounds at shallow, intermediate, and deep locations. The depth of the PRB would not be limited by the nitrate profile.

Recalculating nitrate flux for the Duck Hole PRB assuming a length of 4,100 feet and a vertical extent of 83 feet provides and a potential range of nitrogen flux from 492 to 2,228 kg/year. Assuming an 80 percent reduction in nitrate flux based on potential PRB performance gives a nitrate load removal between 394 kg/yr. and 1,782 kg/yr.

This location is recommended for further consideration of full-scale PRB installation.

2) Briar Spring PRB

Briar Spring lithologic conditions appear hydraulically suitable for PRB installation from the water table (elevation 2 feet) down to elevation -70 feet (72 feet total) and this depth can likely be reached in a reasonable period of time based on penetration tests. Some locations along the path of the PRB are at higher topographic elevation that may reduce the target depth below land surface.

The nitrate concentration was low or non-detect and conditions were anoxic at 5 of the 6 deep Briar Spring monitoring wells. Based on these data a PRB at this location would not extend deeper than observed nitrate concentrations greater than 1 mg/l at intermediate depth wells. Based on nitrate concentration limitations the proposed PRB would have a vertical extent from elevation from 2 to – 40 feet.

Recalculating nitrate flux for the Briar Spring PRB assuming a length of 2,900 feet and a vertical extent of 42 feet provides and potential range of nitrogen flux from 93 to 302 kg/year. Assuming an 80 percent reduction in nitrate flux based on potential PRB performance gives a nitrate load removal between 74 kg/yr. and 242 kg/yr.

This location is recommended for further consideration of full-scale PRB installation.

3) Namequoit PRB and Ridge PRB

Namequoit and Ridge lithologic conditions were observed to be more complex than other PRB locations. The shallower saturated zone was permeable fine to coarse sand while intermediate and deeper zones included lower permeability silty sand, and silt and clay lenses. The depth to groundwater was significant at several monitoring locations including NA-2 and RI-3 and would limit the extent of potential PRBs.

The nitrate concentration was low at most monitoring locations. The only monitoring wells with nitrate exceeding 1 mg/L in both rounds of testing were NA-1-78 and RI-2-44. Monitoring well location NA-2 showed anoxic conditions and non-detect levels of nitrate at shallow, intermediate, and deep monitoring wells. This may be associated with the extensive wetlands nearby where natural denitrification may be occurring. This wetland area may also be influencing the local groundwater flow direction. Based on both geologic conditions and nitrate concentrations the Namequoit PRB and Ridge PRB are not suitable candidate locations for PRBs.

This location is not recommended for further consideration of full-scale PRB installation.

14. References

AECOM 2021, Memorandum: Permeable Reactive Barriers (PRB) Full-Scale Watershed Planning

Barbaro, J.R., Belaval, M., Truslow, D.B., LeBlanc, D.R., Cambareri, T.C., and Michaud, S.C., 2019, Hydrologic site assessment for passive treatment of groundwater nitrogen with permeable reactive barriers, Cape Cod, Massachusetts: U.S. Geological Survey Scientific Investigations Report 2019–5047, 39 p., https://doi.org/10.3133/sir20195047

Colman, J.A., Masterson, J.P., Wendy J. Pabich, W.J. and Walter, J. A., 2004, Effects of Aquifer Travel Time on Nitrogen Transport to a Coastal Embayment. Ground Water (Vol. 42, Issue 7.)

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Tables

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Table 1 Orleans Monitoring Well Construction Details

Well ID	TOC Elevation (ft)	Total Well Depth (ft bgs)	Screen Beginning Depth (ft bgs)	Screen End Depth (ft bgs)	Top Screen Elevation (ft)	Bottom Screen Elevation (ft)	Mid-Screen Elevation (ft)	Screen Length (ft)	Inst. Date	Location
DU-1-100	25.31	99.15	90.0	100.0	-64.69	-74.69	-69.69	10.0	9/21/21	Countryside Ln
DU-1-68	24.93	66.65	58.0	68.0	-33.07	-43.07	-38.07	10.0	11/17/21	Countryside Ln
DU-1-37	24.74	36.65	22.0	37.0	2.74	-12.26	-4.76	15.0	11/17/21	Countryside Ln
DU-2-100	14.69	101.50	90.0	100.0	-75.31	-85.31	-80.31	10.0	9/20/21	Countryside Ln
DU-2-63	14.68	61.10	53.0	63.0	-38.32	-48.32	-43.32	10.0	11/17/21	Countryside Ln
DU-2-26	14.50	25.50	11.0	26.0	3.50	-11.50	-4.00	15.0	11/17/21	Countryside Ln
DU-3-100	39.60	99.58	90.0	100.0	-50.40	-60.40	-55.40	10.0	9/21/21	Windswept Ln
DU-3-76	39.47	75.40	66.0	76.0	-26.53	-36.53	-31.53	10.0	11/17/21	Windswept Ln
DU-3-51	39.70	51.00	36.0	51.0	3.70	-11.30	-3.80	15.0	11/17/21	Windswept Ln
DU-4-100	40.64	100.12	90.0	100.0	-49.36	-59.36	-54.36	10.0	9/22/21	Old Duck Hole Rd
DU-4-76	40.66	75.40	66.0	76.0	-25.34	-35.34	-30.34	10.0	11/15/21	Old Duck Hole Rd
DU-4-52	39.88	48.20	37.0	52.0	2.88	-12.12	-4.62	15.0	11/16/21	Old Duck Hole Rd
DU-5-100	22.25	100.00	90.0	100.0	-67.75	-77.75	-72.75	10.0	9/23/21	Old Duck Hole Rd
DU-5-67	21.97	66.40	57.0	67.0	-35.03	-45.03	-40.03	10.0	11/16/21	Old Duck Hole Rd
DU-5-34	21.50	33.65	19.0	34.0	2.50	-12.50	-5.00	15.0	11/16/21	Old Duck Hole Rd
DU-6-100	21.38	100.00	90.0	100.0	-68.62	-78.62	-73.62	10.0	9/23/21	Old Duck Hole Rd
DU-6-67	21.24	67.00	57.0	67.0	-35.76	-45.76	-40.76	10.0	11/16/21	Old Duck Hole Rd
DU-6-33	21.40	33.00	18.0	33.0	3.40	-11.60	-4.10	15.0	11/16/21	Old Duck Hole Rd
BR-1-98	43.10	97.75	88.0	98.0	-44.90	-54.90	-49.90	10.0	9/17/21	Dale Ann Dr
BR-1-77	43.02	77.00	67.0	77.0	-23.98	-33.98	-28.98	10.0	11/18/21	Dale Ann Dr
BR-1-55	42.81	55.00	40.0	55.0	2.81	-12.19	-4.69	15.0	11/18/21	Dale Ann Dr
BR-2-96	23.11	96.00	86.0	96.0	-62.89	-72.89	-67.89	10.0	9/17/21	Briar Springs Ln
BR-2-66	22.86	66.00	56.0	66.0	-33.14	-43.14	-38.14	10.0	11/18/21	Briar Springs Ln
BR-2-36	22.96	36.00	21.0	36.0	1.96	-13.04	-5.54	15.0	11/18/21	Briar Springs Ln
BR-3-100	44.56	102.00	90.0	100.0	-45.44	-55.44	-50.44	10.0	10/7/21	Briar Springs Ln
BR-3-80	44.63	80.00	70.0	80.0	-25.37	-35.37	-30.37	10.0	11/18/21	Briar Springs Ln
BR-3-60	44.52	60.95	50.0	60.0	-5.48	-15.48	-10.48	10.0	9/15/21	Briar Springs Ln
BR-4-100	56.21	100.00	90.0	100.0	-33.79	-43.79	-38.79	10.0	10/6/21	Briar Springs Ln
BR-4-84	56.26	84.00	74.0	84.0	-17.74	-27.74	-22.74	10.0	11/19/21	Briar Springs Ln
BR-4-68	56.32	68.00	53.0	68.0	3.32	-11.68	-4.18	15.0	11/19/21	Briar Springs Ln
BR-5-90	25.88	89.90	80.0	90.0	-54.12	-64.12	-59.12	10.0	10/2/21	Gilman Ln
BR-5-64	25.96	63.35	54.0	64.0	-28.04	-38.04	-33.04	10.0	11/19/21	Gilman Ln
BR-5-37	25.69	37.00	22.0	37.0	3.69	-11.31	-3.81	15.0	11/19/21	Gilman Ln

Table 1 Orleans Monitoring Well Construction Details

Well ID	TOC Elevation (ft)	Total Well Depth (ft bgs)	Screen Beginning Depth (ft bgs)	Screen End Depth (ft bgs)	Top Screen Elevation (ft)	Bottom Screen Elevation (ft)	Mid-Screen Elevation (ft)	Screen Length (ft)	Inst. Date	Location
BR-6-100	44.25	100.00	90.0	100.0	-45.75	-55.75	-50.75	10.0	9/20/21	Briar Springs Ln
BR-6-78	44.56	77.43	68.0	78.0	-23.44	-33.44	-28.44	10.0	11/22/21	Briar Springs Ln
BR-6-56	43.26	56.00	41.0	56.0	2.26	-12.74	-5.24	15.0	11/22/21	Briar Springs Ln
NA-1-92	74.29	92.00	82.0	92.0	-7.71	-17.71	-12.71	10.0	9/30/21	Namequoit Rd
NA-1-78	74.23	78.00	63.0	78.0	11.23	-3.77	3.73	15.0	11/22/21	Namequoit Rd
NA-2-88	14.22	88.00	78.0	88.0	-63.78	-73.78	-68.78	10.0	10/1/21	Little Marsh Ln
NA-2-55	14.35	55.00	45.0	55.0	-30.65	-40.65	-35.65	10.0	11/22/21	Little Marsh Ln
NA-2-22	14.35	22.00	7.0	22.0	7.35	-7.65	-0.15	15.0	11/22/21	Little Marsh Ln
RI-1-105	95.86	106.78	95.0	105.0	0.86	-9.14	-4.14	10.0	9/30/21	Highwood Rd
RI-2-58	36.57	58.95	48.0	58.0	-11.43	-21.43	-16.43	10.0	9/25/21	Ridgegwood Rd
RI-2-44	36.70	44.00	28.0	44.0	8.70	-7.30	0.70	16.0	11/22/21	Ridgegwood Rd
RI-3-90	67.65	90.00	80.0	90.0	-12.35	-22.35	-17.35	10.0	9/29/21	Ridgegwood Rd
RI-3-77	66.81	77.00	61.0	77.0	5.81	-10.19	-2.19	16.0	11/19/2021	Ridgegwood Rd

Notes:

N/A = Not Available

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
DU-1-100	Countryside Ln	11/4/2021	25.31	21.58	3.73
DU-1-68	Countryside Ln	12/21/2021	24.93		
DU-1-37	Countryside Ln	1/25/2022	24.74	21.45	3.29
DU-2-100	Countryside Ln	11/4/2021	14.69	11.16	3.53
DU-2-63	Countryside Ln	12/22/2021	14.68	11.62	3.06
DU-2-26	Countryside Ln	12/22/2021	14.50	11.50	3.00
DU-3-100	Windswept Ln	11/4/2021	39.60	36.03	3.57
DU-3-76	Windswept Ln	12/22/2021	39.47	36.52	2.95
DU-3-51	Windswept Ln	12/22/2021	39.70	36.71	2.99
DU-4-100	Old Duck Hole Rd	11/4/2021	40.64	37.17	3.47
DU-4-76	Old Duck Hole Rd	12/22/2021	40.66	37.80	2.86
DU-4-52	Old Duck Hole Rd	12/22/2021	39.88	37.20	2.68
DU-5-100	Old Duck Hole Rd	11/4/2021	22.25	18.83	3.42
DU-5-67	Old Duck Hole Rd	12/22/2021	21.97	19.05	2.92
DU-5-34	Old Duck Hole Rd	12/22/2021	21.50	18.70	2.80
DU-6-100	Old Duck Hole Rd	11/4/2021	21.38	18.29	3.09
DU-6-67	Old Duck Hole Rd	1/24/2022	21.24	18.52	2.72
DU-6-33	Old Duck Hole Rd	1/25/2022	21.40	18.65	2.75
BR-1-98	Dale Ann Dr	11/3/2021	43.10	40.15	2.95
BR-1-77	Dale Ann Dr	1/27/2022	43.02	40.67	2.35
BR-1-55	Dale Ann Dr	1/27/2022	42.81	40.42	2.39
BR-2-96	Briar Springs Ln	11/3/2021	23.11	21.40	1.71
BR-2-66	Briar Springs Ln	1/27/2022	22.86	20.73	2.13
BR-2-36	Briar Springs Ln	1/27/2022	22.96	20.73	2.23
BR-3-100	Briar Springs Ln	11/3/2021	44.56	41.63	2.93
BR-3-80	Briar Springs Ln	1/27/2022	44.63	42.15	2.48
BR-3-60	Briar Springs Ln	11/3/2021	44.52	41.54	2.98
BR-3-60	Briar Springs Ln	1/27/2022	44.52	42.31	2.21

Table 2 Orleans Groundwater Elevations

Well ID	Location	Date	TOC Elevation (ft)	Depth to Water (ft)	GW Elevation (ft)
BR-4-100	Briar Springs Ln	11/3/2021	56.21	53.31	2.90
BR-4-84	Briar Springs Ln	2/3/2022	56.26	53.75	2.51
BR-4-68	Briar Springs Ln	2/3/2022	56.32	53.75	2.57
BR-5-90	Gilman Ln	11/3/2021	25.88	23.20	2.68
BR-5-64	Gilman Ln	2/3/2022	25.96	23.82	2.14
BR-5-37	Gilman Ln	2/3/2022	25.69	23.61	2.08
BR-6-100	Briar Springs Ln	11/3/2021	44.25	41.40	2.85
BR-6-78	Briar Springs Ln	12/21/2021	44.56	43.20	1.36
BR-6-56	Briar Springs Ln	1/27/2022	43.26	41.00	2.26
NA-1-92	Heritage Drive	11/2/2021	74.29	63.40	10.89
NA-1-78	Heritage Drive	1/26/2022	74.23	64.80	9.43
NA-2-88	Little Marsh Ln	11/3/2021	14.22	7.33	6.89
NA-2-55	Little Marsh Ln	2/3/2022	14.35	8.00	6.35
NA-2-22	Little Marsh Ln	2/3/2022	14.35	9.03	5.32
RI-1-105	Highwood Rd	11/2/2021	95.86	86.24	9.62
RI-2-58	Ridgegwood Rd	11/2/2021	36.57	28.55	8.02
RI-2-44	Ridgegwood Rd	1/26/2022	36.70	28.49	8.21
RI-3-90	Ridgegwood Rd	11/2/2021	67.65	61.78	5.87
RI-3-77	Ridgegwood Rd	2/3/2022	66.81	61.11	5.70

Notes:

N/A = Not Available

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**DU-1-100**		**DU-1-68**		**DU-1-37**		**DU-2-100**		**DU-2-63**		**DU-2-26**		**DU-3-100**	
Top of Screen Elevation (ft)	-64.69		-33.07		2.74		-75.31		-38.32		3.50		-50.40	
Bottom of Screen Elevation (ft)	-74.69		-43.07		-12.26		-85.31		-48.32		-11.50		-60.40	
Sampling Date	11/4/2021	5/10/2022	12/21/2021	5/10/2022	1/25/2022	5/10/2022	11/4/2021	5/10/2022	12/22/2021	5/10/2022	12/22/2021	5/10/2022	11/4/2021	5/10/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements														
pH (SU)	7.32	5.78	6.62	5.64	5.33	4.93	6.67	5.99	6.44	6.07	6.08	5.62	6.24	6.26
Temperature (^{o}C)	12.30	12.20	11.90	12.30	12.85	12.30	12.32	12.10	11.90	12.00	13.75	11.20	13.0	12.9
Dissolved Oxygen (DO, mg/L)	2.08	7.71	5.72	8.88	6.76	8.38	0.70	2.09	6.62	7.43	3.87	5.02	3.06	5.58
Redox Potential (ORP; mV)	-108.00	18.00	96.60	191.90	-31.60	280.00	-9.10	-37.70	139.50	130.00	156.70	4.30	190.5	157.8
Specific Conductivity (µS/cm)[c]	208.80	263.30	258.40	310.30	184.00	162.40	364.00	337.50	203.10	172.00	661.00	460.40	200.7	299.0
Turbidity (NTU)	9.87	4.15	7.29	5.05	168.00	18.94	2.36	7.04	10.70	20.13	42.70	9.46	32.80	13.89
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	**0.985**	**3.46**	**0.782**	**1.56**	**0.813**	**0.246**	**0.158**	**0.654**	**1.19**	**1.18**	**2.69**	**4.15**	**1.12**	**2.68**
Nitrite as N (mg/L)	**0.168**	<0.01	-	<0.01	-	<0.01	0.01	<0.01	-	<0.01	-	<0.01	**0.064**	<0.01
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	**1.15**	**3.69**	**1.09**	**1.56**	**1.21**	**0.483**	0.2	**0.654**	1.21	**1.43**	3.43	**4.65**	**1.19**	**2.68**
Other														
DOC (mg/L)	**-**	**0.588**	**-**	**1.05**	**-**	**2.13**	**-**	**0.554**	**-**	**0.794**	**-**	**5.23**	**-**	**0.974**
Elements														
Dissolved Iron (mg/L)	**0.595**	<0.1	**<0.1**	<0.1	0.1	<0.1	**2.48**	**1.09**	0.1	<0.1	**0.107**	<0.1	**0.521**	<0.1
Dissolved Manganese (mg/L)	**1.2**	**0.199**	**0.769**	**0.088**	**0.025**	**0.038**	**1.08**	**0.433**	**0.174**	**0.049**	**<0.02**	<0.02	**0.215**	**0.043**

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**DU-3-76**		**DU-3-51**		**DU-4-100**		**DU-4-76**		**DU-4-52**		**DU-5-100**		**DU-5-67**	
Top of Screen Elevation (ft)	-26.53		3.70		-49.36		-25.34		2.88		-67.75		-35.03	
Bottom of Screen Elevation (ft)	-36.53		-11.30		-59.36		-35.34		-12.12		-77.75		-45.03	
Sampling Date	12/22/2021	5/10/2022	12/22/2021	5/10/2022	11/4/2021	5/11/2022	12/22/2021	5/11/2022	12/22/2021	5/11/2022	11/4/2021	5/13/2022	12/22/2021	5/13/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements														
pH (SU)	6.13	5.59	6.28	5.37	7.41	5.94	6.54	5.93	6.05	5.67	6.42	5.90	6.30	5.81
Temperature (^{o}C)	12.9	13.5	13.0	14.3	11.8	11.8	11.5	11.8	11.5	12.3	11.5	11.6	11.4	11.8
Dissolved Oxygen (DO, mg/L)	5.66	7.30	6.49	6.53	3.81	6.70	5.68	7.82	8.59	8.64	1.79	4.63	8.29	9.43
Redox Potential (ORP; mV)	138.2	184.4	159.0	194.1	146.5	164.3	61.4	127.7	149.4	186.1	30.5	-12.8	133.5	213.4
Specific Conductivity (µS/cm)[c]	611.0	479.1	555.0	569.0	149.9	174.8	271.7	228.2	946.0	387.7	175.0	157.5	352.5	255.5
Turbidity (NTU)	14.80	104.54	10.40	19.88	5.25	3.00	10.90	6.28	124.00	10.40	0.02	13.86	25.80	4.41
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	**2.56**	**2.81**	**0.821**	**0.99**	**0.621**	**1.58**	**1.32**	**1.73**	**0.81**	**1.32**	**0.106**	**0.232**	**1.45**	**1.04**
Nitrite as N (mg/L)	-	<0.01	-	<0.01	**0.053**	<0.01	-	<0.01	-	<0.01	0.01	<0.01	-	<0.01
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	**2.57**	**3.72**	**1.07**	**1.3**	**0.674**	**1.58**	**1.35**	**1.73**	**0.824**	**1.32**	0.2	**0.581**	1.73	**1.82**
Other														
DOC (mg/L)	**1.37**	**1.16**	**-**	**1.83**	**-**	**0.896**	**-**	**0.926**	**-**	**0.896**	**-**	**0.776**	**-**	**1.04**
Elements														
Dissolved Iron (mg/L)	**0.308**	**0.143**	0.1	<0.1	0.1	<0.1	0.798	<0.1	<0.1	<0.1	**0.798**	<0.1	**0.128**	<0.1
Dissolved Manganese (mg/L)	**0.492**	**0.087**	**0.101**	<0.02	**0.315**	**0.166**	**0.399**	**0.113**	**0.151**	**0.02**	**0.556**	**0.041**	**0.048**	<0.02

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**DU-5-34**		**DU-6-100**		**DU-6-67**		**DU-6-33**		**BR-1-98**		**BR-1-77**		**BR-1-55**	
Top of Screen Elevation (ft)	2.50		-68.62		-35.76		3.40		-44.90		-23.98		2.81	
Bottom of Screen Elevation (ft)	-12.50		-78.62		-45.76		-11.60		-54.90		-33.98		-12.19	
Sampling Date	12/22/2021	5/13/2022	11/4/2021	5/13/2022	1/24/2022	5/13/2022	1/25/2022	5/13/2022	11/3/2021	5/12/2022	1/27/2022	5/12/2022	1/27/2022	5/12/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements														
pH (SU)	5.97	5.80	6.28	5.79	6.28	5.54	5.61	5.10	6.56	5.98	5.71	5.43	5.90	5.29
Temperature (^{o}C)	12.5	11.7	12.23	14.80	12.29	12.50	14.88	13.40	11.70	12.10	11.80	12.40	12.60	12.90
Dissolved Oxygen (DO, mg/L)	9.17	9.20	6.64	7.66	6.54	7.52	7.60	8.75	0.09	0.36	3.70	3.65	10.86	8.29
Redox Potential (ORP; mV)	188.7	29.9	112.60	32.10	-122.20	229.60	111.90	47.90	44.30	-58.10	16.70	205.10	185.10	264.30
Specific Conductivity (µS/cm)[c]	332.0	250.1	283.00	282.10	284.00	292.80	640.00	1228.00	149.90	204.60	243.00	207.20	361.00	770.00
Turbidity (NTU)	4.06	28.62	732.00	46.38	168.00	2.52	5.82	3.62	1.09	12.21	6.98	22.16	6.80	2.28
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	**1.13**	**0.83**	**1.09**	**1.45**	**5.2**	**3.66**	**8.72**	**1.61**	**0.162**	**0.293**	**1.31**	**1.99**	**0.806**	**0.758**
Nitrite as N (mg/L)	-	<0.01	**0.019**	<0.01	-	<0.01	-	<0.01	0.01	<0.010	-	<0.010	-	<0.010
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	1.13	**1.16**	**1.11**	**1.45**	**5.8**	**3.66**	**8.72**	**1.61**	0.2	**0.293**	1.31	**1.99**	0.806	**0.758**
Other														
DOC (mg/L)	**-**	**1.41**	**-**	**1.14**	**-**	**1.17**	**-**	**1.18**	**-**	**1.32**	1.47	**1.24**	**-**	**0.855**
Elements														
Dissolved Iron (mg/L)	0.1	<0.1	0.1	<0.1	**0.456**	<0.1	0.1	<0.1	**0.701**	<0.100	**0.155**	<0.100	**<0.1**	<0.100
Dissolved Manganese (mg/L)	**0.035**	**0.028**	**0.755**	**0.05**	**0.08**	<0.02	**0.091**	**0.11**	**0.506**	**0.055**	**0.068**	**0.037**	**0.025**	**0.034**

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**BR-2-96**		**BR-2-66**		**BR-2-36**		**BR-3-100**		**BR-3-80**		**BR-3-60**		
Top of Screen Elevation (ft)	-62.89		-33.14		1.96		-45.44		-25.37		-5.48		
Bottom of Screen Elevation (ft)	-72.89		-43.14		-13.04		-55.44		-35.37		-15.48		
Sampling Date	11/3/2021	5/12/2022	1/27/2022	5/12/2022	1/27/2022	5/12/2022	11/3/2021	5/12/2022	1/27/2022	5/12/2022	11/3/2021	1/27/2022	5/12/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements													
pH (SU)	6.53	7.09	5.87	5.54	5.77	5.85	7.32	6.38	6.03	5.77	6.45	5.91	5.65
Temperature (^{o}C)	12.0	11.9	11.6	12.4	12.1	13.0	12.0	11.9	11.9	12.1	12.3	12.1	12.4
Dissolved Oxygen (DO, mg/L)	0.32	0.12	8.51	6.81	9.76	8.76	0.21	0.14	6.92	5.57	7.08	7.30	7.31
Redox Potential (ORP; mV)	-79.9	-99.9	177.2	206.5	130.2	15.7	-73.7	-70.1	190.0	158.1	83.8	106.5	29.8
Specific Conductivity (µS/cm)[c]	6631.0	11700.0	215.0	249.6	263.0	413.7	398.0	443.1	355.0	395.0	364.0	372.0	367.5
Turbidity (NTU)	4.30	8.72	27.20	1.11	5.67	14.63	102.00	8.50	6.21	5.57	0.02	2.63	4.75
Laboratory Analyses													
Nitrogen													
Nitrate as N (mg/L)	0.03	<0.03	0.807	**0.827**	1.06	**1.35**	0.03	<0.0300	0.62	**0.654**	**0.566**	**0.646**	**0.631**
Nitrite as N (mg/L)	0.01	<0.010	-	<0.010	-	<0.010	0.01	**0.012**	-	<0.010	0.01	-	<0.010
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	**1.09**	**1.5**	**0.807**	**0.827**	**1.06**	**1.35**	**0.325**	**0.815**	**0.62**	**0.963**	**0.566**	**0.861**	**0.947**
Other													
DOC (mg/L)	-	**1.49**	-	**0.897**	-	**1.24**	-	**1.2**	-	**1.12**	-	-	**6.19**
Elements													
Dissolved Iron (mg/L)	**3.28**	**3.92**	**0.15**	<0.100	**<0.1**	<0.100	**0.904**	**6.03**	**<0.1**	<0.100	**0.151**	**0.465**	**0.241**
Dissolved Manganese (mg/L)	**0.368**	**0.225**	**0.053**	<0.020	**<0.02**	<0.020	**0.349**	**1.51**	**0.152**	**0.022**	**0.043**	**<0.02**	<0.020

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**BR-4-100**		**BR-4-84**		**BR-4-68**		**BR-5-90**		**BR-5-64**		**BR-5-37**		**BR-6-100**	
Top of Screen Elevation (ft)	-33.79		-17.74		3.32		-54.12		-28.04		3.69		-45.75	
Bottom of Screen Elevation (ft)	-43.79		-27.74		-11.68		-64.12		-38.04		-11.31		-55.75	
Sampling Date	11/3/2021	5/19/2022	2/3/2022	5/19/2022	2/3/2022	5/19/2022	11/3/2021	5/18/2022	2/3/2022	5/18/2022	2/3/2022	5/18/2022	11/3/2021	5/12/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements														
pH (SU)	6.74	5.89	6.15	5.70	6.14	5.91	6.53	6.21	6.17	5.86	6.00	5.87	6.77	6.26
Temperature (^{o}C)	11.7	11.8	11.7	11.8	12.3	11.8	11.5	12.1	11.4	11.7	13.4	13.2	11.4	11.7
Dissolved Oxygen (DO, mg/L)	4.56	5.78	9.71	8.45	8.19	7.84	0.02	0.09	10.91	7.66	4.64	NA	0.35	0.14
Redox Potential (ORP; mV)	24.1	6.0	113.8	36.3	116.7	140.5	-317.7	-115.0	180.9	175.5	108.5	21.4	23.7	-108.0
Specific Conductivity (µS/cm)[c]	204.0	204.5	172.0	215.7	410.0	385.7	607.9	1218.0	230.0	216.9	1490.0	1561.0	176.0	176.0
Turbidity (NTU)	47.40	12.20	22.10	29.07	34.80	13.19	1.26	2.12	16.70	14.50	5.31	8.39	0.38	22.64
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	**0.804**	**1.79**	**2.6**	**2.18**	**0.435**	**0.44**	0.03	<0.03	**1.09**	**1.1**	**1.07**	**0.731**	0.03	<0.0300
Nitrite as N (mg/L)	**0.046**	<0.01	-	<0.01	-	<0.01	0.01	<0.01	-	**0.011**	-	<0.01	0.01	<0.010
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	**0.851**	**1.79**	**2.62**	**2.18**	**0.824**	**0.643**	**0.247**	<0.2	**1.45**	**1.11**	**1.43**	**1.08**	**0.412**	**0.405**
Other														
DOC (mg/L)	**-**	**1.06**	**-**	**0.928**	**-**	**1.9**	**-**	**1.05**	**-**	**0.938**	**-**	**3.47**	**-**	**1.38**
Elements														
Dissolved Iron (mg/L)	0.1	<0.1	**0.181**	**0.141**	**0.223**	<0.1	**3.71**	**3.28**	**0.133**	<0.1	<0.1	<0.1	**1.37**	**3.89**
Dissolved Manganese (mg/L)	**0.332**	**0.21**	**0.183**	**0.084**	**0.045**	**0.118**	**0.843**	**0.49**	**0.044**	<0.02	**0.449**	**0.075**	**0.401**	**0.194**

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**BR-6-78**		**BR-6-56**		**NA-1-92**		**NA-1-78**		**NA-2-88**		**NA-2-55**		**NA-2-22**	
Top of Screen Elevation (ft)	-23.44		2.26		-7.71		11.23		-63.78		-30.65		7.35	
Bottom of Screen Elevation (ft)	-33.44		-12.74		-17.71		-3.77		-73.78		-40.65		-7.65	
Sampling Date	12/21/2021	5/18/2022	1/27/2022	5/18/2022	11/2/2021	5/9/2022	1/26/2022	5/9/2022	11/3/2021	5/19/2022	2/3/2022	5/20/2022	2/3/2022	5/20/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements														
pH (SU)	6.23	5.74	6.20	6.13	6.06	5.62	5.77	5.53	7.18	6.73	7.19	6.83	5.56	5.21
Temperature (^{o}C)	11.1	12.4	11.4	13.6	11.8	11.5	11.5	11.9	11.1	10.4	10.1	11.4	10.1	10.6
Dissolved Oxygen (DO, mg/L)	3.36	5.80	8.81	8.73	5.75	8.33	9.59	9.68	0.17	0.29	0.02	0.18	0.29	0.51
Redox Potential (ORP; mV)	99.0	24.8	22,8	136.90	66.7	192.1	-22.3	37.7	-25.0	-85.6	-501.6	-120.6	-509.3	34.1
Specific Conductivity (µS/cm)[c]	224.6	247.6	200.0	227.3	449.0	475.6	260.0	802.7	136.0	124.5	91.0	102.6	111.0	168.0
Turbidity (NTU)	10.90	61.51	7.24	42.41	7.59	22.66	7.75	4.69	102.00	16.95	736.00	133.66	7.75	73.03
Laboratory Analyses														
Nitrogen														
Nitrate as N (mg/L)	1.45	**2.21**	1.86	**1.34**	**0.552**	**0.739**	**1.71**	**1.83**	0.03	<0.03	<0.03	<0.0300	<0.03	<0.0300
Nitrite as N (mg/L)	-	<0.01	-	<0.01	**0.017**	<0.01	-	<0.01	0.01	**0.011**	-	<0.010	-	**0.011**
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	1.45	**2.21**	**2.11**	**1.34**	**0.774**	**1.39**	**1.93**	**1.83**	**0.33**	<0.2	**0.695**	**0.203**	**0.758**	**0.597**
Other														
DOC (mg/L)	-	**0.889**	-	**1.03**	-	**0.648**	-	**0.65**	-	**0.91**	**1**	**0.523**	-	**11**
Elements														
Dissolved Iron (mg/L)	**0.347**	<0.1	**<0.1**	**0.119**	**0.117**	<0.1	0.1	<0.1	**0.695**	**0.927**	**1.17**	**0.837**	**3**	**4.01**
Dissolved Manganese (mg/L)	**0.274**	**0.027**	**<0.02**	<0.02	**0.207**	<0.02	0.02	<0.02	**0.445**	**0.523**	**1.38**	**1.56**	**0.096**	**0.117**

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Table 3 Orleans Monitoring Well Groundwater Data Summary

Sample ID	**RI-1-105**		**RI-2-58**		**RI-2-44**		**RI-3-90**		**RI-3-77**	
Top of Screen Elevation (ft)	0.86		-11.43		8.70		-12.35		5.81	
Bottom of Screen Elevation (ft)	-9.14		-21.43		-7.30		-22.35		-10.19	
Sampling Date	11/2/2021	5/13/2022	11/3/2021	5/9/2022	1/26/2022	5/9/2022	11/2/2021	5/9/2022	2/3/2022	5/9/2022
Type of Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample	Sample
Field Measurements										
pH (SU)	6.00	5.94	7.00	5.77	5.68	5.24	6.06	5.14	5.70	5.11
Temperature (^{o}C)	11.6	12.7	11.8	12.1	11.9	11.9	11.61	12.30	11.42	12.30
Dissolved Oxygen (DO, mg/L)	10.81	10.04	0.24	5.34	3.78	6.33	7.61	9.00	9.11	9.07
Redox Potential (ORP; mV)	90.4	53.5	-390.4	2.6	-15.6	215.6	38.60	48.00	118.10	255.50
Specific Conductivity (µS/cm)[c]	333.0	345.8	279.0	3.6	500.0	806.0	515.00	1247.00	164.00	711.00
Turbidity (NTU)	0.23	12.96	800.00	115.63	8.10	9.59	0.59	4.25	9.80	5.26
Laboratory Analyses										
Nitrogen										
Nitrate as N (mg/L)	**0.449**	**0.431**	**0.36**	**0.451**	**1.34**	**1.13**	**0.494**	**1.58**	**1.14**	**0.481**
Nitrite as N (mg/L)	0.01	<0.01	**0.366**	<0.01	-	<0.01	0.01	<0.01	-	<0.01
Total Kjeldahl Nitrogen (TKN) (mg/L)	-	-	-	-	-	-	-	-	-	-
Total Nitrogen (mg/L)	**0.449**	**0.431**	**1.42**	**0.882**	**1.34**	**1.67**	**0.494**	**1.58**	**1.34**	**0.481**
Other										
DOC (mg/L)	**-**	**0.965**	**-**	**0.751**	**-**	<0.5	**-**	**0.69**	**-**	**0.776**
Elements										
Dissolved Iron (mg/L)	0.1	<0.1	0.1	**2.16**	0.1	<0.1	**2.19**	**0.157**	<0.1	<0.1
Dissolved Manganese (mg/L)	**0.13**	<0.02	**1.23**	**0.419**	0.02	**0.028**	**0.443**	**0.105**	**0.058**	**0.065**

Notes:

NS - Not Sampled

Bold - detected above the Minimum Detection Limit

Figures

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Rock Harbor
Norseman
Tonset
Duck Hole
Blossom
Gosnold
Briar Spring
Keziahs
Monument
Mayflower
Namequoit
Ridge
Lockwood
Richwood
Grannys
Quonset
Quonset
Winslow

EASTHAM
BREWSTER
HARWICH
Orleans
East Orleans
South Orleans
Weeset
Tonset
Nauset Heights
Town Cove
Cedar Pond
Mill Pond
Crystal Lake
The River
Pilgrim Lake
Baker Pond
Meeting House Pond
Little Pleasant Bay
Pleasant Bay
Sampson Island
Hog Island
Sipson Island
Pochet Island Marshes
Rock Harbor Rd
Mid-Cape Hwy
Cranberry Hwy
Old Colony Way
Namskaket Rd
Main St
Route 6
Route 28
Route 6A

FIGURE 1

POTENTIAL PRB LOCATIONS

Legend

- Permeable Reactive Barrier
- Capture Zone Flow Paths
- Investigated PRBs

0 1,000 2,000 Feet

1 inch = 2,000 feet

AECOM

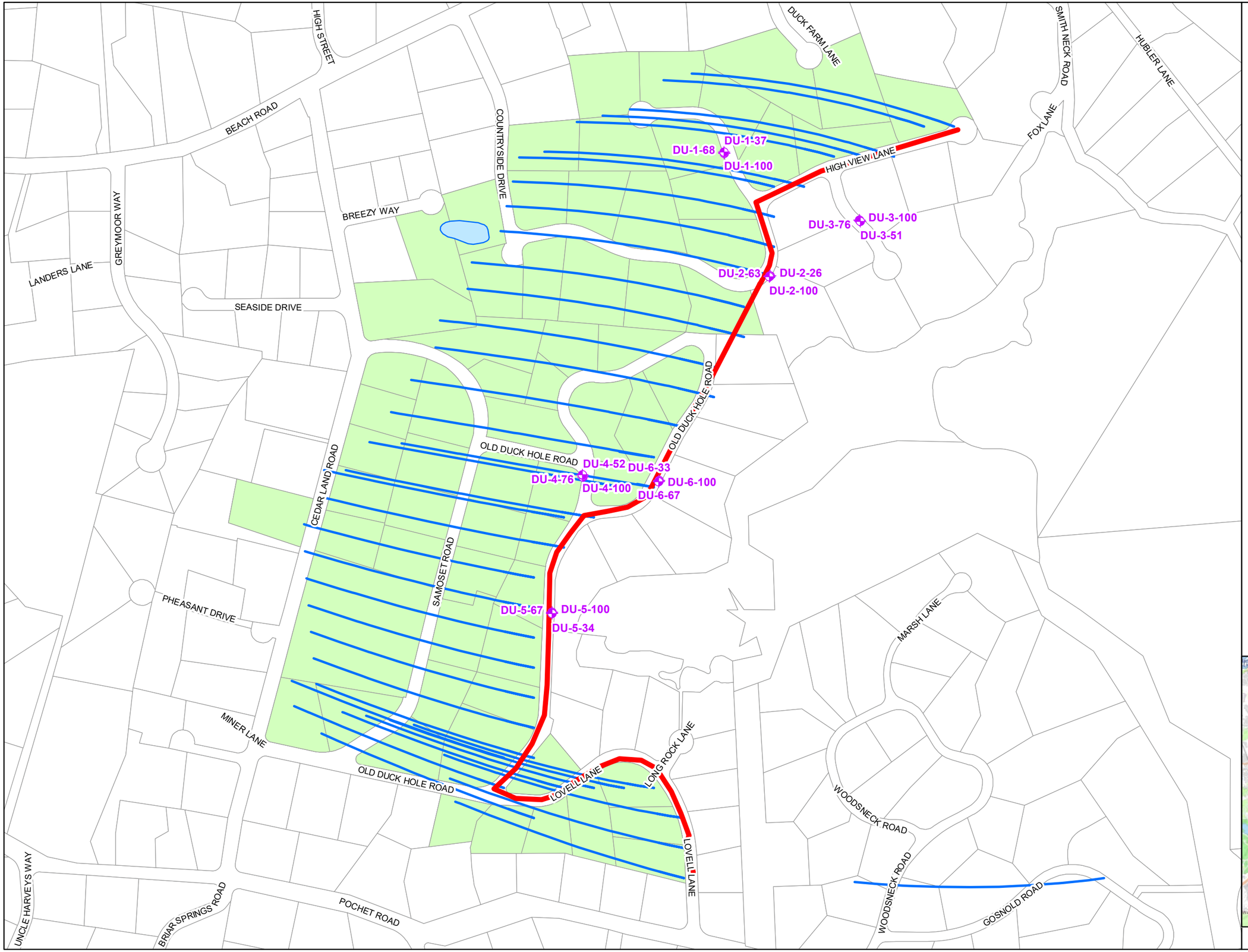
Date: 10/13/2022

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREM (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) Op Community

C:\Work\60476644\ORL\Maps\PotentialPRBLocations.mxd

FIGURE 2

DUCK HOLE PRB



Legend

- PRB Monitoring Well
- Permeable Reactive Barrier
- Capture Zone Flow Paths
- Parcel Upgradient of PRB
- Parcel Boundary

0 150 300 Feet

1 inch = 300 feet

AECOM

Date: 8/22/2022



Locator Map

C:\Work\60476644ORL\Maps\SelectedPRBs_full.mxd

FIGURE 3

DUCK HOLE 01

DUCK FARM LANE

HIGH VIEW LANE

WINDSWEPT LANE

COUNTRYSIDE DRIVE

OLD DUCK HOLE ROAD

DU-1-68
DU-1-100
DU-1-37

DU-3-100
DU-3-51
DU-3-76
A'

DU-2-100
DU-2-26
DU-2-63
A

Legend

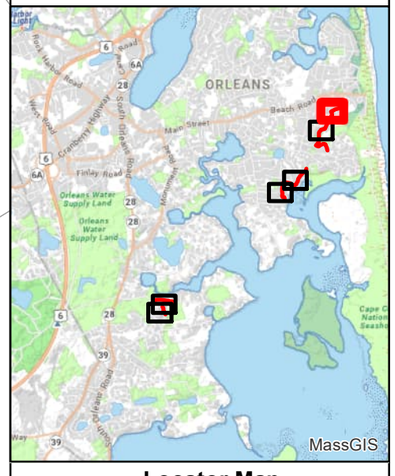
- PRB Monitoring Well
- Approximate Groundwater Flow Direction
- Permeable Reactive Barrier
- Cross-Section
- Parcel Upgradient of PRB

0 50 100 Feet

1 inch = 100 feet

AECOM

Date: 8/22/2022



Locator Map

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FIGURE 4

DUCK HOLE 02

OLD DUCK HOLE ROAD

OLD DUCK HOLE ROAD

OLD DUCK HOLE ROAD

SAMOSET ROAD

DU-4-76
DU-4-52
DU-4-100

DU-6-67
DU-6-100
DU-6-33

B'

DU-5-34
DU-5-100
DU-5-67

B

Legend

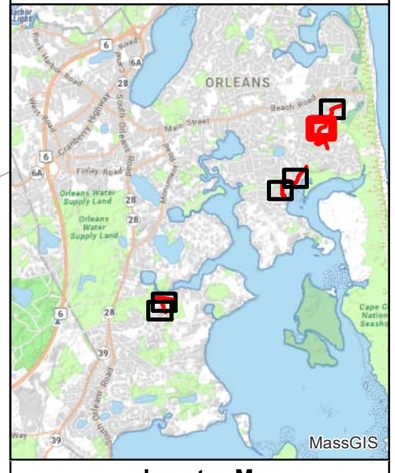
- PRB Monitoring Well
- Approximate Groundwater Flow Direction
- Permeable Reactive Barrier
- Cross-Section
- Parcel Upgradient of PRB

0 50 100 Feet

1 inch = 100 feet

AECOM

Date: 8/22/2022



Locator Map

C:\Work\60476644\ORL\Maps\SelectedPRBs_detail.mxd

FIGURE 5

BRIAR SPRING PRB

HARVEYS LANE
FISHER WAY
SEA MIST DRIVE
BARLEY NECK ROAD
FOX RIDGE DRIVE
CARRIAGE PLACE
TWISS ROAD
GILMAN LANE
PLEASANT VIEW DRIVE
DALE ANN DRIVE
UNCLE HARVEYS WAY
BRIAR SPRINGS ROAD
SHORE VIEW DRIVE
SPARROWHAWK ROAD
SIBSIE LANE
BLOSSOM LANE

Uncle Harveys Pond

BR-3-100
BR-3-80
BR-3-60
BR-1-98
BR-1-55
BR-1-77
BR-2-66
BR-2-96
BR-2-36
BR-6-56
BR-6-78
BR-6-100
BR-4-68
BR-4-84
BR-4-100
BR-5-64
BR-5-90
BR-5-37

Legend

- PRB Monitoring Well
- Permeable Reactive Barrier
- Capture Zone Flow Paths
- Parcel Upgradient of PRB
- Parcel Boundary

0 125 250 Feet

1 inch = 250 feet

N

AECOM

Date: 8/22/2022



Locator Map

C:\Work\60476644\ORL\Maps\SelectedPRBs_full.mxd

FIGURE 6

BRIAR SPRING 01

DALE ANN DRIVE

FOX RIDGE DRIVE

FOX RIDGE DRIVE

DALE ANN DRIVE

SHORE VIEW DRIVE

BRIAR SPRINGS ROAD

BR-1-98

BR-1-77

BR-1-55

C'

BR-3-80

BR-3-100

BR-3-60

BR-2-96

BR-2-36

BR-2-66

C

Legend

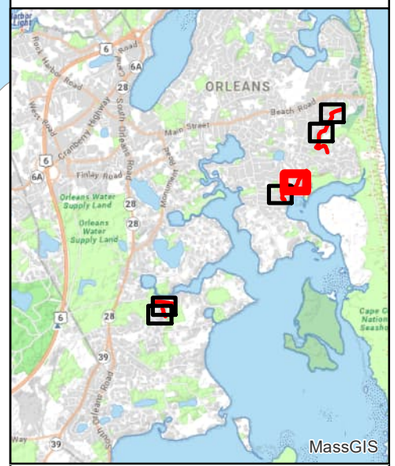
- PRB Monitoring Well
- Approximate Groundwater Flow Direction
- Permeable Reactive Barrier
- Cross-Section
- Parcel Upgradient of PRB

0 50 100 Feet

1 inch = 100 feet

AECOM

Date: 8/22/2022

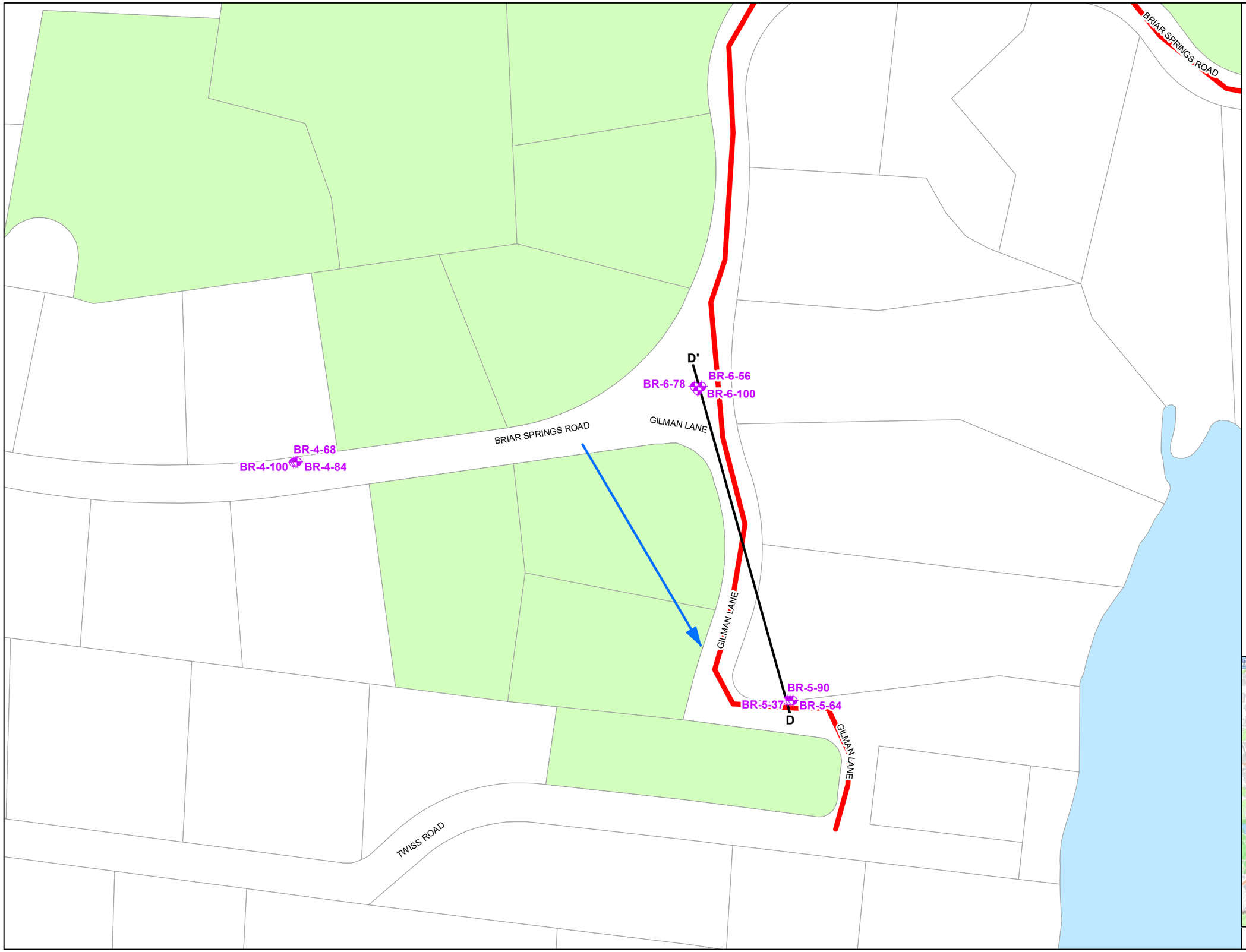


Locator Map

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FIGURE 7

BRIAR SPRING 02



Legend

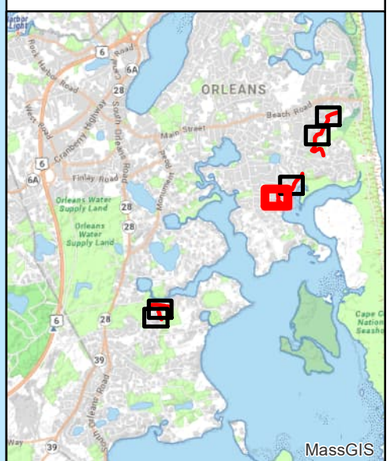
- PRB Monitoring Well
- Approximate Groundwater Flow Direction
- Permeable Reactive Barrier
- Cross-Section
- Parcel Upgradient of PRB

0 50 100 Feet

1 inch = 100 feet

AECOM

Date: 8/22/2022



Locator Map

C:\Work\60476644ORL\Maps\SelectedPRBs_detail.mxd

FIGURE 8

NAMEQUOIT/RIDGE PRB

SOUTH ORLEANS ROAD
WINDJAMMER WAY
NAMEQUOIT ROAD
LITTLE MARSH LANE
NA-2-88
NA-2-22
NA-2-55
NA-1-78
NA-1-92
RI-3-90
RI-3-77
WINDSOR LANE
RIDGEWOOD ROAD
RI-2-44
RI-2-58
RI-1-105
HIGHWOOD ROAD
PILGRIM DRIVE
STURBRIDGE DRIVE
HERITAGE DRIVE
COLONIAL DRIVE
JOHN KENRICK ROAD
CAROLINES WAY
LINDSAY LANE
PORTANIMICUT ROAD
RICHWOOD FARM LANE
INDIAN FORT HILL LANE

Legend

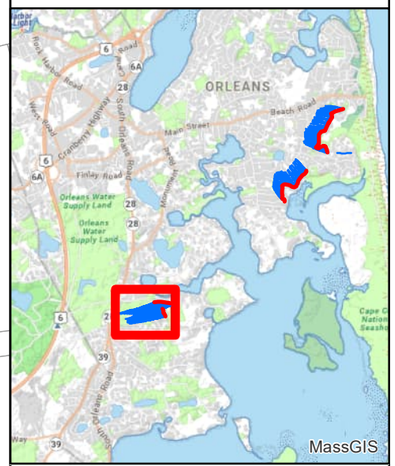
- PRB Monitoring Well
- Permeable Reactive Barrier
- Capture Zone Flow Paths
- Parcel Upgradient of PRB
- Parcel Boundary

0 125 250 Feet

1 inch = 250 feet

AECOM

Date: 8/22/2022



Locator Map

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FIGURE 9

NAMEQUOIT/RIDGE

NAMEQUOIT ROAD

LITTLE MARSH LANE

WINDSOR LANE

HERITAGE DRIVE

RIDGEWOOD ROAD

HIGHWOOD ROAD

NA-1-92

NA-1-78

E

E'

NA-2-22

NA-2-88

NA-2-55

F

RI-3-90

RI-3-77

RI-2-58

RI-2-44

F'

RI-1-105

Legend

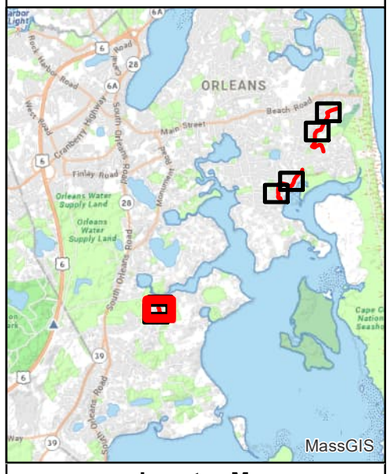
- PRB Monitoring Well
- Approximate Groundwater Flow Direction
- Permeable Reactive Barrier
- Cross-Section
- Parcel Upgradient of PRB

0 50 100 Feet

1 inch = 100 feet

AECOM

Date: 10/28/2022

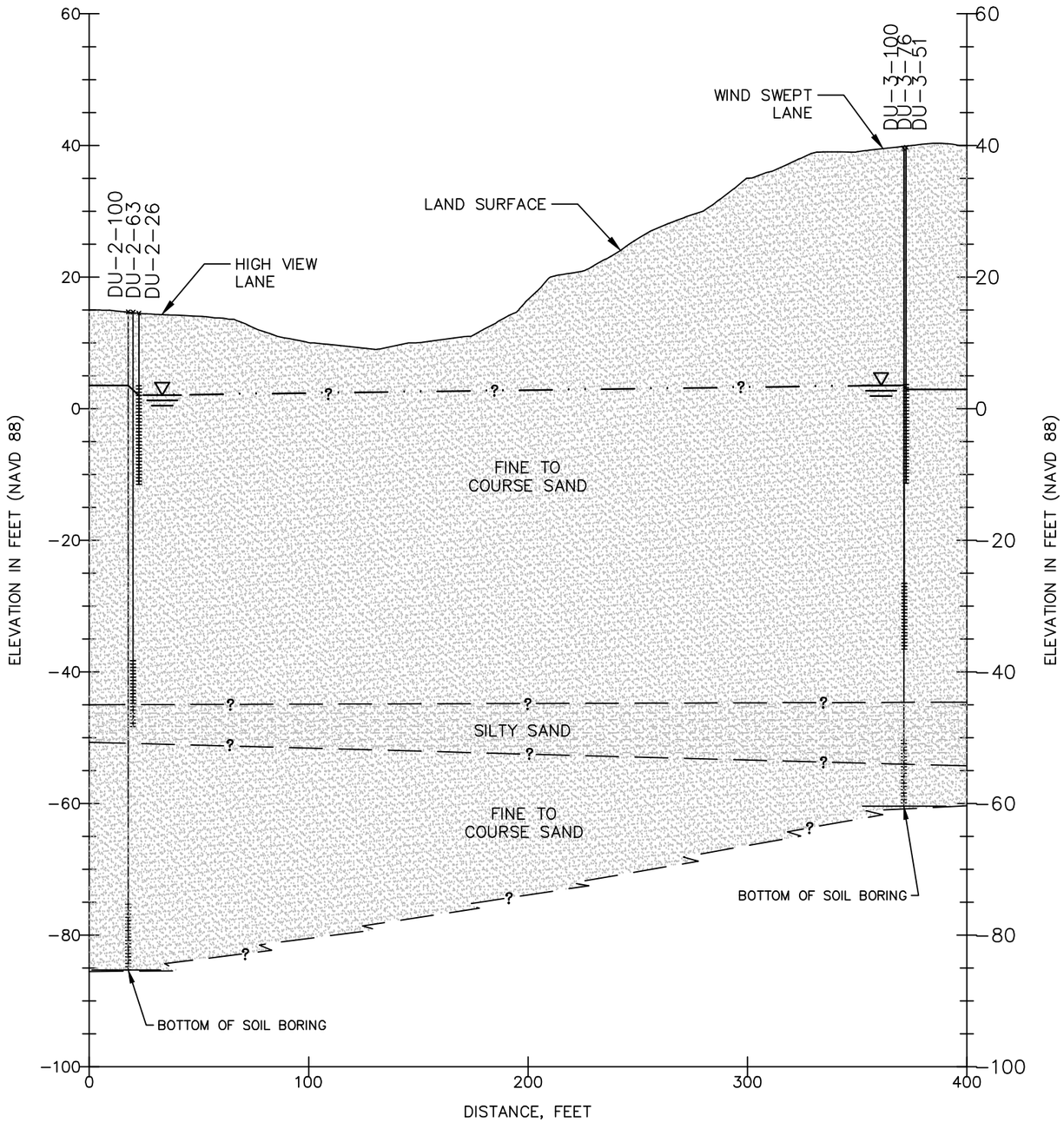


Locator Map

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A (SOUTHWEST)

A' (NORTHEAST)



LEGEND

SAND
SILTY SAND
SILT AND CLAY
SAND AND GRAVEL
SILT
GROUNDWATER SURFACE
WATER TABLE

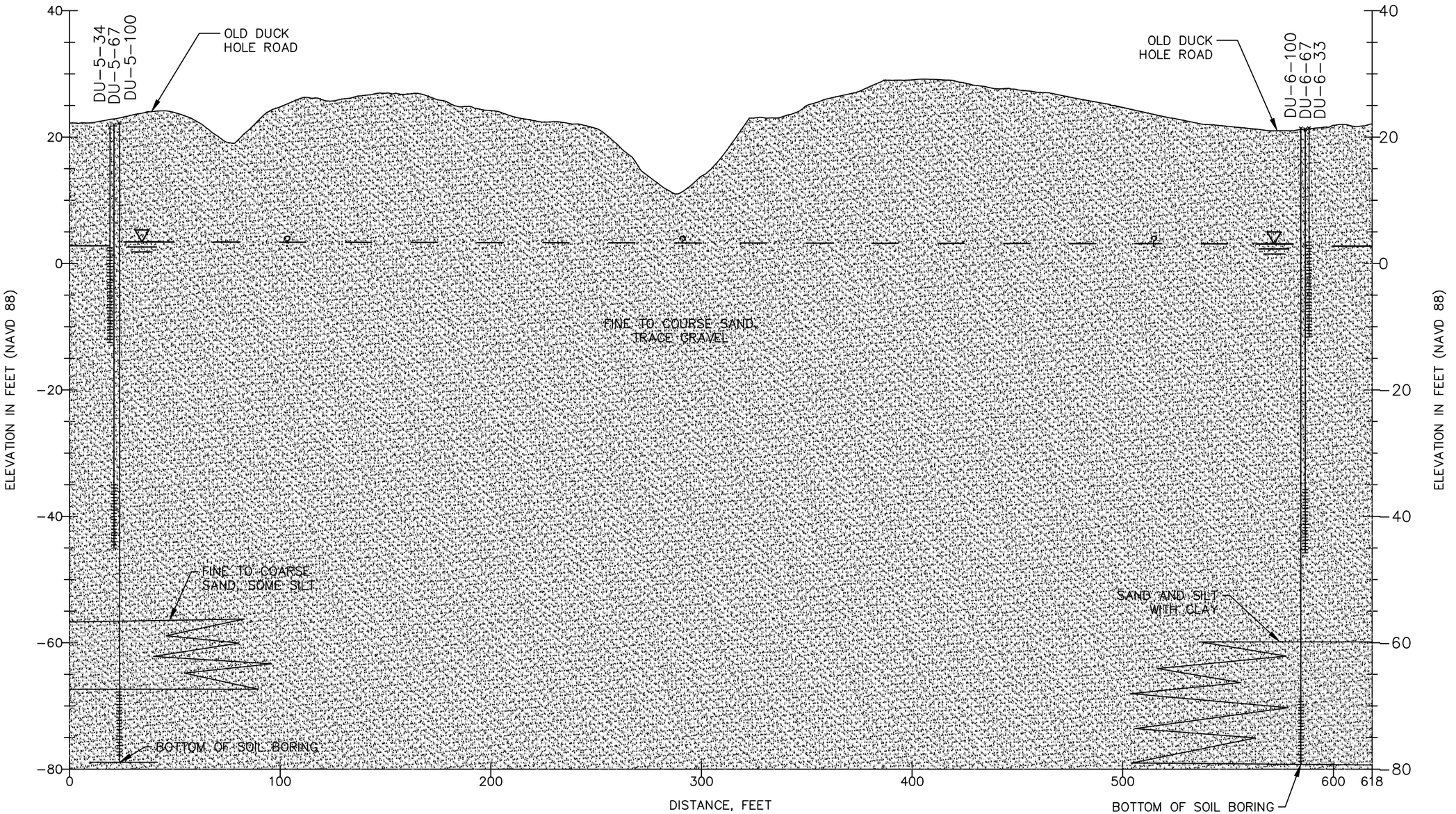
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Figure: 10

GEOLOGIC CROSS SECTION A-A'
DUCK HOLE PRB
TOWN OF ORLEANS, MA
Project No.: 60476644 Date: 2022-11-16

B (SOUTHWEST)

B' (NORTHEAST)



LEGEND

SAND

SILTY SAND

SILT AND CLAY

SAND AND GRAVEL

SILT

GROUNDWATER SURFACE

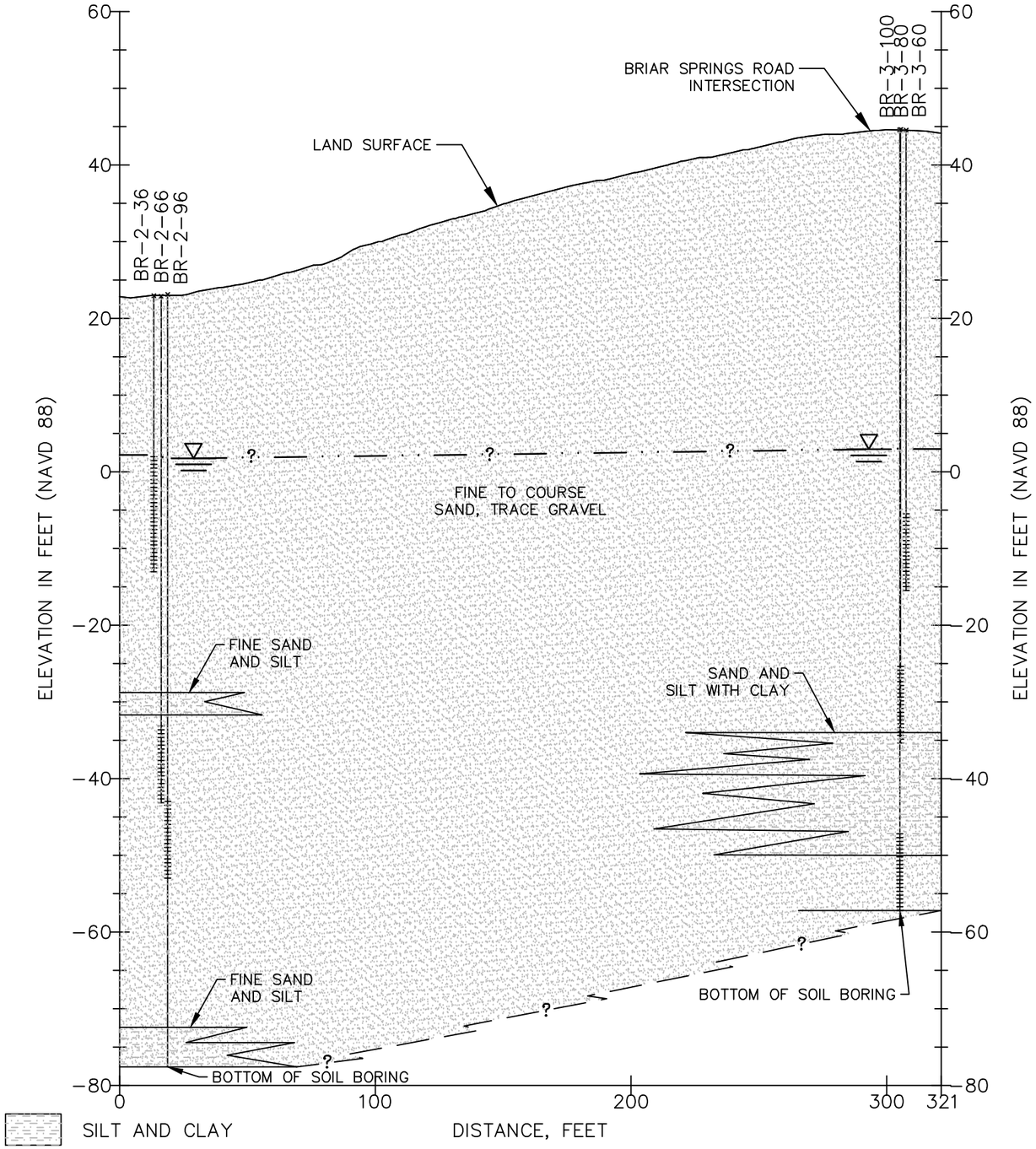
WATER TABLE

AECOM

Figure: 11

GEOLOGIC CROSS SECTION B-B'
DUCK HOLE PRB
TOWN OF ORLEANS, MA
Project No.: 60476644 Date: 2022-11-16

C (SOUTHWEST) **C' (NORTHEAST)**



LEGEND

SAND
SILTY SAND
SILT AND CLAY
SAND AND GRAVEL
SILT
GROUNDWATER SURFACE
WATER TABLE

GEOLOGIC CROSS SECTION C-C'
BRIAR SPRING PRB
TOWN OF ORLEANS, MA
Project No.: 60476644 Date: 2022-11-16

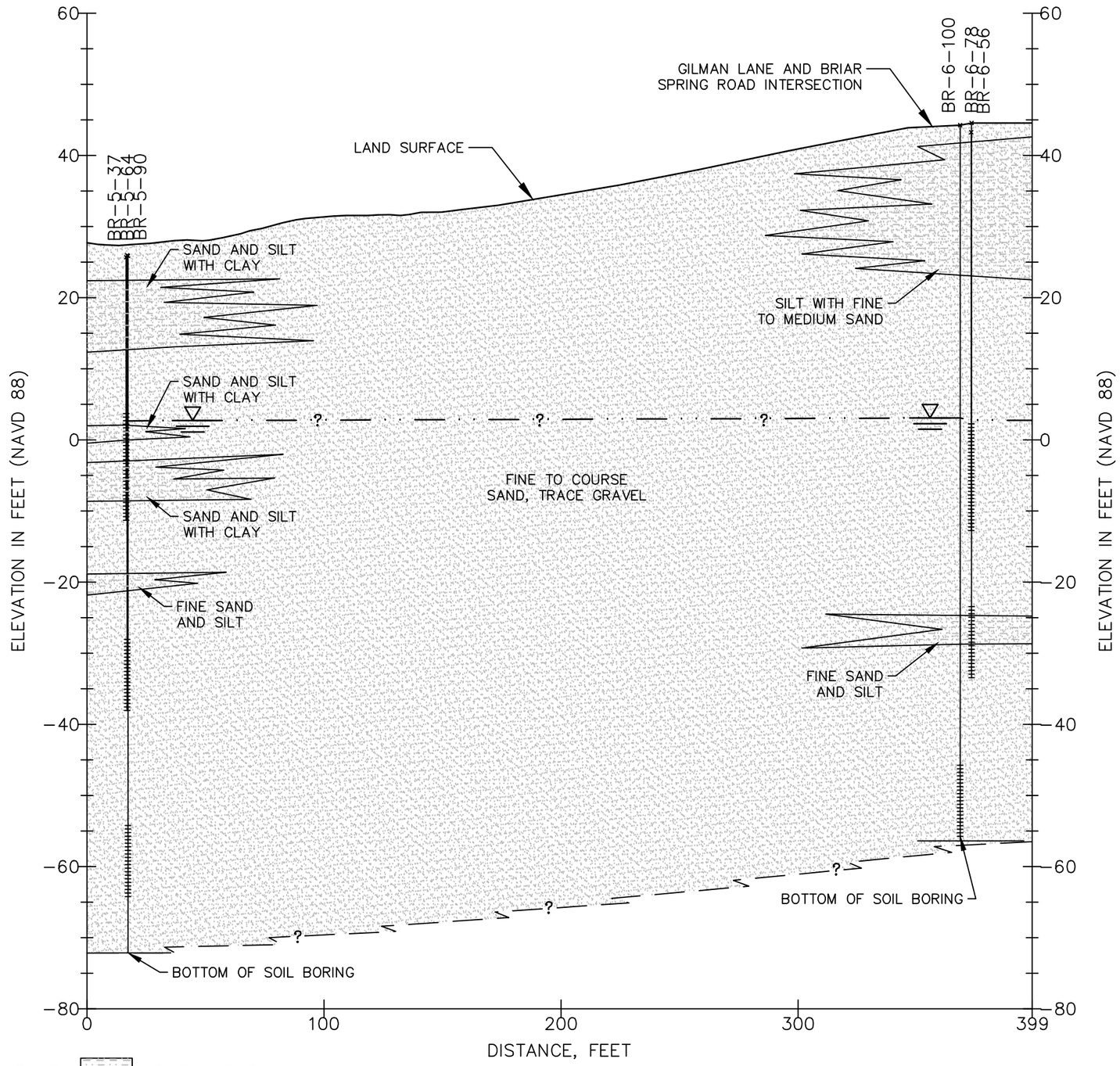
AECOM
Figure: 12

AECOM

Figure: 13

D (SOUTHEAST)

D' (NORTHWEST)



LEGEND

SAND

SILTY SAND

SILT AND CLAY

SAND AND GRAVEL

SILT

GROUNDWATER SURFACE

WATER TABLE

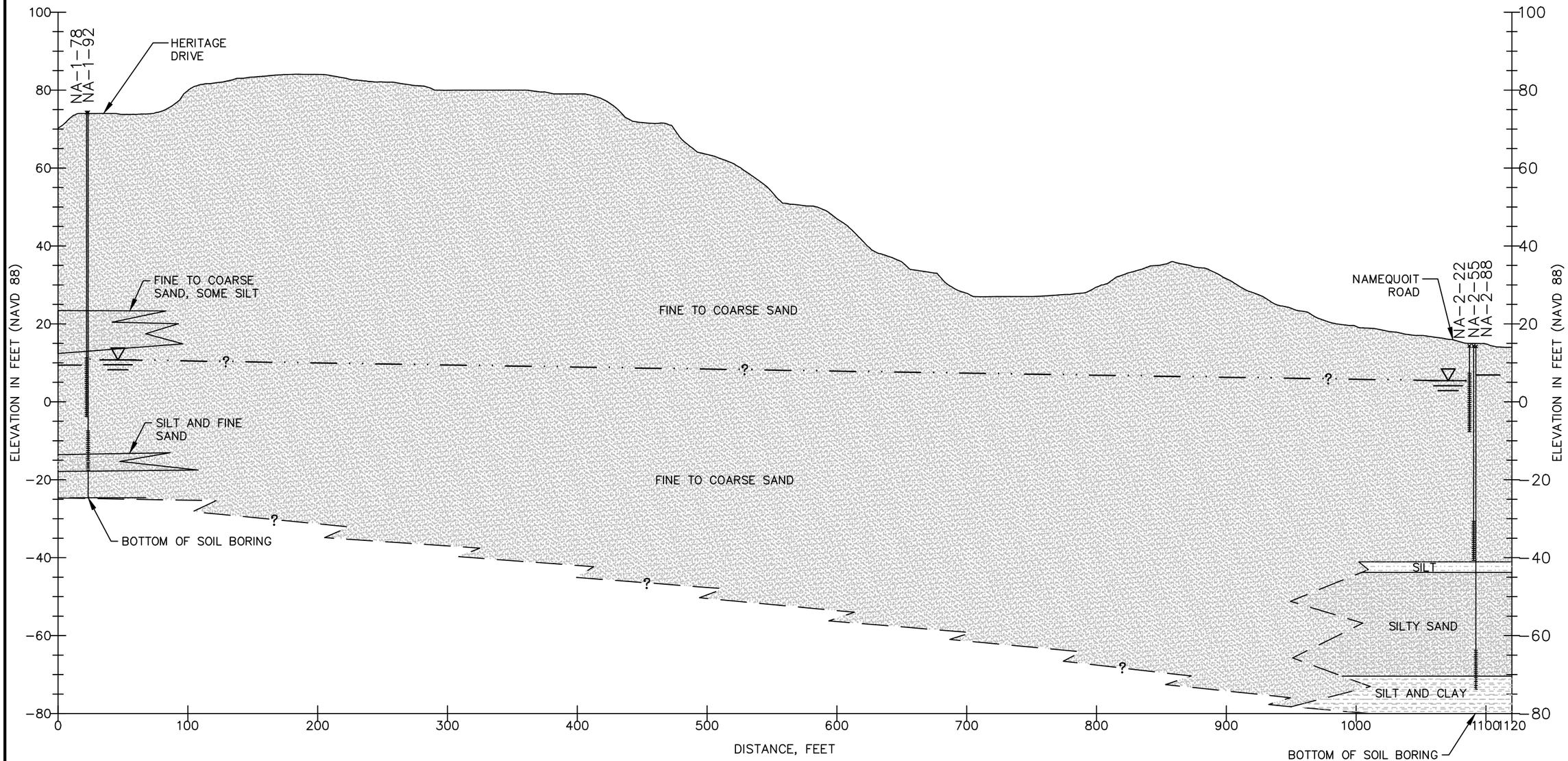
GEOLOGIC CROSS SECTION D-D'
BRIAR SPRING PRB
TOWN OF ORLEANS, MA
Project No.: 60476644 Date: 2022-11-16

AECOM

Figure: 14

E (SOUTHWEST)

E' (NORTHEAST)

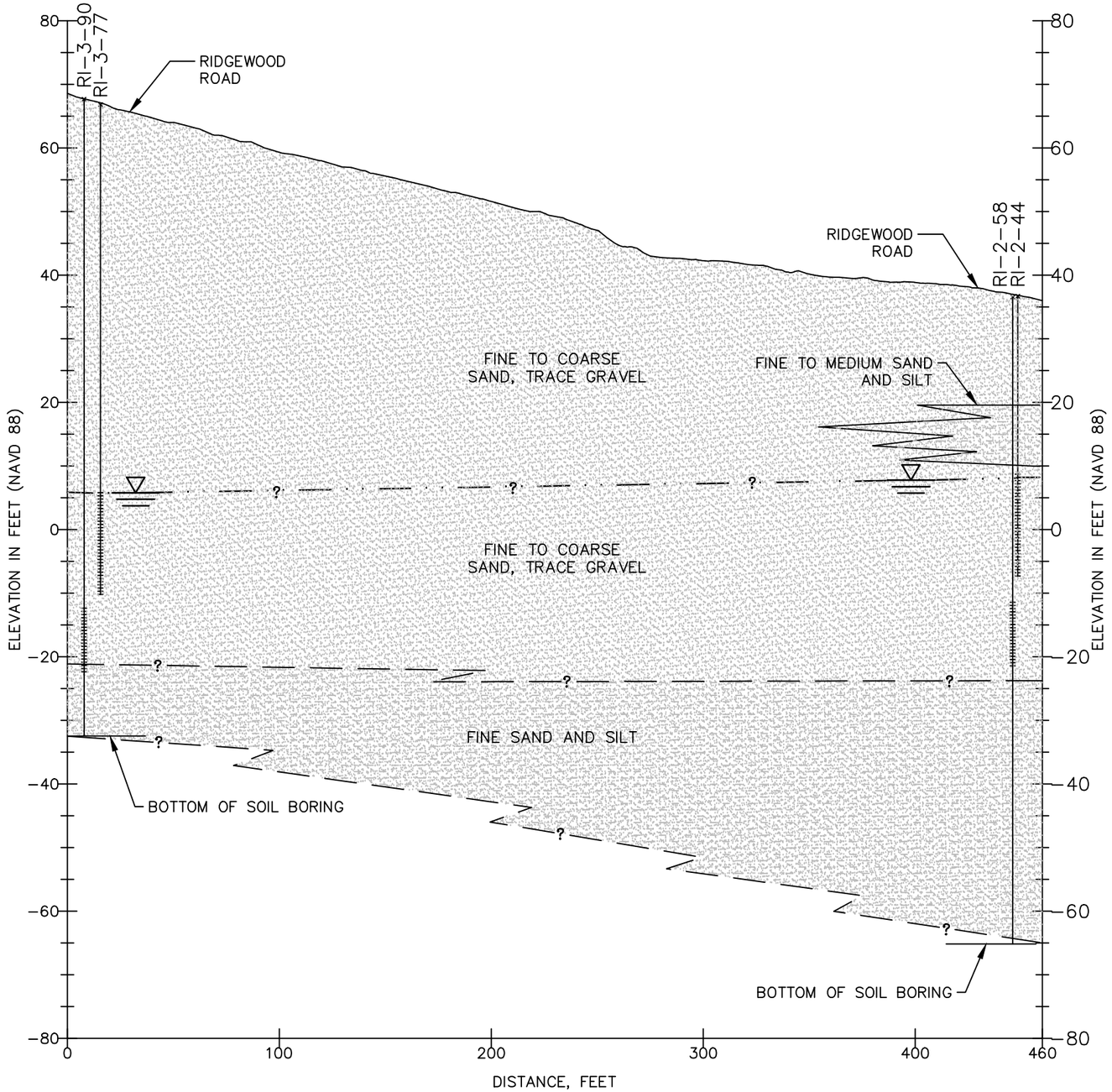


LEGEND

SAND | SILTY SAND | SILT AND CLAY | SAND AND GRAVEL | SILT | GROUNDWATER SURFACE | WATER TABLE

GEOLOGIC CROSS SECTION E-E'
NAMEQUOIT/RIDGE PRB
TOWN OF ORLEANS, MA
Project No.: 60476644 Date: 2022-11-16

F (NORTHWEST) **F (SOUTHEAST)**



LEGEND

SAND
SILTY SAND
SILT AND CLAY
SAND AND GRAVEL
SILT
GROUNDWATER SURFACE
WATER TABLE

AECOM

Figure: 15

GEOLOGIC CROSS SECTION F-F'
NAMEQUOIT/RIDGE PRB
TOWN OF ORLEANS, MA
Project No.: 60476644 Date: 2022-11-16

Appendix A: Implementation Plan for Full-Scale PRBs

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508.833.6951 fax

Memorandum

To	George Meservey, Director of Planning & Community Development
CC	Betsy Shreve, AICP, AECOM Project Director James Begley, LSP, MT Environmental AECOM PRB Team
Subject	**Town of Orleans, MA** **Water Quality and Wastewater Planning** **Task Number 12.1.B – NT Demonstration Projects** **Task 12.1.B.2 - Technical Memorandum: Permeable Reactive Barriers (PRB)** **Full-Scale Watershed Planning - Final**
Project Number	60476644
From	Thomas Parece, P.E., AECOM Project Manager
Date	January 7, 2021

1. Introduction

This Technical Memorandum has been prepared to identify potential full-scale Permeable Reactive Barrier (PRB) locations for implementation in accordance with the overall objectives of the Town of Orleans Amended Comprehensive Wastewater Management Plan (ACWMP). The ACWMP was developed in accordance with the Cape Cod 208 Water Quality Plan, which has been approved by both the United States Environmental Protection Agency (US EPA) and the Massachusetts Department of Environmental Protection (MassDEP).

The ACWMP is a "hybrid" plan that includes provisions for use of conventional wastewater treatment and non-traditional technologies, including PRBs, to remediate nitrate in groundwater. The PRB is a remediation technology that intercepts and removes nitrogen in groundwater at key locations in the watersheds before it discharges to sensitive embayments. Using a non-traditional technology allows for a reduction in sewer collection system coverage and wastewater treatment facility costs while still achieving nitrogen control objectives.

A PRB demonstration project is currently underway at the Eldredge Parkway site at the Nauset Regional Middle School in Orleans. The PRB was implemented in November 2016 and was designed for evaluating of PRB performance. Over the last four years, the project has shown that a PRB is effective in removing nitrate in groundwater. As part of the ACWMP, the Town is planning to install additional PRBs to reduce the nitrate load from nitrate impacted watersheds and estuaries in a cost-effective manner.

Three major watersheds have been identified for PRB groundwater remediation. These include the watersheds to Pleasant Bay, Nauset Estuary and Rock Harbor shown in Figure 1. A planning document Technical Memorandum "Permeable Reactive Barriers Implementation Plan for Full-Scale PRBs" (Implementation Plan) was prepared for the Town of Orleans dated August 6, 2018 and included details on the design and logistics of implementation of full-scale PRBs. The Implementation Plan for full-scale PRBs is in Appendix A and is also available on the Town of Orleans website https://www.town.orleans.ma.us/water-quality-and-wastewater-planning/pages/permeable-reactive-barriers-prb.

2. Orleans Nitrogen Load Reduction Objectives

The watersheds recharging Pleasant Bay, Nauset Estuary and Rock Harbor in Orleans include numerous sub-watersheds that discharge to creeks, rivers and salt ponds as shown in Figure 1. Total Maximum Daily Loads (TMDLs) define the maximum nitrogen load that the water body can receive from all sources, including watersheds, while still meeting necessary water quality criteria. To develop embayment specific TMDLs, the Massachusetts Estuaries Project (MEP) assessed nitrogen loading to the estuaries using an analytical method called the Linked Watershed-Embayment Management Modeling Approach. The model links watershed nitrogen inputs with surface water circulation and nitrogen characteristics to establish nitrogen loading threshold concentrations that must be achieved to restore and maintain water quality standards within the embayments. Exceeding thresholds has significant environmental consequences. For embayments that exceed the TMDL, corrective actions are needed to reduce nitrogen loading to achieve TMDLs in compliance with the federal Clean Water Act and state law.

Threshold nitrogen concentration and TMDLs were developed with results from analysis by MEP documented in technical reports prepared for Pleasant Bay, Rock Harbor and the Nauset Estuary (MEP 2006, MEP 2007, MEP 2012, respectively). The MassDEP and US EPA have approved nitrogen TMDLs for Pleasant Bay. Additional TMDLs are undergoing review by the regulatory agencies. TMDL thresholds and target goals for these estuaries are discussed in more detail below.

A. Pleasant Bay TMDLs

Pleasant Bay is connected to the Atlantic Ocean and is characterized by three main basins including Little Pleasant Bay, Pleasant Bay and Chatham Harbor. The bay has numerous sub-embayments. These sub-embayments are at particular risk of eutrophication from high nitrogen loads entering by direct groundwater discharge and by restricted tidal exchange. The main basins in or adjacent to Orleans include Pleasant Bay Main Basin and Little Pleasant Bay. Sub-embayments in Orleans include Meetinghouse Pond, the Upper and Lower River, Lonnie's Pond (also known as Kescayo Gansett Pond), Namequoit River and Aries Pond, Paw Wah Pond, Quanset Pond, and Pochet Inlet. The estimated nitrate loads to each of the watersheds and sub-watersheds are detailed in the MEP issued report "Massachusetts Estuaries Project Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Pleasant Bay System, Massachusetts" in May 2006.

In June 2017, the Select Boards of Brewster, Chatham, Harwich, and Orleans voted to sign a Resolution of the Towns sharing the Watershed of Pleasant Bay, endorsing the Pleasant Bay Composite Nitrogen Management Analysis as an accurate representation of each Town's share of the current nitrogen load and its responsibility to remove nitrogen in Pleasant Bay (Pleasant Bay Alliance, March 2017). The agreed Town of Orleans share of the Pleasant Bay Watershed nitrogen load is 6,980 kilograms per year (kg/yr) targeting sub-embayments as shown on Table 1.

The Towns also agreed to participate in a Watershed Permit Pilot Project with the Pleasant Bay Alliance, MassDEP, US EPA and the Cape Cod Commission (CCC) to pursue efficiencies and cost savings through coordinated implementation of nutrient management actions. The Pleasant Bay Watershed Permit was issued by MassDEP in August 2018 in accordance with M.G.L. c. 21, § 27(6) and Section 2A of Chapter 259 of the Acts of 2014.

At this time, the Town of Orleans has targeted 100 percent of its share of the nitrogen load to be removed by non-traditional technologies for Lonnie's Pond, Arey's Pond, Lower River, Namequoit River, Paw Wah Pond, Quanset Pond, Pochet, Pleasant Bay Main Basin and Little Pleasant Bay. Other sub-embayment removal goals have smaller targets for non-traditional technologies including 2 percent for Meetinghouse Pond, which will be mainly addressed with conventional wastewater collection and treatment system and 54 percent for the Upper River. Given the expected favorable economic benefits of utilizing non-traditional technologies, the current objective for full-scale PRB selection in this evaluation was to consider all feasible locations within the Pleasant Bay Watershed.

B. Nauset Harbor Embayment System TMDLs

The Nauset Harbor Embayment System in Orleans and Eastham is connected to the Atlantic Ocean and is comprised of open waters including Nauset Harbor, Town Cove, Nauset Marsh (located behind Nauset Barrier Beach) and three sub-embayments: Salt Pond, Wood Cove and Mill Pond. The Nauset Harbor Estuary watershed is shared by the Towns of Orleans, Eastham and Brewster. The most impacted areas with impaired habitat and therefore the focus of nitrogen load reduction in Orleans, include the upper reach at Town Cove and the semi-enclosed Mill Pond and Wood Cove sub-embayments. The Salt Pond sub-embayment in Eastham is also at risk of eutrophication. MEP issued the report "Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System, Towns of Orleans and Eastham, Massachusetts" in 2012 to support TMDLS for the estuary.

The Nauset Embayment System exceeds the MEP established TMDL requiring measures to lower the combined watershed nitrate load to the estuary (Howes et. al., 2012). The Town Cove nitrate TMDL is 21,432 kg/yr with a Target Threshold Watershed Load (comprised of natural background, fertilizer, runoff and septic system loads) of 4,368 kg/yr. According to the MEP report, the existing Watershed Load is 11,532 kg/yr. Therefore, a reduction of 7,164 kg/yr of nitrogen load is necessary to restore and maintain the Town Cove's water quality below the Target Threshold Load. Orleans has identified a PRB technology removal target or goal of 566 kg/yr for Town Cove. The objective for full-scale PRB selection in this evaluation was to consider all feasible locations within the Nauset Watershed.

C. Rock Harbor Embayment System TMDLs

The Rock Harbor Embayment System is in the Towns of Orleans and Eastham. Rock Harbor is a man-made harbor at the mouth of a tidal river and salt marsh and opens to Cape Cod Bay to the north. Significant habitat quality impairment and the presence of algal mats have been observed in the lower reach harbor area, while the upper reach marsh area has a higher quality habitat. MEP issued the report "Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Rock Harbor Embayment System, Towns of Orleans, Massachusetts" in December 2008 to support TMDLs for the estuary. The Rock Harbor System total TMDL 1,827 kg/yr with at Target Threshold Watershed Load of 1,358. The Present Watershed Load, comprised of natural background, fertilizer, runoff, WWTF and septic system loads, is 3,309 kg/yr, leaving 1,951 kg/yr to be removed. The Orleans' PRB technology removal target for nitrate is 634 kg/yr. The objective in this evaluation was to consider all possible locations within the Rock Harbor Watershed.

3. Site Selection Process

The PRB site selection process documented in this technical memorandum has identified 14 potential PRB locations within the sub-watersheds to Pleasant Bay, 3 PRB locations in the Nauset watershed and 1 location within the Rock Harbor watershed. PRBs were identified using local roadway names. Location and physical characteristics of the potential PRBs are included in Table 2 and shown on Figure 2.

A variety of information sources were used to support the PRB selection process. Land use was reviewed in the Orleans Geographic Information System https://www.town.orleans.ma.us/planning-department/pages/gis-mapping. Hydrogeologic information including groundwater flow and watershed delineations were gathered from MEP reports and from the regional USGS Monomoy Lens groundwater model (Walter and Whealan, 2005). Additional groundwater data were obtained from a 1990s CCC investigation of soils, water level and water quality data across the Town of Orleans. The CCC gathered soil boring and water level data from numerous previous investigations and installed additional soil borings and monitoring wells to evaluate soil and groundwater elevations throughout Orleans. These data were summarized in a report titled "Orleans Water Table Mapping Project, Orleans Massachusetts", dated May 1995.

Full scale PRB location screening considered overall nitrogen remediation objectives, environmental conditions, land use, downgradient water use, topography, wastewater nitrogen load upgradient within the capture zone of the PRB and practical limitations to cost effective implementation of the technology.

4. PRB Characteristics and Initial Siting Criteria

Initial PRB siting criteria were used to assess potential full-scale PRB locations in each of the three major watersheds. Criteria included:

- Locating PRBs along roadways that are cross-gradient to the regional groundwater flow direction and within a watershed requiring long term groundwater remediation;
- The depth to groundwater, generally less than 40 feet (depth affects costs and may affect feasibility);
- The accessibility of the PRB for installation, upgradient and downgradient monitoring well installation, and long-term monitoring; and
- The location where groundwater discharges to the most sensitive upper reaches of the estuary where possible.

A PRB screening matrix was developed to identify relevant characteristics and record results of assessments of effectiveness discussed below. Candidate locations were mapped, depth to groundwater was estimated based on topography and groundwater elevation contours and the vertical extent of the PRB was defined. Screening included evaluation of roadway orientation upgradient of target embayments, considering sub-watersheds to determine PRB location and PRB total length. The road layout and land use assessment utilizing the Orleans Geographic Information System (GIS) database was followed up with field surveys.

5. Detailed Analysis of PRB Effectiveness

Potential PRB locations identified in the initial screening were assessed for effectiveness of nitrogen mass removal by evaluating:

- The dimensions of the proposed PRB;
- Groundwater flow direction;
- The density of wastewater nitrogen sources upgradient of and within the capture zone of the PRB; and
- The ability in aggregate to achieve PRB nitrate mass remediation goals given the current assumptions.

The density of septic system wastewater nitrogen sources was assessed by estimating the number of parcels within the capture zone or area of groundwater intercepted by the PRB and then calculating the nitrogen load generated in that area with specified assumptions. A feasible PRB installation depth of approximately 70 to 80 feet below ground surface was assumed. This depth limitation and the depth to groundwater affects the size of the upgradient capture zone of a PRB. The upgradient area of groundwater that will flow through the PRB is limited because groundwater generally flows deeper into the aquifer as it moves towards the receiving water. Once it reaches the receiving water body groundwater moves up to discharge. At a certain distance upgradient, groundwater originating further upgradient will flow under the PRB and groundwater from that area cannot be treated by the PRB.

AECOM developed a groundwater flow model for the Town of Orleans based on the USGS, Sagamore and Monomoy flow lens Model (Walter and Whealan 2005). This model has been previously used to evaluate groundwater mounding and alterations to groundwater flow paths resulting from the proposed WWTF Groundwater Discharge at 32 Lots Hollow Road and 43 Lots Hollow Road in Orleans (AECOM, 2018). The model is also suitable for evaluating the area contributing groundwater to the proposed PRBs. The capture zone area was estimated by using the model to backtrack particles, simulating a drop of water's flow path, upgradient of each PRB. This was accomplished by using MODPATH (Pollock, 1994) in conjunction with the MODFLOW (McDonald and Harbaugh, 1988) software.

The wastewater load within the defined capture zone was then estimated by counting parcels within the capture zone and assigning an annual nitrogen load for the PRB. This estimate considers wastewater related nitrogen only and does not account for fertilizer applied to the land and atmospheric deposition of nitrogen within the capture zone. The wastewater load estimate assumed one house per parcel. The parcel nitrate load assigned was based on a reference wastewater nitrogen concentration of 26.25 mg/L used in MEP studies and a town-wide average water use of 150 gallons per day per parcel based on Orleans water records for 2014 and 2015. The estimated annual nitrogen load generated per parcel was 5.44 kg/yr.

Nitrogen from fertilizer, atmospheric deposition, and the presence of multi-unit condominiums on one parcel would increase the estimated nitrogen load in the capture zone. MassDEP has indicated a preference for use of actual nitrogen flux data and PRB nitrogen removal performance for determining the nitrogen load removal credit assigned to PRBs. However, the MEP based estimate of 5.44 kg/yr has been used as a surrogate in this evaluation. Ultimately PRB performance will be measured by actual groundwater nitrogen load and PRB reduction as determined through groundwater monitoring.

Prior to assigning a nitrate load to each parcel, the parcels were reviewed for land use type and mapped conservation land and parcels without obvious development were not counted. The parcel count is included in Table 3. PRB lines, particle backtracks, and highlighted parcels show the capture zones and counted parcels on Figure 2. For the purposes of site selection screening, the assumed nitrogen load removal by PRBs is 80 percent of the wastewater load generated within the capture zone. Current monitoring of the Eldredge Parkway Demonstration PRB indicates a greater than 80 percent nitrogen removal efficiency. However, it is anticipated that an 80 percent efficiency will be selected as the target for PRB management over time, triggering replenishment of PRB carbon source once average efficiency drops below 80 percent.

The estimated annual nitrogen load in the capture zone of each PRB was normalized to PRB length to assess load reduction on a kilogram per linear foot per year (Kg/LF/yr) basis for comparison with other potential PRBs. The estimated PRB efficiency considering all locations ranged from 0.09 to 0.40 Kg/LF/yr. PRBs in each major watershed were ranked for efficiency and given a rank as shown in Table 3.

The calculated efficiency was supplemented with a qualitative evaluation of PRB location relative to the most impacted sub-embayments based on MEP modeled total nitrogen concentrations and embayment specific non-traditional technology goals to guide potential funding and implementation planning.

6. Implementation Cost

AECOM has estimated the implementation cost for each PRB installation based on $1,230.00 per linear foot of PRB line. This cost includes:

- Town administration;
- Engineering design;
- Monitoring well installation and baseline sampling;
- Injection contractor and sub-state costs; and
- Engineering oversight of implementation.

PRB implementation costs range from $492,000 for a 400-foot PRB to $8,979,000 for a 7,300-foot PRB as shown in Table 4. Additional future costs will include long term monitoring, replacement costs for any damaged monitoring wells and subsequent substrate injection events. These costs were developed for the Wastewater Infrastructure Long Term Financial Plan that will address a phased implementation schedule for selected PRBs over a 10-year period.

7. Life Cycle Cost Analysis

A Life Cycle Cost Analysis (LCCA) was performed to compare PRBs and Traditional Systems. The purpose of this LCCA was to estimate the overall costs of PRBs and Traditional Systems and to utilize the information to assist the Town in selecting the alternative which will provide the lowest overall cost (implementation plus operation and maintenance) based on a cost per kg nitrate removed.

For both the PRBs and Traditional Systems, numerous costs associated with implementation (e.g. planning, design, bidding, construction, etc.) plus operation and maintenance of each the alternative was estimated. The following summarizes the unit costs utilized for the LCCA.

PRBs

Description	Unit Cost
Implementation Cost [1] ($/LF)	$1,230
Replacement Cost [2] ($/LF Annual basis)	$63
Monitoring Cost [3] ($/LF)	$17

Notes:

1. Unit costs developed based on the Eldredge Park Way PRB Demonstration Project.
2. Replacement costs will occur every 15 years for PRB reinjection.
3. Monitoring costs represent an average on $/LF basis. This may vary by location due to reporting efforts and costs.

Traditional Systems

Description	Unit Cost
Collection System and Pumping Stations	
Gravity Sewer (lf)	$425
Low-Pressure Sewer (lf)	$200
Pumping Station (each)	$1,500,000
Force Main (lf)	$200
Highway Crossing (l.s.)	$500,000
O&M Cost ($/gal)	$1.75
WWTF and Aquifer Recharge	
WWTF ($/gal)	$100
Force Main (lf)	$200
Effluent Disposal ($/gal)	$10
O&M Cost ($/gal)	$3.25

Notes:

1. Based on the Average of Bids Received on May 6, 2020 for Contract 2019-02 - Downtown Area Collection System and Pumping Stations
2. O&M Cost Based on Estimated O&M Cost for Contract 2019-02 - Downtown Area Collection System and Pumping Stations
3. Based on the Average of Bids Received on May 13, 2020 for Contract 2019-01 - Downtown Area WWTF and Effluent Disposal
4. O&M Cost Based on Estimated O&M Cost for Contract 2019-01 - Downtown Area WWTF and Effluent Disposal

The LCCA utilized the following assumptions:

Factors	N Removal
Term at 30, 60 and 100 Years	Utilized 26.25 mg/l per MEP Studies
Interest Rate at 1.5%	PRBs - 80% Removal from Watershed
Inflation at 3.0%	Traditional System - 100% Removal from Watershed

The PRB LCCA costs (on a cost per kg nitrate removed basis) were than compared to the Traditional System LCCA costs (on a cost per kg nitrate removed basis). Conclusions are as follows:

1. When compared to Traditional Systems approximately:
    a. 80 percent of the proposed PRBs are more cost effective (on a cost per kg nitrate removed basis) over a 30-year life-cycle cost analysis; and
    b. 27 percent of the proposed PRBs are more cost effective (on a cost per kg nitrate removed basis) over a 100-year life-cycle cost analysis.
2. The proposed PRBs at Granny's, Richwood, Blossom and Norseman are more cost effective (on a cost per kg nitrate removed basis) compared to the Traditional Systems based on the 30-year, 60-year and 100-year life-cycle costs.
3. The proposed PRBs at Winslow, Gosnold and Rock Harbor are not as cost effective (on a cost per kg nitrate removed basis) as compared to the Traditional Systems based on the 30-year, 60-year and 100-year life-cycle costs.

Refer to the following summary; Table 4 for the 30-year, 60-year and 100-year life-cycle cost analysis for PRBs; and Table 5 for the 30-year, 60-year and 100-year life-cycle cost analysis for Traditional Systems.

Comparison of PRBs and Tranditional Systems on a Cost per kg Nitrate Removed Basis						
PRB Description	LCCA at 30 Years		LCCA at 60 Years		LCCA at 100 Years	
	PRBs	Traditional System	PRBs	Traditional System	PRBs	Traditional System
Pleasant Bay Estuary						
Monument	X			X		X
Keziah's	X			X		X
Mayflower	X		X			X
Namequoit, Ridge & Lockwood	X		X			X
Quonset 1, 2, & 3	X		X			X
Granny's	X		X		X	
Winslow		X		X		X
Richwood	X		X		X	
Duck Hole	X			X		X
Gosnold		X		X		X
Briar Spring	X			X		X
Blossom	X		X		X	
Nauset Estuary						
Tonset Road and Main Street	X			X		X
Norseman	X		X		X	
Rock Harbor Estuary						
Rock Harbor		X		X		X
Totals	12	3	7	8	4	11

8. Consideration of Current Groundwater Use for Water Supply

Groundwater is currently used for water supply throughout the Town of Orleans. The Town operates municipal wells and has a water main distribution system servicing much of the Town. Private potable water supply wells are scattered throughout the Town with concentrations of these wells in certain areas. Parcels with private wells are shown on Figure 2. PRBs were only considered at locations downgradient of zones of contribution to municipal wells. AECOM assessed the distribution of private wells through town records and identified several potential private wells and parcels with potential private wells downgradient of PRBs. Parcels with private wells near potential PRBs appear to also be located adjacent to town municipal water mains and will need to be connected to town water to avoid any potential secondary water quality effects to potable water and to facilitate permitting PRB injection through the Massachusetts Underground Injection Control Program.

9. Conclusions

The performance of PRBs was considered against specific nitrogen reduction goals for non-traditional technologies. In certain watersheds, such as the watersheds to Town Cove and Meetinghouse Pond, traditional wastewater treatment will provide most of the nitrogen load reduction necessary to achieve TMDLs. Enhanced aquaculture will be also be pursued as an additional non-traditional technology but will not be assigned a specific share of the non-traditional remediation goal for watershed permitting in current planning.

The PRB siting criteria that specifies locating PRBs along roadways that are cross-gradient to the regional groundwater flow direction is important for access and feasible installation. However, this criterion also significantly limits the locations that can be selected. This limitation is considered the single most restrictive criterium for placement of PRBs, affecting PRB options and achievement of nitrogen remediation goals. Areas with significant concentrations of private wells were also avoided in locating PRBs due to concern for potential impacts to drinking water quality. A modified approach to PRB installation may be necessary to select additional locations or other alternatives may be necessary to achieve remediation goals. The ability of PRBs to achieve specific watershed goals are discussed in more detail below.

A. Pleasant Bay PRBs

A total of fourteen PRBs were identified in the Pleasant Bay Watershed. PRBs were placed in targeted sub-watersheds to the extent possible. Nitrogen removal requirements for sub-embayments are presented in Table 1. Nitrogen remediation requirements for Quanset Pond were included with Pleasant Bay/Little Pleasant Bay in this analysis due to difficulties in addressing Quanset Pond directly, giving a total of nine remediation goals used for comparison to estimate nitrogen load reductions. Measures of PRB effectiveness in relation to remediation goals are presented in Table 3 including:

- Estimated sewer load reduced (kg/yr) at 80% PRB efficiency;
- Percentage of embayment non-traditional technology goal achieved; and
- Estimated PRB efficiency (kg/LF/yr).

The nine targeted sub-watersheds cannot be fully remediated with PRBs to exceed the required non-traditional technology targets with the given assumptions. The overall projected PRB nitrogen reduction for Pleasant Bay based on the given assumptions was 2,115 kg/yr which is less than half the total Pleasant Bay non-traditional technology remediation goal of 4,966 kg/yr. However, the proposed PRBs could remove a significant percentage, ranging from 29 percent to 70 percent of the required removal load to impacted sub-watersheds.

The most efficient PRB in the Pleasant Bay watershed on a kilograms-of-nitrogen removed per linear foot per year basis was the Ridge (Ridgewood Road) PRB with a nitrogen removal efficiency of 0.27 Kg/LF/yr. In combination, the Ridge PRB and the Namequoit (Namequoit Road) PRB achieved an estimated 70 percent reduction in targeted nitrogen load to the Namequoit River. The Namequoit River is also an upper reach priority embayment that is significantly impacted by nitrogen load. Nitrogen load reduction in upper reaches of the estuary is a priority because upper reaches are the most impacted and nitrogen reduction in upper reaches will also benefit all lower areas in the estuary closer to the inlet to the bay.

Four PRB locations were identified in the Pochet Neck Stream and Pochet watersheds which is also a priority upper reach of the estuary with significant impact from nitrogen load. In combination these PRBs would remove 48 percent of the 1,564 kilograms of nitrogen load targeted for Pochet.

PRB locations could not be identified for Arey's Pond mainly due to roadway orientation and developed parcel locations. Meetinghouse Pond watershed will be remediated with conventional wastewater treatment and no PRB were located in the Meetinghouse Pond sub-watershed.

B. Nauset Estuary PRBs

Three potential PRBs were identified for the Nauset Estuary with a total projected nitrogen remediation of 866 kg/yr, which significantly exceeds the non-traditional technology goal of 566 kg/yr for Town Cove. The Tonset PRB was the largest identified and could be considered to help achieve the 7,164 kg/yr of nitrogen load reduction necessary to restore and maintain the Town Cove's water quality on an interim basis, treating existing load already in the groundwater while traditional wastewater systems are brought online. The relatively small 750-foot-long Main Street PRB was projected to be very efficient with a nitrogen removal of 0.4 Kg/LF/yr while the much longer Tonset PRB had a significantly lower nitrogen removal efficiency of 0.06 Kg/LF/yr.

C. Rock Harbor PRBs

One PRB location was identified for Rock Harbor along Rock Harbor Road that is estimated to remove 305 kg/yr of nitrogen which is less than half the Rock Harbor non-traditional remediation goal of 634 kg/yr. The Rock Harbor PRB had a relatively low nitrogen removal efficiency of 0.08 kg/LF/yr.

The results of the effort to identify potential full-scale PRB locations indicated there are many viable options for PRBs. Preliminary analysis indicates some locations are clearly more efficient and cost effective than others. PRBs identified in this process do not fully achieve nitrogen remediation goals for non-traditional technologies and additional alternatives may be required. The identified PRBs do however provide an important starting point for implementation of non-traditional technologies and are expected to provide for significant nitrogen removal. Actual groundwater data from field investigations will be necessary to confirm expected PRB performance in relation to remediation goals and may indicate higher effectiveness by accounting for additional nitrogen sources and/or higher source strength than considered in the screening assumptions. Groundwater data and a calculated mass flux of nitrogen is the MassDEP's preferred method for assessing PRB performance. The field data collected from monitoring wells will be used to assess the actual mass of nitrogen intercepted by the PRB on an annual basis.

Each of the potential PRB locations were evaluated based on the following considerations:

- Estimated PRB Efficiency (kg/LF/yr)
- Ability to meet PRB Non-traditional technology goal (kg/yr)
- Life Cycle Cost Analysis (PRBs vs Traditional System)
- Secondary Water Impacts (Public and Private Water Supplies: Existing and Future)
- Location of PRBs vs. Wastewater Service Areas
- PRB location with regards to embayment
- Watershed Compliance (N Reduction)
- Environmental Response (Short Term vs. Long Term)
- Implementation Costs (Capital Improvement Plan)

Critical factors include the estimated PRB efficiency (Kg/LF/yr), location, and ability to contribute to remedial goals (percent nitrogen reduction). Even PRBs with relatively low efficiency can be beneficial if sufficient length can be installed to achieve significant nitrogen reduction (% N reduction). In some cases, short length PRBs with high efficiency but low % N reduction can be worthwhile and are cost effective. In addition, PRB location with respect to the upper reach or head of the estuary matters. The upper reaches are the most impacted by eutrophication from nitrogen loading, with documented overload of nutrients. Reducing nitrogen loading in the upper estuary improves water quality throughout the bay. The following table presents the results of the evaluation as well as identifies as to whether the location is feasible for PRB implementation.

Embayment	PRB Name	Remarks	Feasible PRB Location (Y / N)
Pleasant Bay Estuary (Orleans)			
Meetinghouse Pond	None	N/A Conventional treatment	N/A
Lonnies Pond / Kescayo Gansett River	Monument	• High priority upper reach • Higher efficiency • Significant % N reduction	Y
Aery's Pond	None	Fails to meet siting criteria	N
Upper River	Keziahs	• High priority upper reach • Moderate efficiency • Significant % N reduction	Y
Lower River	Mayflower	• High priority upper reach • Moderate efficiency • Low % N reduction	Y
Namequoit River	Namequoit	• High priority upper reach • Higher efficiency • Highest % N reduction	Y
	Ridge	• High priority upper reach • Highest efficiency • Highest % N reduction	Y
Pah Wah Pond	Lockwood	• High priority upper reach • Moderate efficiency • Lower % N reduction	Y
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	• High priority upper reach • Moderate efficiency • Significant % N reduction	Y
	Grannys	• Lower priority location • Higher efficiency • Moderate % N reduction	Y
	Winslow	• Lower priority location • Low efficiency • Low % N reduction	N

Embayment	PRB Name	Remarks	Feasible PRB Location (Y / N)
Pochet	Richwood	• Lower priority location • Higher efficiency • Significant % N reduction	Y
	Duck Hole	• High priority upper reach • Lower efficiency • Significant % N reduction	Y
	Gosnold	• High priority upper reach • Low efficiency • Moderate % N reduction	Y
	Briar Spring	• High priority upper reach • Moderate efficiency • Significant % N reduction	Y
	Blossom	• High priority upper reach • Higher efficiency • Low % N reduction	Y
Nauset Estuary (Orleans)			
Town Cove	Tonset	• High priority upper reach • Low efficiency • High % reduction	Y
	Main	• High priority upper reach • High efficiency • High % reduction	Y
Mill Pond	Norseman	• Lower priority location • Higher efficiency • Significant % reduction	Y
Rock Harbor Estuary (Orleans)			
Rock Harbor	Rock Harbor	• High priority upper reach • Lower efficiency • Significant % reduction	Y

Not all feasible PRBs are recommended for implementation and some of the feasible PRBs are less beneficial than others and should be installed after the more advantageous locations. The Rock Harbor PRB and the Nauset Watershed Tonset PRB are in areas adjacent to planned conventional wastewater treatment service areas and would be better served by extending the conventional system. The Rock Harbor and Tonset PRBs are therefore not recommended for additional investigation. The potential Winslow PRB in the Pleasant Bay Watershed does not rank high enough to be considered for implementation due to projected low efficiency and low nitrogen removal, in addition to being in an area that does not affect the upper reaches or a confined sub-embayment of Pleasant Bay.

Implementation of the remaining feasible PRBs in the watersheds to Nauset Estuary and Pleasant Bay should move forward. In Nauset Estuary the recommended PRBs include the Main Street PRB adjacent to Town Cove, a relatively short cost effective PRB at a location that could provide a significant short-term benefit prior to the water quality improvements resulting from the Downtown conventional system. If implemented this PRB could address nitrogen already released to groundwater and migrating to Town Cove over the next 20 years. The Norseman PRB is also a relatively short PRB that is cost effective and would improve water quality in the Mill Pond sub-embayment. These locations should be investigated as described in the Next Steps presented below.

The remaining 13 PRBs in the Pleasant Bay Watershed should also move forward in the process and be investigated to confirm hydrogeologic conditions and water quality. A priority for implementation should be established based on the additional information and consideration of efficiency and nitrogen reduction potential.

10. Next Steps

Additional effort is necessary to confirm potential PRB locations and plan the appropriate sequencing of PRB implementation. Additional criteria for final selection of PRB locations will include site specific investigations and evaluations as follows:

A. Continue PRB Watershed Planning in order to reduce nitrogen based on the results of the Eldredge Park PRB Demonstration Test and previous Watershed Planning Activities. Conduct (a) field investigations; (b) subsurface investigations; and (c) sampling, analysis and evaluation on the following:

- Two potential PRB locations in the Nauset Estuary
  - ✓ Main Street
  - ✓ Norseman
- Thirteen potential PRB locations in the Pleasant Bay Estuary
  - ✓ Blossom
  - ✓ Briar Spring
  - ✓ Duck Hole
  - ✓ Gosnold
  - ✓ Grannys
  - ✓ Keziahs
  - ✓ Lockwood
  - ✓ Mayflower
  - ✓ Monument
  - ✓ Namequoit
  - ✓ Quonset 1,2,3
  - ✓ Richwood
  - ✓ Ridge

B. Field Investigations

- Perform field investigations to confirm suitability of the proposed PRB locations along roadways; types of utilities present; roadway ownership; accessibility for upgradient and downgradient monitoring well installation and long-term monitoring; and potential environmental impacts.
- Based on Board of Health information, verify the location and status of any private wells located in the vicinity of the proposed PRBs.
- Field investigations to occur on up to ten PRB locations.

C. Subsurface Investigations

- Perform subsurface investigations to obtain subsurface geologic condition and to confirm groundwater flow directions and water quality.
- Subsurface investigations to occur as follows:
  - ✓ Part 1 – Conduct drilling operations with soil sampling, groundwater profiling, and groundwater monitoring well installation and sampling at up to three locations at each potential PRB site. Based on the information obtain, evaluate the feasibility of each location as a potential PRB location and conduct additional subsurface investigations at sites which are deemed feasible.
  - ✓ Part 2 – Conduct drilling operations with soil sampling, groundwater profiling, and groundwater monitoring well installation and sampling at up to five additional locations at each potential PRB site identified as feasible.

D. Sampling, Analysis and Evaluation

- Obtain hydrogeologic information and results of groundwater analyses and conduct an evaluation to develop a baseline nitrogen concentration profile, geologic and geochemistry data to support a cost-effective implementation.
- Sampling and evaluation to occur on up to eight monitoring well locations at each PRB.

E. Regulatory and Local Coordination

- Coordinate with the MassDEP, the Town of Orleans and the Pleasant Bay Alliance to discuss planning activities, the results of the investigations and the evaluation of the proposed PRB site. Setup and participate in up to two meetings.
- Update the Town's webpage to include documents and presentations prepared as part of this phase of the project.

F. Update the Full-Scale Watershed Planning Report – Update the Full-Scale Watershed Planning Report to incorporate the planning activities, the results of the investigations and the evaluation of the proposed PRB sites.

G. Meetings

- Prepare for and conduct two public meetings with the Select Board, Board of Water and Sewer Commissioners, Planning Department and the public at large to obtain stakeholder input;
- Prepare for and conduct four coordination meetings Board of Water and Sewer Commissioners, Planning Department and Department of Public Works and Natural Resources the public at large to obtain stakeholder input.

This Technical Memorandum provides information for review by public stakeholders to facilitate ongoing public involvement in the process. Prior to final selection, location-specific assessment are necessary to confirm existing conditions and the nature of hydrogeological conditions and groundwater chemistry to estimate nitrogen flux at PRB locations.

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Tables

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Table 1
Orleans PRB Selection Matrix

Pleasant Bay Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	Length (ft)	Roads	Saturated Depth (ft)	Depth Range to GW (ft)	Estimated Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Estimated kg/LF/yr	Pleasant Bay Watershed PRB kg/yr Efficincy Rank	PRB Installation Cost Estimate	30-year LCCA for PRB (Present Worth)	Evaluation Notes
Meeting House Pond	None						**0**	**0**	**40**					
Lonnies Pond/Kescayo Gansett River							**41**	**178**	**284**					
Lonnies Pond/Kescayo Gansett River	Monument	25, 26 Lonnies Pond/Kescayo Gansett River	1,675	Monument	30	25 to 50	41	178		0.11	**8**	$2,060,250	$4,889,900	Upper Reach Priority embayment
Aerys Pond	None						**0**	**0**	**113**					
Upper River							**26**	**113**	**202**					
Upper River	Keziahs	41 Upper River	1,250	Keziahs	30	15 to 40	26	113		0.09	**9**	$1,537,500	$3,775,700	Upper Reach Priority embayment
Lower River							**35**	**152**	**517**					
Lower River	Mayflower	28 Lower River	1,700	Pershing, Kenneth	30	10 to 30	35	152		0.09	**11**	$2,091,000	$4,969,200	
Namequoit River							**56**	**244**	**348**					
Namequoit River	Namequoit	30 Namequoit River	1,000	Namequoit Road	30	10 to 40	27	117		0.12	**6**	$1,230,000	$7,577,200	Upper Reach Priority embayment
Namequoit River	Ridge	30 Namequoit River	460	Ridgewood Rd	30	10 to 30	29	126		0.27	**1**	$565,800	d with Namequoit PRB	Upper Reach Priority embayment
Pah Wah Pond							**35**	**152**	**413**					
Pah Wah Pond	Lockwood	32 Pah Wah Pond	1,230	Lockwood	30	5 to 15	35	152		0.12	**5**	$1,512,900	d with Namequoit PRB	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin							**122**	**531**	**1485**					
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	33, 37 Pleasant Bay and Quanset Pond	1,745	Towhee, Lake Dr, Oyster	30	10 to 40	43	187		0.11	**7**	$2,146,350	$5,071,900	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Grannys	33, 37 Pleasant Bay and Quanset Pond	650	Grannys Ln	30	15 to 20	24	104		0.16	**4**	$799,500	$2,174,200	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Winslow	33, 37 Pleasant Bay and Quanset Pond	1,150	Winslow Dr and Way	30	5 to 40	14	61		0.05	**14**	$1,414,500	$3,496,900	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Richwood	33, 37 Pleasant Bay and Quanset Pond	890	Richwood Farm	30	10 to 15	41	178		0.20	**2**	$1,094,700	$2,805,100	Upper Reach Priority embayment
Pochet							**171**	**744**	**1,564**					
Pochet	Duck Hole	35 Pochet Neck Stream	4,100	High View, Old Duck Hole, Lovell	30	5 to 35	68	296		0.07	**12**	$5,043,000	$11,335,800	Upper Reach Priority embayment
Pochet	Gosnold	34, 35 Pochet and Pochet Neck Stream	2,081	Gosnold,	30	10 to 30	29	126		0.06	**13**	$2,559,630	$5,966,700	Upper Reach Priority embayment
Pochet	Briar Spring	34 Pochet	2,906	Briar Spring	30	10 to 35	59	257		0.09	**10**	$3,574,380	$8,168,400	Upper Reach Priority embayment
Pochet	Blossom	35 Pochet	400	Blossom , Sparrowhawk	30	30 to 40	15	65		0.16	**3**	$492,000	$1,513,400	Upper Reach Priority embayment
Pleasant Bay Estuary (Orleans)			**21,237**				**486**	**2,115**	**4,966**			**$26,121,510**	**$61,744,400**	
	Average Efficiency kg/LF/yr									**0.10**				

Nauset Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	Length (ft)	Roads	Saturated Depth (ft)	Depth Range to GW (ft)	Estimated Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Estimated kg/LF/yr	Pleasant Bay Watershed PRB kg/yr Efficincy Rank	PRB Installation Cost Estimate	30-year LCCA for PRB (Present Worth)	Evaluation Notes
Town Cove							**171**	**744**	**566**					
Town Cove	Tonset	5 Town Cove	7,300	Gibson, Tonset	30	10 to 30	93	405		0.06	**3**	$8,979,000	$22,059,000	Upper Reach Priority embayment
Town Cove	Main	5 Town Cove	850	Main	40	5 to 10	78	339		0.40	**2**	$1,045,500	luded with Tonset PRB	Upper Reach Priority embayment
Mill Pond							**28**	**122**						
Mill Pond	Norseman	8 Mill Pond	580	Norsemans Road, Mill Pond Rd	40	10 to 35	28	122		0.21	**1**	$713,400	$1,999,700	Upper Reach Priority embayment
Nauset Estuary (Orleans)			**8,730**				**199**	**866**				**$10,737,900**	**$24,058,700**	
	Average Efficiency kg/LF/yr									**0.22**				

Rock Harbor Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	Length (ft)	Roads	Saturated Depth (ft)	Depth Range to GW (ft)	Estimated Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Estimated kg/LF/yr	Pleasant Bay Watershed PRB kg/yr Efficincy Rank	PRB Installation Cost Estimate	30-year LCCA for PRB (Present Worth)	Evaluation Notes
Rock Harbor Main	**Rock Harbor**						**70**	**305**	**634**					
Rock Harbor	Rock Harbor	3 Rock Harbor Main	3,940	Rock Harbor	50	5 to 15	70	305		0.08	1	$103,425	$10,896,700	Upper Reach Priority embayment
Rock Harbor Estuary (Orleans)	**Rock Harbor**		**3,940**				**70**	**305**	**634**	**0.08**		**$4,846,200**	**$10,896,700**	

PRB Townwide Potential Total			**33,907**				**755**	**3,286**				**$41,705,610**	**$96,699,800**	

Table 2
Orleans PRB Selection Matrix - PRB Characteristics

Pleasant Bay Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	Roads	Saturated Thickness of PRB (ft)	Depth Range to Groundwater (ft)
Meeting House Pond	None					
Lonnies Pond/ Kescayo Gansett River						
Lonnies Pond/Kescayo Gansett River	Monument	25, 26 Lonnies Pond/Kescayo Gansett River	1,675	Monument	30	25 to 50
Aerys Pond	None					
Upper River						
Upper River	Keziahs	41 Upper River	1,250	Keziahs	30	15 to 40
Lower River						
Lower River	Mayflower	28 Lower River	1,700	Pershing, Kenneth	30	10 to 30
Namequoit River						
Namequoit River	Namequoit	30 Namequoit River	1,000	Namequoit Road	30	10 to 40
Namequoit River	Ridge	30 Namequoit River	460	Ridgewood Rd	30	10 to 30
Pah Wah Pond						
Pah Wah Pond	Lockwood	32 Pah Wah Pond	1,230	Lockwood	30	5 to 15
Quanset and Pleasant Bay Main Basin						
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	33, 37 Pleasant Bay and Quanset Pond	1,745	Towhee, Lake Dr, Oyster	30	10 to 40
Quanset and Pleasant Bay Main Basin	Grannys	33, 37 Pleasant Bay and Quanset Pond	650	Grannys	30	15 to 20
Quanset and Pleasant Bay Main Basin	Winslow	33, 37 Pleasant Bay and Quanset Pond	1,150	Winslow Dr and Way	30	5 to 40
Quanset and Pleasant Bay Main Basin	Richwood	33, 37 Pleasant Bay and Quanset Pond	890	Richwood Farm	30	10 to 15
Pochet						
Pochet	Duck Hole	35 Pochet Neck Stream	4,100	High View, Old Duck Hole, Lovell	30	5 to 35
Pochet	Gosnold	34, 35 Pochet and Pochet Neck Stream	2,081	Gosnold,	30	10 to 30
Pochet	Briar Spring	34 Pochet	2,906	Briar Spring	30	10 to 35
Pochet	Blossom	34 Pochet	400	Blossom , Sparrowhawk	30	30 to 40
Pleasant Bay Estuary (Orleans)			**21,237**			

Nauset Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	Roads	PRB Saturated Thickness (ft)	Depth Range to Groundwater (ft)
Town Cove						
Town Cove	Tonset	5 Town Cove	7,300	Gibson, Tonset	30	10 to 30
Town Cove	Main	5 Town Cove	850	Main	40	5 to 10
Mill Pond						
Mill Pond	Norseman	8 Mill Pond	580	Norsemans Road, Mill Pond Rd	40	10 to 35
Nauset Estuary (Orleans)			**8,730**			

Rock Harbor Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	Roads	PRB Saturated Thickness (ft)	Depth Range to Groundwater (ft)
Rock Harbor Main	Rock Harbor					
Rock Harbor	Rock Harbor	3 Rock Harbor Main	3,940	Rock Harbor	50	5 to 15
Rock Harbor Estuary (Orleans)	Rock Harbor		**3,940**			

PRB Townwide Potential Total			**33,907**			

Table 3
Orleans PRB Selection Matrix - Effectiveness

Pleasant Bay Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	Estimated Number of Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Percentage Removed	Estimated PRB Efficiency (kg/LF/yr)	PRB Watershed Efficincy Rank (kg/yr)	Evaluation Notes
Meeting House Pond	None			**0**	**0**	**40**	**0**			Traditional Technology to be Used
Lonnies Pond/Kescayo Gansett River				**41**	**178**	**284**	**63**			
Lonnies Pond/Kescayo Gansett River	Monument	Gansett River	1,675	41	178			0.11	**8**	Upper Reach Priority embayment
Aerys Pond	None			**0**	**0**	**113**	**0**			
Upper River				**26**	**113**	**202**	**56**			
Upper River	Keziahs	41 Upper River	1,250	26	113			0.09	**9**	Upper Reach Priority embayment
Lower River				**35**	**152**	**517**	**29**			
Lower River	Mayflower	28 Lower River	1,700	35	152			0.09	**11**	Upper Reach Priority embayment
Namequoit River				**56**	**244**	**348**	**70**			
Namequoit River	Namequoit	30 Namequoit River	1,000	27	117			0.12	**6**	Upper Reach Priority embayment
Namequoit River	Ridge	30 Namequoit River	460	29	126			0.27	**1**	Upper Reach Priority embayment
Pah Wah Pond				**35**	**152**	**413**	**37**			
Pah Wah Pond	Lockwood	32 Pah Wah Pond	1,230	35	152			0.12	**5**	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin				**122**	**531**	**1,485**	**36**			
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	Pond	1,745	43	187			0.11	**7**	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Grannys	Pond	650	24	104			0.16	**4**	Lower Priority
Quanset and Pleasant Bay Main Basin	Winslow	Pond	1,150	14	61			0.05	**14**	Lower Priority
Quanset and Pleasant Bay Main Basin	Richwood	Pond	890	41	178			0.20	**2**	Lower Priority
Pochet				**171**	**744**	**1,564**	**48**			
Pochet	Duck Hole	35 Pochet Neck Stream	4,100	68	296			0.07	**12**	Upper Reach Priority embayment
Pochet	Gosnold	Stream	2,081	29	126			0.06	**13**	Upper Reach Priority embayment
Pochet	Briar Spring	34 Pochet	2,906	59	257			0.09	**10**	Upper Reach Priority embayment
Pochet	Blossom	35 Pochet	400	15	65			0.16	**3**	Upper Reach Priority embayment
Pleasant Bay Estuary (Orleans)			**21,237**	**486**	**2,115**	**4,966**	**43**			

Nauset Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	Estimated Number of Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Percentage Removed	Estimated PRB Efficiency (kg/LF/yr)	PRB Watershed Efficincy Rank (kg/yr)	Evaluation Notes
Town Cove				**171**	**744**	**566**	**131**			
Town Cove	Tonset	5 Town Cove	7,300	93	405			0.06	**3**	Upper Reach Priority embayment
Town Cove	Main	5 Town Cove	850	78	339			0.40	**1**	Upper Reach Priority embayment
Mill Pond				**28**	**122**	**0**				
Mill Pond	Norseman	8 Mill Pond	580	28	122			0.21	**2**	Lower Priority
Nauset Estuary (Orleans)			**8,730**	**199**	**866**	**566**	**153**			

Rock Harbor Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	Estimated Number of Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Percentage Removed	Estimated PRB Efficiency (kg/LF/yr)	PRB Watershed Efficincy Rank (kg/yr)	Evaluation Notes
Rock Harbor Main	**Rock Harbor**			**70**	**305**	**634**	**48**			
Rock Harbor	Rock Harbor	3 Rock Harbor Main	3,940	70	305			0.08	**1**	Upper Reach Priority embayment
Rock Harbor Estuary (Orleans)	**Rock Harbor**		**3,940**	**70**	**305**	**634**	**48**			

PRB Townwide Potential Total			**33,907**	**755**	**3,286**					

Table 4
Orleans PRB Selection Matrix - Cost

Orleans Potential Full Scale PRBs - Pleasant Bay

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	PRB Installation Cost Estimate (Using Avg. $/LF)	30-year LCCA for PRB	60-year LCCA for PRB	100-year LCCA for PRB
Meeting House Pond	None						
Lonnies Pond/Kescayo Gansett River							
Lonnies Pond/Kescayo Gansett River	Monument	25, 26 Lonnies Pond/Kescayo Gansett River	1,675	$2,060,250	$4,889,900	$11,771,500	$29,263,500
Aerys Pond	None						
Upper River							
Upper River	Keziahs	41 Upper River	1,250	$1,537,500	$3,775,700	$9,105,000	$22,593,400
Lower River							
Lower River	Mayflower	28 Lower River	1,700	$2,091,000	$4,969,200	$11,956,900	$29,715,300
Namequoit River							
Namequoit River	Namequoit	30 Namequoit River	1,000	$1,230,000	$7,577,200	$18,219,500	$45,400,700
Namequoit River	Ridge	30 Namequoit River	460	$565,800	Included with Namequoit PRB		
Pah Wah Pond							
Pah Wah Pond	Lockwood	32 Pah Wah Pond	1,230	$1,512,900	Included with Namequoit PRB		
Quanset and Pleasant Bay Main Basin							
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	33, 37 Pleasant Bay and Quanset Pond	1,745	$2,146,350	$5,071,900	$12,209,000	$30,358,200
Quanset and Pleasant Bay Main Basin	Grannys	33, 37 Pleasant Bay and Quanset Pond	650	$799,500	$2,174,200	$5,274,000	$13,024,100
Quanset and Pleasant Bay Main Basin	Winslow	33, 37 Pleasant Bay and Quanset Pond	1,150	$1,414,500	$3,496,900	$8,444,200	$20,954,000
Quanset and Pleasant Bay Main Basin	Richwood	33, 37 Pleasant Bay and Quanset Pond	890	$1,094,700	$2,805,100	$6,785,400	$16,804,500
Pochet							
Pochet	Duck Hole	35 Pochet Neck Stream	4,100	$5,043,000	$11,335,800	$27,203,000	$67,830,500
Pochet	Gosnold	34, 35 Pochet and Pochet Neck Stream	2,081	$2,559,630	$5,966,700	$14,355,900	$35,730,300
Pochet	Briar Spring	34 Pochet	2,906	$3,574,380	$8,168,400	$19,624,000	$48,891,500
Pochet	Blossom	35 Pochet	400	$492,000	$1,513,400	$3,693,000	$9,072,400
Pleasant Bay Estuary (Orleans)			**21,237**	**$26,121,510**	**$61,744,400**	**$148,641,400**	**$369,638,400**

Orleans Potential Full Scale PRBs - Nauset Estuary

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	PRB Installation Cost Estimate (Using Avg. $/LF)	30-year LCCA for PRB	60-year LCCA for PRB	100-year LCCA for PRB
Town Cove							
Town Cove	Tonset	5 Town Cove	7,300	$8,979,000	$22,059,000	$52,885,100	$132,049,100
Town Cove	Main	5 Town Cove	850	$1,045,500	Included with Tonset PRB		
Mill Pond							
Mill Pond	Norseman	8 Mill Pond	580	$713,400	$1,999,700	$4,855,300	$11,973,500
Nauset Estuary (Orleans)			**8,730**	**$10,737,900**	**$24,058,700**	**$57,740,400**	**$144,022,600**

Orleans Potential Full Scale PRBs - Rock Harbor

Embayment	PRB Name	MEP Watershed ID	PRB Length (ft)	PRB Installation Cost Estimate (Using Avg. $/LF)	30-year LCCA for PRB	60-year LCCA for PRB	100-year LCCA for PRB
Rock Harbor Main	**Rock Harbor**						
Rock Harbor	Rock Harbor	3 Rock Harbor Main	3,940	$4,846,200	$10,896,700	$26,158,100	$65,232,700
Rock Harbor Estuary (Orleans)			**3,940**	**$4,846,200**	**$10,896,700**	**$26,158,100**	**$65,232,700**

PRB Townwide Potential Total			**33,907**	**$41,705,610**	**$96,699,800**	**$232,539,900**	**$578,893,700**

Table 5
Orleans Traditional Costs for Potential Full Scale PRB Areas

Orleans Traditional Costs for Potential Full Scale PRBs - Pleasant Bay

Embayment	PRB Name	Number of Parcels	Gravity Sewer (LF)	Low-Pressure Sewer (LF)	Pumping Station	Force Main (LF)	Highway Crossing	30-year LCCA for Traditional Treatment of PRB Area	60-year LCCA for Traditional Treatment of PRB Area	100-year LCCA for Traditional Treatment of PRB Area
Meeting House Pond	None									
Lonnies Pond/Kescayo Gansett River										
Lonnies Pond/Kescayo Gansett River	Monument	56	-	5,100	1	2,800	-	$11,229,800	$15,734,500	$27,359,400
Aerys Pond	None									
Upper River										
Upper River	Keziahs	38	-	4,620	1	1,050	0	$10,035,300	$14,393,400	$25,650,700
Lower River										
Lower River	Mayflower	39	-	6,120	1	2,400	-	$12,765,500	$18,543,100	$33,692,900
Namequoit River										
Namequoit River	Namequoit	112	-	12,030	1	2,330	-	$19,643,800	$29,703,600	$56,663,500
Namequoit River	Ridge	Included with Namequoit PRB								
Pah Wah Pond										
Pah Wah Pond	Lockwood	Included with Namequoit PRB								
Quanset and Pleasant Bay Main Basin										
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	48	-	7,370	1	6,925	-	$15,991,500	$22,244,300	$38,615,600
Quanset and Pleasant Bay Main Basin	Grannys	34	-	3,650	1	4,200	-	$10,881,800	$15,022,900	$25,634,900
Quanset and Pleasant Bay Main Basin	Winslow	33	-	3,100	1	1,100	-	$8,991,300	$12,956,400	$23,135,400
Quanset and Pleasant Bay Main Basin	Richwood	57	-	5,000	1	-	-	$11,027,600	$16,752,400	$31,824,500
Pochet										
Pochet	Duck Hole	49	-	12,240		-	-	$13,930,300	$22,394,800	$45,712,100
Pochet	Gosnold	43	-	5,250	1	1,450	-	$10,909,800	$15,672,600	$28,034,500
Pochet	Briar Spring	65	-	7,855	1	2,000	-	$14,027,700	$20,485,700	$37,516,300
Pochet	Blossom	22	-	1,925	1	1,350	-	$7,749,600	$10,875,800	$18,740,100
Pleasant Bay Estuary (Orleans)								**$147,184,000**	**$214,779,500**	**$392,579,900**

Orleans Traditional Costs for Potential Full Scale PRBs - Nauset Estuary

Embayment	PRB Name	Number of Parcels	Gravity Sewer (LF)	Low-Pressure Sewer (LF)	Pumping Station	Force Main (LF)	Highway Crossing	30-year LCCA for Traditional Treatment of PRB Area	60-year LCCA for Traditional Treatment of PRB Area	100-year LCCA for Traditional Treatment of PRB Area
Town Cove										
Town Cove	Tonset	229	11,000	9,850	1	3,500	-	$38,691,600	$57,626,500	$109,101,700
Town Cove	Main	Included with Tonset PRB								
Mill Pond										
Mill Pond	Norseman	37	-	3,200	1	7,000	-	$12,338,300	$16,772,700	$28,160,100
Nauset Estuary (Orleans)								**$51,029,900**	**$74,399,200**	**$137,261,800**

Orleans Traditional Costs for Potential Full Scale PRBs - Rock Harbor

Embayment	PRB Name	Number of Parcels	Gravity Sewer (LF)	Low-Pressure Sewer (LF)	Pumping Station	Force Main (LF)	Highway Crossing	30-year LCCA for Traditional Treatment of PRB Area	60-year LCCA for Traditional Treatment of PRB Area	100-year LCCA for Traditional Treatment of PRB Area
Rock Harbor Main	**Rock Harbor**									
Rock Harbor	Rock Harbor	81	0	8200	0	0	1	$10,994,600	$17,218,300	$34,367,700
Rock Harbor Estuary (Orleans)								**$10,994,600**	**$17,218,300**	**$34,367,700**

Traditional Costs for PRB Townwide Potential Total								**$209,208,500**	**$306,397,000**	**$564,209,400**

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Figures

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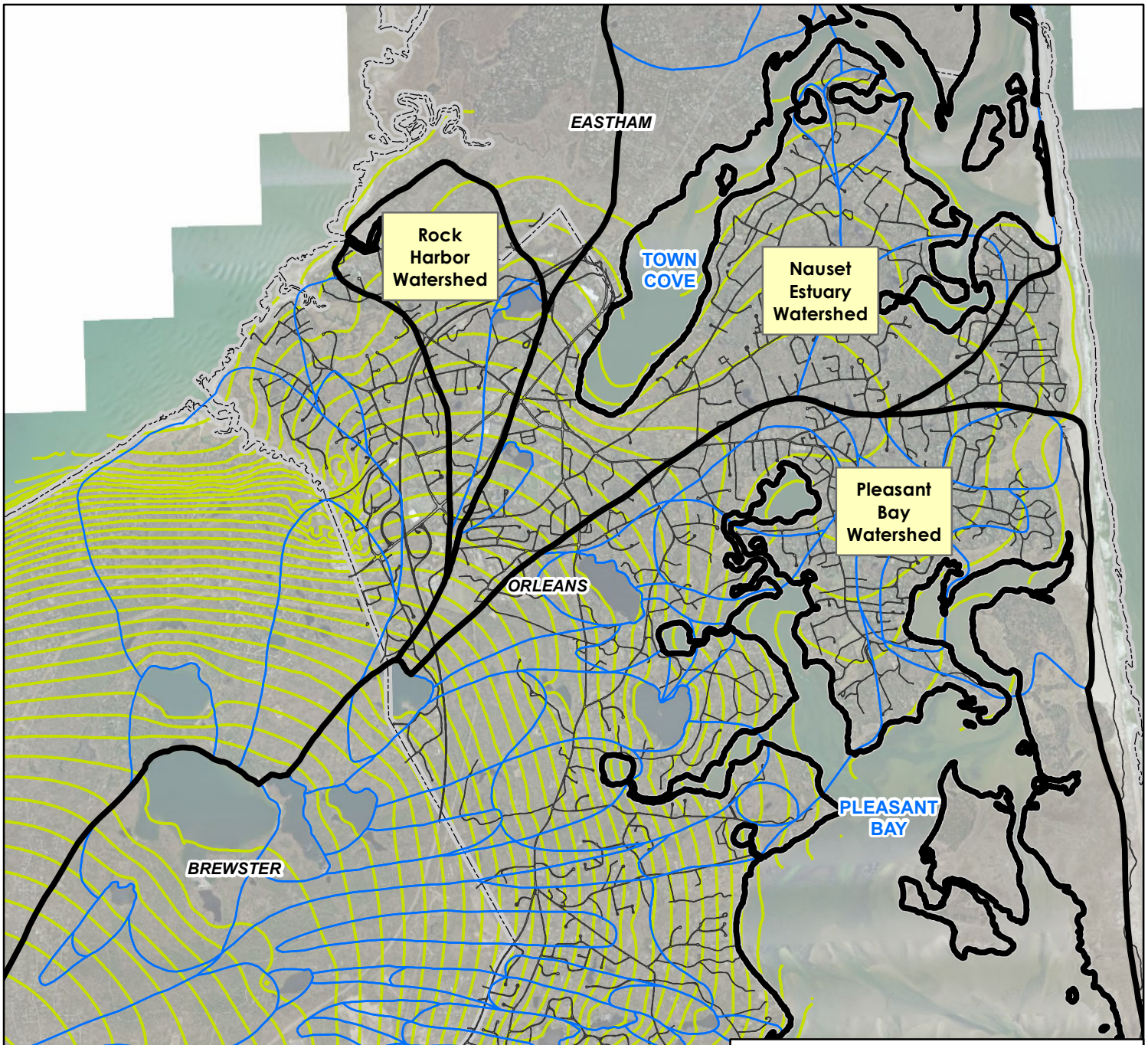


FIGURE 1

TOWN OF ORLEANS, MA
WATER QUALITY AND WASTEWATER PLANNING

MAJOR AND SUB-WATERSHEDS

Legend

- Groundwater Contour
- Edge of Pavement
- MEP Subwatershed
- Town Boundary

1 inch = 4,000 feet

0 2,500 5,000 Feet

AECOM

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AECOM

FIGURE 2
PARTICLE TRACKING

TOWN OF ORLEANS
MASSACHUSETTS

AUGUST 2020

N

0 600 1,200 2,400 3,600 4,800
Feet

Rock Harbor PRB
Rock Harbor
Little Namskaket
Cedar Pond
Rock Harbor Watershed
Namskaket
Tonset PRB
Town Cove
Nauset Estuary Watershed
Norseman PRB
Mill Pond
Main St PRB
Pleasant Bay Watershed
Duck Hole PRB
Gosnold PRB
Meetinghouse Pond
Uncle Harvey's Pond
Blossom PRB
Briar Spring PRB
Pochet
Crystal Lake
Keziah's PRB
Upper River
Lonies Pond
Monument PRB
Mayflower PRB
Baker's Pond
Pilgrim Lake
Lower River
Namequoit River
Arey's Pond
Namequoit PRB
Ridge PRB
Lockwood PRB
Richwood PRB
Grannys PRB
Uncle Israel's Pond
Twinings Pond
Sarah's Pond
Shoal Pond
Meadow Bog Pond
Deep Pond
Quanset 3 PRB
Quanset
Quanset 2 PRB
Quanset 1 PRB
Winslow PRB
LITTLE PLEASANT BAY
HARWICH
PLEASANT BAY
CHATHAM

Legend

- Permeable Reactive Barrier
- Paths
- MEP Subwatershed
- Potable Well
- Potential Potable Well - VERIFY
- 208_Embayments
- Parcel with PRB (755)
- Other Parcels (4,705)

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Appendix A: Implementation Plan for Full-Scale PRBs

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AECOM
9 Jonathan Bourne Drive
Pocasset, MA 02559
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508.833.6950 tel
508.833.6951 fax

Memorandum

To	George Meservey, Director of Planning & Community Development
CC	Betsy Shreve, AICP, AECOM Project Director James Begley, LSP, MT Environmental AECOM PRB Team
Subject	**Town of Orleans, MA** **Water Quality and Wastewater Planning** **Task 11.1.B.2 - Permeable Reactive Barriers (PRB)** **Implementation Plan for Full-Scale PRBs - Final**
Project Number	60476644
From	Thomas Parece, P.E., AECOM Project Manager
Date	August 6, 2018

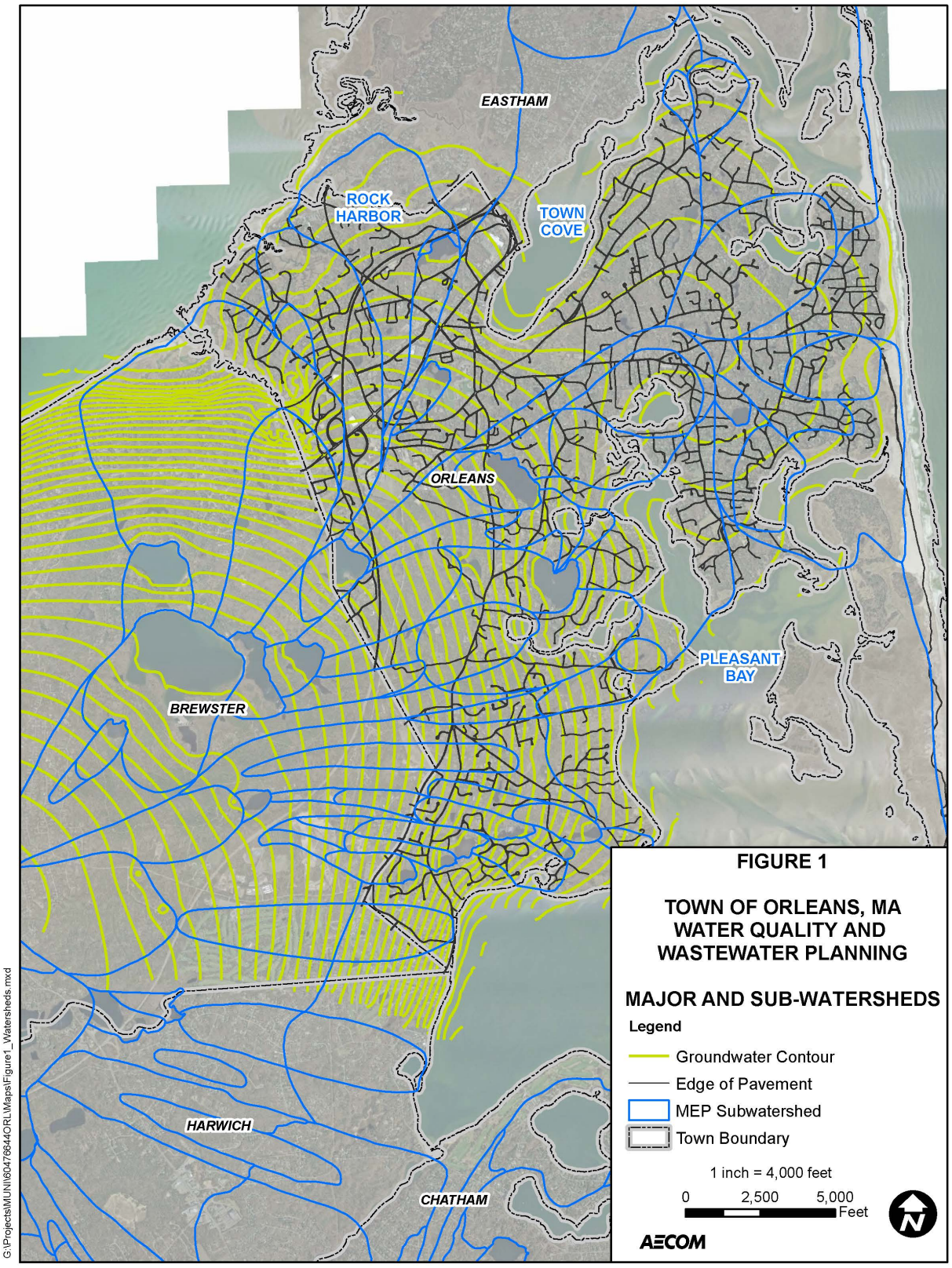
Approvals	Date	Signature / Initials
George Meservey, Orleans, MA Director of Planning & Community Development		

1. Introduction

This full-scale Permeable Reactive Barrier (PRB) Implementation Plan has been developed on behalf of the Town of Orleans Massachusetts (the Town) and includes preliminary design information and planning steps necessary for successful application of PRBs to reduce nitrogen loading to estuaries in Orleans. The estuaries include Rock Harbor, Nauset Estuary, and Pleasant Bay with proposed PRB systems in their respective watersheds. The PRBs will treat watershed nitrate prior to discharge to surface waters and be located to provide the most cost-effective treatment. The objective of this Implementation Plan is to provide preliminary design information and identify actions necessary to permit and install the PRBs and achieve verified nitrogen reductions. This plan identifies several potential PRB locations, but final locations will be selected after assessment of potential sites and public input on the proposed locations.

2. Background

Major watersheds in the Town include Nauset Harbor and Pleasant Bay sub-watersheds within the Atlantic Ocean watershed, and Namskaket Creek, Little Namskaket Creek, and Rock Harbor sub-watersheds within the Cape Cod Bay watershed. The groundwater system comprising these watersheds is part of the Monomoy Lens of the Cape Cod Aquifer. These major watersheds are characterized by numerous sub-watersheds contributing groundwater discharge to freshwater ponds, and estuaries including bays, salt ponds, and inlets as shown in Figure 1. Nitrogen in the form of nitrate, mainly from septic systems and fertilizer use is released to groundwater in the watersheds and then moves as a large dilute plume with groundwater flow and eventually discharges to the estuaries and coastal waters. This groundwater source of nitrogen is combined with additional sources such as stormwater runoff and fertilizer resulting in significant nitrogen loading to the surface water. When nitrogen loading reaches a certain threshold, it causes eutrophication or over enrichment of nutrients in estuaries resulting in algae blooms, scum layers, unpleasant odors, and periodic fish kills due to low oxygen conditions.


EASTHAM
ROCK HARBOR
TOWN COVE
ORLEANS
PLEASANT BAY
BREWSTER
HARWICH
CHATHAM
G:\Projects\MUNI\60476644\ORL\Maps\Figure1_Watersheds.mxd
FIGURE 1
TOWN OF ORLEANS, MA
WATER QUALITY AND
WASTEWATER PLANNING
MAJOR AND SUB-WATERSHEDS
Legend
Groundwater Contour
Edge of Pavement
MEP Subwatershed
Town Boundary
1 inch = 4,000 feet
0
2,500
5,000
Feet
AECOM

To address these concerns and comply with the Clean Water Act, the Town prepared a Comprehensive Wastewater Management Plan (CWMP) in December 2010. In response to comments on the CWMP, the Town re-evaluated its previously recommended approach to nitrogen control, which focused on installation of an extensive sewage collection system and new treatment facility with discharge at the Tri-Town Septage Treatment Facility site.

Subsequently, a draft Amended Comprehensive Wastewater Management Plan (ACWMP) was developed to document proposed changes including a revised Hybrid Plan. The ACWMP was developed in accordance with the Cape Cod 208 Water Quality Plan, which has been approved by both the United States Environmental Protection Agency (US EPA) and the Massachusetts Department of Environmental Protection (MassDEP).

The 25 percent Preliminary Design Report (PDR) plans for sewers in two areas including approximately 330 parcels encompassing the Downtown Area and approximately 406 parcels within the Meetinghouse Pond Area.

As this time, the revised ACWMP Hybrid Plan also included provisions for use of non-traditional technologies including PRBs and shellfish propagation to control nitrogen including an ongoing aquaculture demonstration in Lonnies Pond. Demonstrations for both PRBs and shellfish propagation are currently underway. Using these non-traditional technologies allows for reduced sewer collection system coverage while still achieving nitrogen control objectives. Permeable Reactive Barriers (PRBs) provide a way to intercept nitrogen in groundwater at key locations in the watersheds before it reaches sensitive embayments.

A PRB Demonstration Test has been implemented at the Eldredge Park Way location in Orleans to assess feasibility, determine PRB nitrogen removal efficiency, and assess the environmental sustainability of the alternative. The demonstration project was implemented in November 2016, was expanded in June 2018 and is subject to an intensive ongoing monitoring program to quantify nitrogen removal and secondary water quality effects. The cost for the three year demonstration test (investigations, implementation, expansion and monitoring) is approximately $917,000. Preliminary monitoring data indicate that the PRB is serving to reduce nitrogen concentrations in groundwater without significant secondary water quality impacts. Information gained through the demonstration will be utilized in determining final engineering details for full-scale implementation, refining monitoring plans, and predicting nitrogen removal efficiency for cost effectively achieving water quality goals.

3. Permeable Reactive Barrier Technology

A PRB is a passive treatment technology, designed in this application to in tercept and treat nitrate in groundwater through biological denitrification before the groundwater reaches downgradient surface waters. The PRB treatment zone is installed in the groundwater saturated zone below the water table, where amendments are added by injection to form the PRB. PRBs are typically oriented perpendicular to the direction of groundwater flow as shown in Figure 2 and rely on the natural groundwater gradient to carry nitrate to the PRB. The system is permeable because the injected amendments are designed not to interfere with groundwater flow, only removing nitrate as the groundwater passes through.

Key Terms

Permeable Reactive Barrier (PRB)
A zone of enhanced denitrification formed in the path of a dissolved nitrate plume.

Denitrification
Biological conversion of nitrate in water to inert nitrogen gas by naturally occurring bacteria. Denitrification: $NO_3^- \rightarrow N_2$ (gas)

PRB Amendment
Emulsified vegetable oil (EVO) used to provide dissolve organic carbon to stimulate naturally occurring bacteria in groundwater to transform nitrate to inert nitrogen gas.

Preliminary Design
Provides a concept with typical layout, materials, and steps to install the PRBs and associated cost elements.

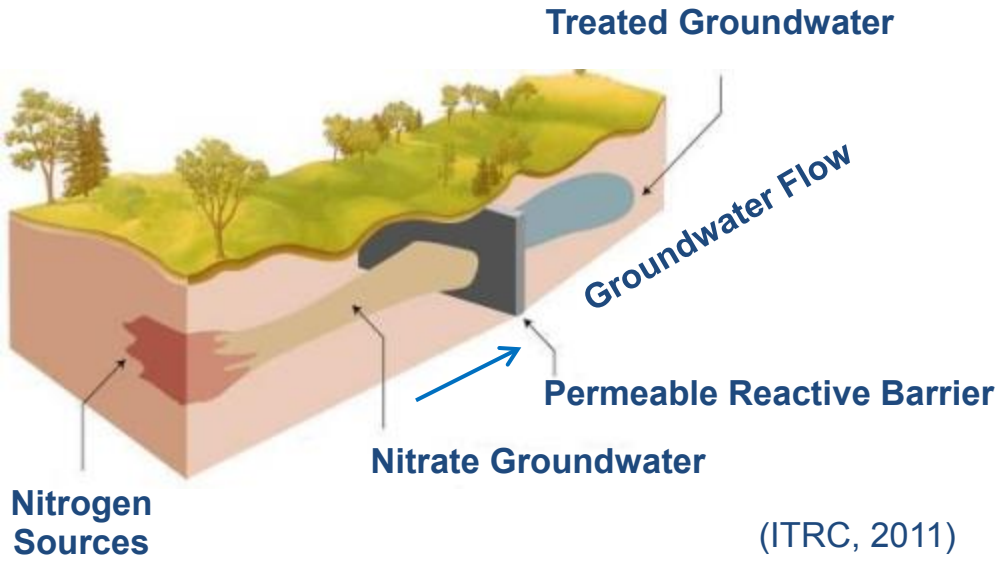


Figure 2 - Permeable Reactive Barrier

The injected amendment used to form the PRB is typically emulsified vegetable oil (EVO), a source of dissolved organic carbon that stimulates naturally occurring microbes in the groundwater to consume the dissolved organic carbon while respiring oxygen and creating anoxic conditions (without oxygen) favorable for denitrifying bacteria. The denitrifying bacteria then continue to use the dissolved organic carbon while respiring nitrate. This process of bacterial metabolism results in the conversion of nitrate to inert nitrogen gas. The PRB will need to be rejuvenated with additional EVO injections following an extended period of operation to replenish the consumed organic carbon.

4. Water Quality Goals

A. General

Development of surface water quality goals in the form of Total Maximum Daily Loads (TMDLs) is required by the Federal Clean Water Act. To develop embayment specific TMDLs, the Massachusetts Estuaries Project (MEP) have assessed nitrogen loading to the estuaries using an analytical method called the Linked Watershed-Embayment Management Modeling Approach. The model links watershed nitrogen inputs with surface water circulation and nitrogen characteristics. The TMDLs define the maximum nitrogen loads that the water bodies can receive while still meeting necessary water quality criteria. Corrective actions are then necessary to reduce nitrogen loading to below the TMDLs.

TMDLs developed by MEP have been documented in technical reports prepared for Pleasant Bay, Rock Harbor, and the Nauset Estuary (MEP 2006, MEP 2007, MEP 2012). Based on the TMDLs developed by the MEP, the MassDEP and US EPA have approved nitrogen TMDLs for Pleasant Bay. Additional TMDLs are undergoing review by the regulatory agencies. MEP assessments of Namskaket and Little Namskaket Creeks indicated no exceedances of developed TMDLs.

B. Pleasant Bay TMDLs

Pleasant Bay is connected to the Atlantic Ocean and is characterized by three main basins including Little Pleasant Bay, Pleasant Bay, and Chatham Harbor. The bay has a long shoreline and numerous sub-embayments. These sub-embayments are at particular risk of eutrophication from high nitrogen loads entering by direct groundwater discharge and restricted tidal exchange. Main basins in or adjacent to Orleans include Pleasant Bay Main Basin and Little Pleasant Bay. The sub-embayments in Orleans include Meetinghouse Pond, the Upper and Lower River, Lonnies Pond, Namequoit River and Aries Pond, Paw Wah Pond, Quanset Pond, and Pochet Inlet.

MEP issued the report "Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for the Pleasant Bay System, Orleans, Chatham, Brewster and Harwich, Massachusetts" in May 2006 that included proposed TMDLs for the system. On June 23, 2017 the Select Boards of Brewster, Chatham, Harwich and Orleans voted to sign a Resolution of the Towns sharing the Watershed of Pleasant Bay, endorsing the Pleasant Bay Composite Nitrogen Management Analysis as an accurate representation of each Town's share of current attenuated nitrogen load and its responsibility to remove nitrogen in Pleasant Bay (Pleasant Bay Alliance, March 2017). The agreed Town of Orleans share of attenuated Pleasant Bay Watershed nitrogen load is 6,980 kg/yr. The Towns sharing the watershed of Pleasant Bay entered an inter-municipal memorandum of agreement in 2018 to coordinate resource management of Pleasant Bay among the member Towns through the Pleasant Bay Alliance. The Pleasant Bay Alliance developed nitrogen removal requirements by Town and by Sub-embayment identifying these requirements is shown on Table 1 (Pleasant Bay Alliance March 2017).

C. Nauset Harbor Embayment System TMDLs

The Nauset Harbor Embayment System in Orleans and Eastham is comprised of open waters including Nauset Harbor and Town Cove, Nauset Marsh, located behind Nauset Barrier Beach, and three sub-embayments including Salt Pond, Wood Cove, and Mill Pond. The Nauset Harbor Estuary watershed is in the Towns of Orleans, Eastham, and Brewster. The most impacted areas with impaired habitat, and therefore the focus of nitrogen load reduction in Orleans, include the upper reach at Town Cove and the semi-enclosed Mill Pond and Wood Cove sub-embayments. The Salt Pond sub-embayment in Eastham is also at risk of eutrophication. MEP issued the report "Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System, Towns of Orleans and Eastham, Massachusetts" in 2012 that included TMDLS for the estuary.

Based on the draft ACWMP, the required nitrogen removal by Orleans for the Nauset system is 5,442 kg/yr, with a PRB technology removal target of 566 kg/yr focused on Town Cove.

D. Rock Harbor TMDLs

The watershed for Rock Harbor is in the Towns of Orleans and Eastham. Rock Harbor is a man-made harbor at the mouth of a tidal river and salt marsh and opens to Cape Cod Bay to the north. Significant habitat quality impairment and the presence of algal mats have been observed in the lower reach harbor area, while the upper reach marsh area has higher quality habitat. MEP issued the report "Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Rock Harbor Embayment System, Towns of Orleans, Massachusetts" in December 2008 that included TMDLs for the estuary.

Based on the draft ACWMP, the required nitrogen removal by Orleans for Rock Harbor is 1,463 kg/yr, with a PRB technology removal target of 634 kg/yr.

Table 1 - Pleasant Bay Composite Nitrogen Management Analysis
Nitrogen Removal Requirements by Town and by Sub-embayment (kg/yr)
(Pleasant Bay Alliance March 2017)

Pleasant Bay Composite Nitrogen Management Analysis

Table 1. Nitrogen Removal Requirements by Town and by Subembayment (kg/yr)

Subembayment	Brewster	Chatham	Harwich	Orleans	Total
Meetinghouse Pond				1,876	1,876
Town Percent of Total Removal				100%	100%
Lonnies Pond	14			284	298
Town Percent of Total Removal	5%			95%	100%
Areys Pond	29			113	142
Town Percent of Total Removal	20%			80%	100%
The River - Upper	3			375	378
Town Percent of Total Removal	1%			99%	100%
The River - Lower	6			518	524
Town Percent of Total Removal	1%			99%	100%
Namequoit River	19			348	367
Town Percent of Total Removal	5%			95%	100%
Paw Wah Pond				413	413
Town Percent of Total Removal				100%	100%
Quanset Pond	29			227	256
Town Percent of Total Removal	11%			89%	100%
Round Cove	1		1,209		1,210
Town Percent of Total Removal	0.1%		99.9%		100%
Muddy Creek Upper		193	584		777
Town Percent of Total Removal		25%	75%		100%
Muddy Creek Lower		584	986		1,570
Town Percent of Total Removal		37%	63%		100%
Ryder's Cove		1,954			1,954
Town Percent of Total Removal		100%			100%
Crows Pond		0			0
Town Percent of Total Removal		-			-
Bassing Harbor		0			0
Town Percent of Total Removal		-			-
Frost Fish Creek		803			803
Town Percent of Total Removal		100%			100%
Pochet				1,569	1,569
Town Percent of Total Removal				100%	100%
Pleasant Bay (including Little Pleasant Bay)	2,161	542	1,620	1,257	5,580
Town Percent of Total Removal	39%	10%	29%	22%	100%
Chatham Harbor		0			0
Town Percent of Total Removal		-			-
Total (All Subembayments)	2,262	4,076	4,399	6,980	17,717
Town Percent of Total Removal	13%	23%	25%	39%	100%

Notes:
1. Blue shading denotes entries that are greater than 5% of total (more than 886 kg/yr).
2. Blue shaded entries account for 71% of overall requirement.
3. See Table A-2 and A-3 in Appendix A for derivation of load removal requirements.

5. Implementation Approach and Phasing of PRB Installations

A. General

Criteria and conditions that will drive the phasing of full scale PRB installations include:

- The progress and outcome of the ongoing PRB Demonstration Test;
- Regulatory permitting timelines;
- Selection and access to proposed PRB locations;
- Availability of staffing resources and implementation funds;
- Availability of carbon substrate, subcontractors, and equipment for monitoring well installation and PRB injection; and
- Adaptive management of PRB implementation.

The PRB design process will include four general steps. These steps are outlined below with approximate time frames:

- Initial planning (this Technical Memorandum);
- Preliminary assessments of potential PRB locations and coordination with stakeholders including public workshops (6-months);
- Investigation of short listed locations with hydrogeologic assessments to confirm groundwater flow, actual water quality, and feasibility (9-months); and
- Full-design (1-year).

B. Development of Project Costs

PRB implementation costs have been developed based on estimated linear feet of PRB implementation defined in the ACWMP and cost information from the demonstration test at Eldredge Parkway location. These costs are outlined in Table 2 and include:

- Town Administration and Engineering;
- Engineering - Planning/Consultation;
- Engineering – Design;
- Contractor mobilization and demobilization;
- Monitoring well drilling and installation;
- Monitoring plan and baseline assessment;
- PRB Injections and materials;
- First year monitoring program implementation; and
- Projected annual replacement costs for monitoring wells and PRB rejuvenation injections.

Key Terms

Implementation Costs
Related to costs to Implement or install the proposed PRB. Implementation Costs are generally financed through a loan or bond program. This provides up front funding for implementation, with principal and interest payments spread out over time.

Annual Operations and Maintenance (O&M) Costs
Related to the day-to-day running and upkeep of the system. O&M Costs include items such as labor, utilities, chemicals, etc.

Annual Replacement Costs
Related to the replacement and/or repair of monitoring wells that have been damaged as well as the annualize cost to re-inject EVO.

Annual Monitoring Costs
Related to the annual compliance monitoring determined by the MassDEP. Annual Monitoring Costs include items such as labor and laboratory analysis.

Table 2 - Estimated Costs (July 2018)

Component	Implementation Cost	Annual O&M Cost	Annual Replacement Cost	Annual Monitoring Cost
Site 1 – Rock Harbor Watershed (4,700 LF)				
Design	$518,600			
Implementation, O&M and Monitoring	$4,148,700	$0		$178,600
Replacement			$745,300	
Site 2 – Pleasant Bay Watershed (1,900 LF)				
Design	$210,700			
Implementation, O&M and Monitoring	$1,685,400	$0		$78,300
Replacement			$307,100	
Site 3 – Nauset Harbor Watershed (2,200 LF)				
Design	$244,500			
Implementation, O&M and Monitoring	$1,956,000	$0		$89,100
Replacement			$354,500	

Notes:

1. The design is expected to occur within a one-year period following site selection. The implementation, O&M, and monitoring is expected to begin after the design year, pending appropriation of funding at the prior year's Town Meeting/Special Town Meeting. The annualized replacement costs are anticipated to begin the year following implementation.
2. The estimated linear feet of PRB for the three sites is based on the 2015 Conceptual Approach developed by Stantec for the Town of Orleans. The estimated costs presented are based on these lengths and are expected to vary based on actual length determined during design development.

AECOM has no control over costs of labor, materials, competitive bidding environments and procedures, unidentified field conditions, financial and/or market conditions or other factors likely to affect the opinion of probable project costs all of which are and will unavoidably remain in a state of change. It is further understood that the probable project costs are a "snapshot in time" and that the reliability of this opinion of probable project costs will inherently degrade over time.

The probable project costs need to be indexed on a common "baseline". The construction industry uses the Engineering News Record (ENR) Construction Cost Index (www.enr.com) that is based on construction and materials costs throughout the United States. Therefore, the probable project costs contained herein are based on an ENR Construction Cost Index of 11117 for July 2018.

The probable project costs will need to be updated based on the actual implementation year.

C. Regulatory Permitting

Massachusetts Section 2A of Chapter 259 of the Acts of 2014 required MassDEP to develop a watershed permitting approach to address and optimize nitrogen management measures intended to restore water quality. Planning for Watershed Permits is included in the approved Cape Cod Nitrogen Management Plan (the 208 Plan Update) developed pursuant to Section 208 of the federal Clean Water Act. The 208 Plan Update designates Cape Cod Towns as Waste Treatment Management Agencies (WMAs) responsible for meeting TMDLs on a watershed basis.

In addition to the Watershed Permit, site specific permitting requirements for PRBs will depend on the proposed location. PRBs will be proposed outside of wetland resource areas and sensitive environmental locations where possible. The preferred approach is to install PRBs through Town roads or rights-of-way or potentially on Town-owned properties. Potential permitting requirements and approving authorities are included in Table 3 and described below.

Table 3 - Potential Permit Requirements Depending on Location

Permit	Regulation	Administrating Agency
Massachusetts Environmental Policy Act Permit	Massachusetts Environmental Policy Act Unit	MEPA Unit
Underground Injection Control Registration	Safe Drinking Water Act	MassDEP
Section 106 & Chapter 254 Historic Preservation Act Compliance	Section 106 of the National Historic Preservation Act	Massachusetts Historical Commission
Massachusetts Endangered Species Act Project Review	Massachusetts Endangered Species Act	Massachusetts Division of Fisheries and Wildlife Natural Heritage & Endangered Species Program
Notice of Intent/Order of Conditions	Wetlands Protection Act/ Rivers Protection Act	Town of Orleans Conservation Commission and MassDEP
Road Opening Permits	Massachusetts Chapter 82A Sections 40 through 40D	Town of Orleans Highway Department

D. Massachusetts Environmental Policy Act

PRB projects may be subject to the Massachusetts Environmental Policy Act (MEPA) 301 CMR 11.00. MEPA review is required when one or more review thresholds are met or exceeded and the subject matter of at least one review threshold is within MEPA jurisdiction. In determining whether a Project is subject to MEPA jurisdiction or meets or exceeds any review thresholds it may be necessary to consider all proposed PRBs together to avoid segmentation concerns.

An Environmental Notification Form (ENF) describing the project and potential environmental impacts along with any feasible measures to mitigate potential environmental damage is submitted to the Executive Office of Energy and Environmental Affairs (EEA). EEA solicits comments from the public and state agencies. Following public comment and consultation, the EEA issues a Certificate stating whether an Environmental Impact Report (EIR) is needed and what the scope of the EIR should include, if required. If the EIR is not required, the state permitting agencies can issue the required permits and the project can go forward. Projects located in designated Areas of Critical Environmental Concern require ENF and a Mandatory EIR. Both Pleasant Bay and Rock Harbor are located within state-designated Areas of Critical Environmental Concern.

E. Underground Injection Control Registrations

PRBs will require a MassDEP issued Underground Injection Control (UIC) Registration to comply with UIC Regulations. The UIC Program is responsible for regulating the implementation, operation, permitting, and closure of injection wells that place fluids underground for storage and disposal. The UIC Program requirements were developed by EPA and designed to be adopted by states. The MassDEP UIC Program, defined in 310 CMR 27.00: Underground Injection Control Regulations, details the regulation of injection of fluids within Massachusetts.

To implement a PRB a UIC permit application (MassDEP form BRPWS 06) must be filed with MassDEP under the category “Aquifer Remediation”. The application would include the design parameters and layout of the PRB along with a Water Quality Monitoring Plan. Similar injections of carbon substrates to enhance biodegradation of groundwater chemicals have been commonly implemented in Massachusetts and many of these sites are exempt from the UIC registration process if the injections are conducted for waste site cleanup in accordance with the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000) or similar federal statutes. PRBs will be implemented in compliance with the requirements of the Massachusetts UIC regulations, including all required monitoring. A fee of $585 for each PRB site would be associated with filing the UIC permit. The UIC permit applications should be submitted at least 60 days in advance of the proposed PRB implementation start date. Status reports documenting PRB implementation and monitoring results are subsequently submitted to MassDEP.

F. Historic Preservation Act

At certain locations project review by the Massachusetts Historical Commission (MHC) may be necessary. The MHC administers the Historic Preservation Act. Any projects that require funding, licenses, or permits from any state agency must be reviewed by MHC in compliance with Massachusetts General Laws Chapter 9, sections 26-27C. This law creates the MHC, the office of the State Archaeologist, and the State Register of Historic Places among other historic preservation programs. It provides for MHC review of state projects, State Archaeologist’s Permits, the protection of archaeological sites on public land from unauthorized digging, and the protection of unmarked burials. The regulations that guide MHC review of state funded, licensed or permitted projects are published in 950 CMR 71. These regulations set up a process for the identification of historic properties, assessment of effect, and consultation among interested parties to avoid, minimize, or mitigate any adverse effects. Projects on slopes or uplands adjacent to rivers, lakes, ponds and the ocean are generally considered to be more sensitive to the presence or archaeological artifacts than other locations. Following consultation with MHC, a Project Notification Form (PNF) is submitted to initiate MHC review. The PNF includes a description of the proposed project, existing conditions, and past development of disturbances in the project area.

G. Massachusetts Endangered Species Act Project Review

Projects and activities within rare species habitat must file with the Natural Heritage & Endangered Species Program (NHESP) for review and approval. Habitats in Massachusetts have been mapped as Priority & Estimated Habitats and maps are available on-line. In review, NHESP determines whether the project, as proposed, will impact state-listed species and their habitats and whether or not a project or activity as proposed will result in a "Take" of state-listed species. Projects may have to be revised to avoid a “Take” or be subject to conditions or restrictions to avoid impacts to state-listed species and their habitats and must meet the performance standards for the issuance of a Conservation and Management Permit.

H. Wetlands Protection Act/Rivers Protection Act

If the PRB project is located within 100 feet of a wetland resource area or within 200 feet of a designated riverfront area a Notice of Intent must be submitted for review by the Orleans Conservation Commission. The Commission will issue an Order of Conditions for an approved project.

I. Road Opening Permit

Additional local permits will include Road Opening Permits where PRBs are implemented by injecting through roadways. PRBs systems implementation and monitoring well installation will also likely require agreements for access to private property, mainly for the installation and sampling of monitoring wells.

6. Project Management and Predesign Planning

A. Implementation Team

The successful implementation of PRBs will require coordination between consultant/contractors and the Town of Orleans, including coordination of location access and permit approvals from Town, county, and state authorities. Teams will include:

- Designated Town Officials and Legal staff;
- Consultant staff, with Injection, Drilling, and Laboratory Sub-contractors; and
- Public Participation Coordinator.

It is anticipated that the Town of Orleans will assign a Town Project Manager within the Department of Public Works and Natural Resources and/or an Owner’s Program Manager for implementation coordination. The Consultant will work with the Town Project Manager and a team of specialty subcontractors to plan and implement PRBs. Due to the nature of the project, Town legal staff assistance will be needed to coordinate location access and assistance with permitting. A public participation coordinator will help facilitate public involvement in the project.

B. Pre-implementation Tasks

A detailed project schedule and project progress tracking and reporting system will be developed to identify action items to keep the project on course. The limits of target geographic areas and limits on existing land use for PRB implementation will be developed to inform location selection and monitoring program design and assure that planning is integrated with the ACWMP.

A process for review of specific potential PRBs and location selection, including public participation, will be developed by the Implementation Team to screen candidate PRB sites. The process will include coordination with the US EPA, MassDEP, Cape Cod Commission, and the Pleasant Bay Alliance, a municipal organization formed by the Towns of Orleans, Chatham, Harwich and Brewster to coordinate the resource management plan for the Pleasant Bay Area of Critical Environmental Concern and watershed. It is anticipated that coordination with the Town of Eastham will also be included in the process where PRBs may address shared resources (e.g. Nauset Estuary and Rock Harbor). Following development of a location short list, selected locations will be subject to further investigation to determine specific land use, location of utilities, and an initial groundwater assessment that will be integrated with Water Quality Monitoring Plans described below.

C. Locations Specific Assessment, Baseline Assessment, and Water Quality Monitoring Plans

Potential PRB locations will be reviewed and selected for implementation in accordance with the overall objectives of the Town Comprehensive Wastewater Management Plan, which includes priority areas. Prior to final selection, a location-specific assessment will be necessary to confirm the nature of hydrogeological conditions and groundwater chemistry for PRB design and monitoring plan development and to develop site specific costs on a cost per kilogram of nitrogen removed basis. The cost per kilogram will depend on implementation and monitoring costs, the dimensions of the PRB, and the flux of nitrate through the specific location.

Water Quality Monitoring Plans will be developed for each PRB location. The monitoring program will be developed based on the Conceptual Site Model for PRBs described below and will be developed in a phased approach. The first phase incorporates the initial location assessment, then builds in the baseline assessment needed before PRB implementation at a selected site, and finally the performance monitoring plan that will be used to track PRB efficiency and water quality affects. The assessments will include groundwater profiling and monitoring well sampling and analyses to assess nitrate mass flux and hydrogeologic conditions. Primary objectives of the monitoring plans are to:

- Evaluate potential PRB locations for selection and design based on mass flux of nitrate and feasibility of implementation;
- Assess potential reduction in nitrate concentrations in groundwater compared to baseline samples and/or wells upgradient of the PRB;
- Identify distance traveled by EVO emulsion and DOC;
- Identify extent of generated reducing conditions;
- Assess hydraulic performance;
- Evaluate persistence of EVO emulsion and anaerobic conditions favorable for denitrifying bacteria after PRB injection; and
- Assess changes in groundwater monitoring parameters.
- Estimate the cost per kilogram of nitrate removal.

The monitoring program will be designed to be dynamic and continuously evaluated to adjust the selected monitoring parameters and frequency of monitoring based on data collected and observations. A list of groundwater monitoring parameters is included in Table 4.

Table 4 - Summary of Potential Analyses for Groundwater Evaluation

Parameter	Relevance to PRB Demonstration Test
Nitrate	Primary groundwater compound targeted for treatment.
Nitrite	Intermediate nitrogen species from the aerobic nitrification of ammonia to nitrate.
Ammonia	Reduced inorganic nitrogen species that occurs in proximity of septic system leach fields and landfills.
TKN	Total Kjeldahl Nitrogen (TKN) is the total concentration of organic nitrogen and ammonia.
Total Nitrogen	Analyses provide a summation of all organic and inorganic nitrogen species in groundwater as a result of leach fields and landfill.
CENSUS-DNA (Denitrifying Bacteria)	Analysis quantifies relative abundance of denitrifying bacteria.
Metals (Fe, Mn, As)	Mobility of metals can be impacted by groundwater geochemistry changes, notably pH and ORP.
DOC	Dissolved Organic Carbon (DOC) is the limiting factor in enhancing denitrification-and is increased by injection of EVO. DOC tracks the area of influence of the PRB.
Sulfate	Sulfate will decrease with generation of sufficiently anaerobic conditions favorable for sulfate-reducing bacteria.
pH	Denitrification optimal pH (6.0 and 8.5). Groundwater pH can decrease as a result of fermentation of injected carbon substrates.
ORP	Oxidation-reduction potential (ORP) will decrease with generation of reducing conditions following injection of carbon substrate.
Chloride	Chloride concentrations indicate potentially infiltrating stormwater.
Alkalinity	Denitrification reactions generate alkalinity (3.57 mg of $CaCO_3$ for each mg of nitrate reduced).
Boron	Boron is present in laundry detergents and is an indicator of groundwater flow emanating from leach fields.

D. Adaptive Management

Coordinated implementation of PRBs is necessary to incorporate the Adaptive Management Approach as outlined in the CWMP, where non-structural elements such as PRBs can be implemented in a way that first documents their effectiveness and then allows their full application with predictable results and regulatory support, with the overall goal of reducing the cost of the structural elements. Adaptive Management Plan elements directly related to PRB implementation will require identification of tasks necessary to monitor and refine PRB placement, monitoring programs, and design and implementation methods moving forward. PRB monitoring programs can be integrated with long-term surface water quality monitoring programs for performance evaluation and optimization.

E. Environmental Considerations

Careful selection of PRB installation locations outside sensitive resource areas will be the primary means of minimizing environmental impact. Compliance with environmental permits will be necessary to assure environmental protection and permit requirements will be included in the progress tracking and recording system. Groundwater monitoring results from the Demonstration Test will be used to gauge the potential for secondary impacts to groundwater quality.

F. Conceptual Site Model for PRBs

Site specific PRB implementation assessment will be based on a Conceptual Site Model (CSM) developed for this project for PRBs based on groundwater conditions and the expected fate and transport of large dilute nitrate plumes on Cape Cod. The general (or Cape Cod) CSM is presented with a visualization in Figure 3 and described below.

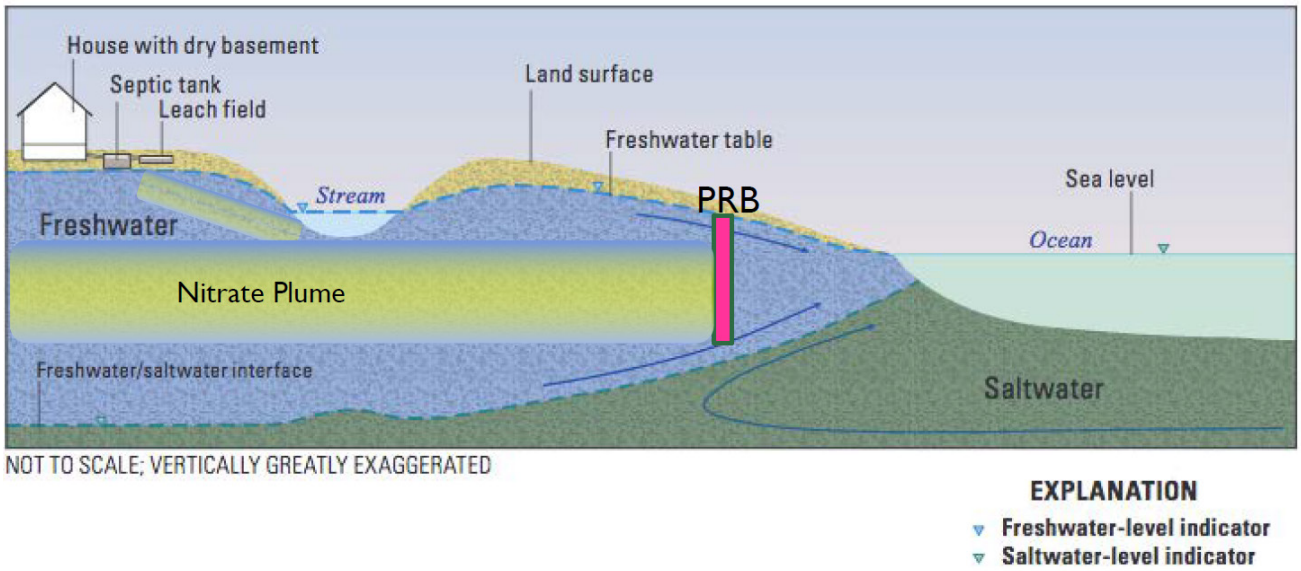
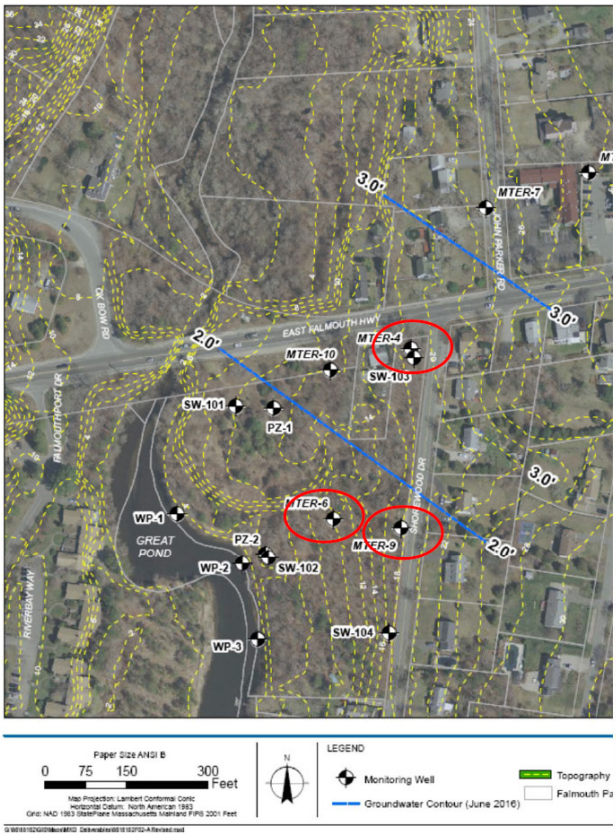


Figure 3 - Visual of Nitrate Plume Treatment PRB
Modified from USGS

Elements of the CSM include the following:

- Groundwater generally flows from the highest water table elevations in the watershed (e.g. approximately 26 feet above sea level in the Nauset Watershed) downgradient toward the receiving surface water body (e.g. Town Cove). In addition to flowing horizontally downgradient, groundwater may flow vertically, recharging deeper portions of the aquifer 100 to 150 feet or more below sea level. Water table elevations vary locally resulting in deviations in local groundwater flow direction.
- The presence of nitrate and nitrate concentrations varies depending on the strength or number of sources upgradient of a location and on the geochemistry of the groundwater. The geochemistry affects fate and transport of nitrogen. Generally septic system nitrogen and nitrogen from fertilizers are released to aerobic groundwater where nitrate is the dominant and most persistent form of nitrogen. Where groundwater travels deep over long distances and into anoxic conditions, natural attenuation may occur. Under these circumstances the profile of nitrate concentrations from shallow to deep in groundwater may indicate that the highest concentrations are generally in shallower groundwater and lower concentrations at depth (see example in Figure 4 below). The profile will in part depend on the distance from sources to the PRB. In recharge areas the plume will move deeper as it travels downgradient.



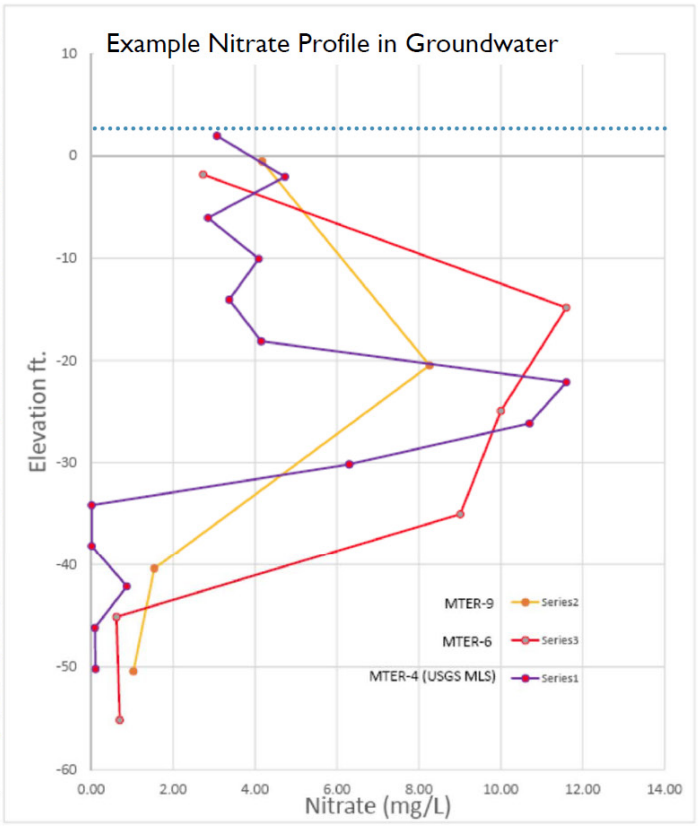


Figure 4 - Example Concentration Profile Nitrate in Groundwater on Cape Cod

- Groundwater flow through freshwater ponds may attenuate nitrogen concentrations.
- Groundwater velocity will vary depending on the local groundwater gradient and hydraulic conductivity of the aquifer material. The aquifer material may contain less permeable clay, silt or fine sand and higher permeability medium sand and gravel. The groundwater velocity may vary from less than 0.1 feet per day to more than 3 feet per day depending on local conditions.
- There may also be layering present in the aquifer material, with layers of more permeable coarser sand and gravel having higher hydraulic conductivity stratified with lower permeability fine sand, silt, or very low hydraulic conductivity clay layers. Mass flux of nitrate would be greater in more permeable layers with faster groundwater flow even if the concentration in lower permeability layers is similar.
- The nitrate treatment PRB will be installed to efficiently intercept the mass flux of nitrate in groundwater upgradient of the surface water to be protected.

The above CSM can be used to develop a site specific CSM to assist in PRB location assessment, PRB design, and development of site specific PRB groundwater monitoring plans. The assessments will include the installation of a set of initial monitoring wells and include groundwater profiling to confirm conditions at depth below the water table. Groundwater profiling will include an assessment of hydraulic conductivity and groundwater chemistry, including redox conditions and one or more nitrogen profiles for the location. Following evaluation of test results and confirmation of location selection, additional monitoring wells will be installed and sampled to establish sufficient information to confirm baseline conditions for comparison and performance assessment once the PRB is in place.

G. Conceptual PRB System Design

PRB conceptual design plans include an overview of installation activities, standard treatment layouts, facilities, and processes to be used to implement the PRB. The PRBs will be installed by injecting a diluted emulsified vegetable oil (EVO) substrate formulation specifically developed to treat nitrate in Cape Cod groundwater. The EVO is injected along a transect line that cuts across the plume of nitrate at the target PRB treatment location. The volume and mixture/type of EVO used to form the PRB will be designed based on the mass flux of nitrate and competing electron acceptors predicted with location specific assessment data. The assessment data may identify high flux zones that can then be targeted as the most cost-effective treatment locations and depths.

Key Terms

Mass flux
A rate measurement specific to a defined area, which is usually a subset of a plume cross section expressed as mass/time/area (e.g., g/d/m2) (ITRC 2010).

Conceptual Site Model (CSM)
Descriptive tool to help understand groundwater conditions and large dilute nitrate plumes on Cape Cod.

Hydraulic Gradient
Groundwater flows down the hydraulic gradient - water table elevations are determined by measuring the depth to water in three or more similar monitoring wells in an area and can then be used to triangulate the hydraulic gradient and horizontal flow direction.

The EVO will be injected with direct push rigs injection rigs (Figure 5) along an injection pathway set perpendicular or close to perpendicular to the groundwater flow direction. The direct push rigs use hydraulics and a vibratory hammer to drive hollow steel rods that serve as piping to the target injection depths. Target injection depths are expected to be up and potentially exceeding 100 feet below ground surface. Injections will be completed with a bottom up approach where the rig will drive direct push rods with typically 4 or 8-foot stainless steel laser cut screens at the bottom of the rods down to the deepest treatment interval. Following the first injection, the screen will be sequentially raised one screen length for subsequent injections until the top of the injection interval is reached.

Direct injection points (without permanent injection well structures) will be located 10 to 15 feet apart depending on the expected radius of influence of injected EVO at each PRB location as determined in the preliminary assessment. The layout and design injection depth will depend on the characteristics of the specific PRB location determined in the location specific assessment.

Design specifications include:

- Depth to ground water;
- PRB length (Linear Feet);
- Target treatment thickness;
- Injection point spacing;
- Number of injection points;
- EVO specification, dilution and additives;
- Injection pressure;



Figure 5 - Direct Injection Rig

- Injection target pore volume;
- Total injection volume (gal); and
- Injection volume per point (gal).

Where possible, PRBs will be implemented along the edge of roadways to minimize implementation related impacts. The objective is to install the PRB in such a way that, following injection, the only indication of the presence of the PRB on the land surface will be the flush mounted surface structure associated with the tops of monitoring wells.

The injection substrate will be delivered to a central staging location or the PRB location in bulk in plastic reusable totes in box trailers, diluted on-site with water to the required strength, and injected. Typically, multiple injection points will be injected simultaneously.

Given the potential length of full scale PRBs, significant advanced planning and coordination with suppliers and field crews will be required. Logistical considerations include:

- A single primary/central staging area will be needed for temporary storage of concentrated EVO in 275-gallon totes. Concentrated volumes required for each specific day can be pulled out of the central staging areas using fork lifts and loaded onto box trucks to move to secondary staging areas adjacent to injection areas. For projects with anticipated multiple secondary staging areas, the use of multiple box trucks can be utilized to minimize any downtime involved with transporting adequate EVO volumes.
- A hydrant water supply and/or water truck will be needed for supplying dilution water near each injection area. Required water supply flow on demand is approximately 40 to 60 gallons per minute.
- Alternatively, diluted EVO batches can be prepared at the central staging area and transported to injection areas on a daily or as-needed basis. Based on weight of water, approximately 6 to 8 totes are near the maximum volume (1,500 to 2,000 gallons) that can be carried in a box truck.
- EVO deliveries to central storage should be sequenced to keep minimum 2 to 3-day buffer to absorb faster/slower injection rates than anticipated. A daily delivery/consumption chart should be prepared and used to coordinate demand and delivery.
- Cumulative injection rates are important to maintain for large volume injections. To sustain high injection rates, 4 to 8 manifolded or dedicated injection lines may need to be operated simultaneously. At high flow rates appropriate staff levels will be needed to coordinate batching, injection, and transport of stock solution, diluted solutions, and/or water.
- Allowable working hours and days will need to be estimated prior to project implementation to effectively deliver EVO and to manage and maintain the injection schedule.
- Traffic flaggers and/or coordination with police for details will be important for maintaining safe working conditions. Police detail may be needed at the central staging area to minimize traffic disturbances with many large trucks arriving at a single location.

The injected EVO provides a long-term source of dissolved organic carbon within and immediately downgradient of the PRB. The dissolved organic carbon is a source of food for naturally occurring groundwater bacteria that will first utilize available oxygen in groundwater for respiration followed by denitrifying bacteria that will utilize nitrate for respiration. This natural process converts available nitrate nitrogen to inert nitrogen gas which is commonly present in groundwater. Once the required biological activity is established the PRB is expected to remove nitrate in groundwater for an extended period of years. The nitrogen load reduction that will be achieved can be predicted with the mass flux of nitrate identified in the assessment.

The process of establishing the PRB biological community in the treatment zones is expected to take several months based on the lag time for increases in naturally occurring biomass. The amount of time required to confirm the increase in biological activity (or biomass) will depend in part on the distance to downgradient monitoring wells along with groundwater velocity and travel time.

eventually, the efficiency of nitrate treatment will begin to decline once the carbon source starts to be depleted. Depletion is expected to occur in high mass flux areas first and will be indicated by decreasing dissolved organic carbon levels and increasing nitrate concentration at downgradient monitoring wells. Once the treatment efficiency decreases to a defined tolerance limit, rejuvenation of the PRB by subsequent injection will be required. The ongoing Demonstration Test is being monitored to assess longevity to provide specific guidance for PRBs in Orleans; expected operational time frames range from 5 to 10 years or more.

H. Post Implementation Tasks

Following implementation of individual PRBs an As-built Completion Report will be prepared documenting implementation, final inspections, and updated Water Quality Monitoring Plans. The report can then be used in conjunction with the Adaptive Management Approach, post installation monitoring, and reporting to track progress toward water quality goals.

7. References

Interstate Technology & Regulatory Council (ITRC) (2010)- Use and Measurement of Mass Flux and Mass Discharge

Interstate Technology & Regulatory Council (ITRC) (2011)- Permeable Reactive Barrier: Technology Update (PRB-5)

MassDEP (May 2007) “Pleasant Bay System, Total Maximum Daily Loads for Total Nitrogen” (Report #96- TMDL-12, Control #244.0)

Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2006). Linked Watershed-Embayment Model to Determine Critical Nitrogen Loading Thresholds for Pleasant Bay, Chatham, Massachusetts. Massachusetts Estuaries Project, Massachusetts Department of Environmental Protection. Boston, MA

Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2007). Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Rock Harbor Embayment System Towns of Orleans and Eastham, Massachusetts

Howes B., S. W. Kelley, J. S. Ramsey, R. Samimy, D. Schlezinger, E. Eichner (2012). Linked Watershed-Embayment Approach to Determine Critical Nitrogen Loading Thresholds for the Nauset Harbor Embayment System Towns of Orleans and Eastham, Massachusetts

Pleasant Bay Alliance (2017) Pleasant Bay Composite Nitrogen Management Analysis

Appendix B: Full-Scale PRB Selection Matrix

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Table 1
Orleans PRB Selection Matrix

Pleasant Bay Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	Length (ft)	Roads	Saturated Depth (ft)	Depth Range to GW (ft)	Estimated Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Estimated kg/LF/yr	Pleasant Bay Watershed PRB kg/yr Efficincy Rank	PRB Installation Cost Estimate	30-year LCCA for PRB (Present Worth)	Evaluation Notes
Meeting House Pond	None						**0**	**0**	**40**					
Lonnies Pond/Kescayo Gansett River							**41**	**178**	**284**					
Lonnies Pond/Kescayo Gansett River	Monument	25, 26 Lonnies Pond/Kescayo Gansett River	1,675	Monument	30	25 to 50	41	178		0.11	**8**	$2,060,250	$4,889,900	Upper Reach Priority embayment
Aerys Pond	None						**0**	**0**	**113**					
Upper River							**26**	**113**	**202**					
Upper River	Keziahs	41 Upper River	1,250	Keziahs	30	15 to 40	26	113		0.09	**9**	$1,537,500	$3,775,700	Upper Reach Priority embayment
Lower River							**35**	**152**	**517**					
Lower River	Mayflower	28 Lower River	1,700	Pershing, Kenneth	30	10 to 30	35	152		0.09	**11**	$2,091,000	$4,969,200	
Namequoit River							**56**	**244**	**348**					
Namequoit River	Namequoit	30 Namequoit River	1,000	Namequoit Road	30	10 to 40	27	117		0.12	**6**	$1,230,000	$7,577,200	Upper Reach Priority embayment
Namequoit River	Ridge	30 Namequoit River	460	Ridgewood Rd	30	10 to 30	29	126		0.27	**1**	$565,800	d with Namequoit PRB	Upper Reach Priority embayment
Pah Wah Pond							**35**	**152**	**413**					
Pah Wah Pond	Lockwood	32 Pah Wah Pond	1,230	Lockwood	30	5 to 15	35	152		0.12	**5**	$1,512,900	d with Namequoit PRB	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin							**122**	**531**	**1485**					
Quanset and Pleasant Bay Main Basin	Quonset 1,2,3	33, 37 Pleasant Bay and Quanset Pond	1,745	Towhee, Lake Dr, Oyster	30	10 to 40	43	187		0.11	**7**	$2,146,350	$5,071,900	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Grannys	33, 37 Pleasant Bay and Quanset Pond	650	Grannys Ln	30	15 to 20	24	104		0.16	**4**	$799,500	$2,174,200	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Winslow	33, 37 Pleasant Bay and Quanset Pond	1,150	Winslow Dr and Way	30	5 to 40	14	61		0.05	**14**	$1,414,500	$3,496,900	Upper Reach Priority embayment
Quanset and Pleasant Bay Main Basin	Richwood	33, 37 Pleasant Bay and Quanset Pond	890	Richwood Farm	30	10 to 15	41	178		0.20	**2**	$1,094,700	$2,805,100	Upper Reach Priority embayment
Pochet							**171**	**744**	**1,564**					
Pochet	Duck Hole	35 Pochet Neck Stream	4,100	High View, Old Duck Hole, Lovell	30	5 to 35	68	296		0.07	**12**	$5,043,000	$11,335,800	Upper Reach Priority embayment
Pochet	Gosnold	34, 35 Pochet and Pochet Neck Stream	2,081	Gosnold,	30	10 to 30	29	126		0.06	**13**	$2,559,630	$5,966,700	Upper Reach Priority embayment
Pochet	Briar Spring	34 Pochet	2,906	Briar Spring	30	10 to 35	59	257		0.09	**10**	$3,574,380	$8,168,400	Upper Reach Priority embayment
Pochet	Blossom	35 Pochet	400	Blossom , Sparrowhawk	30	30 to 40	15	65		0.16	**3**	$492,000	$1,513,400	Upper Reach Priority embayment
Pleasant Bay Estuary (Orleans)			**21,237**				**486**	**2,115**	**4,966**			**$26,121,510**	**$61,744,400**	
	Average Efficiency kg/LF/yr									**0.10**				

Nauset Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	Length (ft)	Roads	Saturated Depth (ft)	Depth Range to GW (ft)	Estimated Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Estimated kg/LF/yr	Pleasant Bay Watershed PRB kg/yr Efficincy Rank	PRB Installation Cost Estimate	30-year LCCA for PRB (Present Worth)	Evaluation Notes
Town Cove							**171**	**744**	**566**					
Town Cove	Tonset	5 Town Cove	7,300	Gibson, Tonset	30	10 to 30	93	405		0.06	**3**	$8,979,000	$22,059,000	Upper Reach Priority embayment
Town Cove	Main	5 Town Cove	850	Main	40	5 to 10	78	339		0.40	**2**	$1,045,500	luded with Tonset PRB	Upper Reach Priority embayment
Mill Pond							**28**	**122**						
Mill Pond	Norseman	8 Mill Pond	580	Norsemans Road, Mill Pond Rd	40	10 to 35	28	122		0.21	**1**	$713,400	$1,999,700	Upper Reach Priority embayment
Nauset Estuary (Orleans)			**8,730**				**199**	**866**				**$10,737,900**	**$24,058,700**	
	Average Efficiency kg/LF/yr									**0.22**				

Rock Harbor Estuary (Orleans)

Embayment	PRB Name	MEP Watershed ID	Length (ft)	Roads	Saturated Depth (ft)	Depth Range to GW (ft)	Estimated Parcels	Estimated Sewer Load reduced (kg/yr) at 80% PRB Efficiency	Embayment Non-Traditional Technology Goal (kg/yr)	Estimated kg/LF/yr	Pleasant Bay Watershed PRB kg/yr Efficincy Rank	PRB Installation Cost Estimate	30-year LCCA for PRB (Present Worth)	Evaluation Notes
Rock Harbor Main	**Rock Harbor**						**70**	**305**	**634**					
Rock Harbor	Rock Harbor	3 Rock Harbor Main	3,940	Rock Harbor	50	5 to 15	70	305		0.08	1	$103,425	$10,896,700	Upper Reach Priority embayment
Rock Harbor Estuary (Orleans)	**Rock Harbor**		**3,940**				**70**	**305**	**634**	**0.08**		**$4,846,200**	**$10,896,700**	

PRB Townwide Potential Total			**33,907**				**755**	**3,286**				**$41,705,610**	**$96,699,800**	

Appendix C: Boring Logs

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Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**BR-1**	
Date	Monday, August 30, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Friday, September 17, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft		dry	0 - 4' : Very dense tan fine to coarse sand, little fine to coarse gravel (fill)				1
2	to 6 ft		dry	4' - 6' : Native tan fine to coarse sand, trace fine gravel, loose				2
3								3
4								4
5								5
6	5 ft to							6
7	10 ft		dry	7' - 33' : Mottled tan/light brown (slightly oxidized) medium to coarse sand, little fine sand, trace fine gravel wet @ 27 ft				7
8								8
9								9
10								10
11	10 ft to							11
12	15 ft							12
13								13
14								14
15								15
16	15 ft to							16
17	20 ft							17
18								18
19								19
20								20
21	20 ft to							21
22	25 ft							22
23								23
24								24
25								25
26	25 ft to							26
27	30 ft							27
28								28
29								29
30								30
31	30 ft to							31
32	35 ft							32
33			dry	33' - 34' : Light brown fine to medium sand, trace coarse sand				33
34			dry	34' - 38' : Mottled tan/light brown (slightly oxidized) medium to coarse sand, little fine sand, trace gravel				34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-1**
Date	Monday, August 30, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Friday, September 17, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38			dry	38' - 39' : Tan medium to coarse sand, trace fine gravel				38
39			dry	39' - 40.5' : Brown fine to medium sand, little coarse sand, trace silt,				39
40			dry	40.5' - 64' : Tan medium to coarse sand, trace fine gravel		▼		40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64			dry dry	64' - 64.5' : Tan fine to medium sand, little coarse sand, very small brown silt 64.5' - 66.5' : Tan medium to coarse sand, trace fine gravel				64
65								65
66	65 ft to 70 ft		dry	66.5' - 67' : Brown mottled silt				66
67			dry	67' - 69' : Oxidized brown/orange medium to coarse sand, some fine sand, trace fine gravel				67
68								68
69			dry	69' - 71' : Tan medium to coarse sand, trace fine gravel				69
70								70

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**BR-1**	
Date	Monday, August 30, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Friday, September 17, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft		dry dry	71' - 71.25' : Brown silt 71.25' - 76' : Brown medium to coarse sand, some fine gravel, little fine silt, trace silt				71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft		dry	76' - 82' : Starts with small brown silt, slightly oxidized				76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82			dry	82' - 86' : Light brown/light orange coarse sand, some medium sand and fine gravel, trace fine sand				82
83								83
84								84
85								85
86	85 ft to 90 ft		dry dry	86' - 86.5' : Tight fine to medium sand, little coarse sand 86.5' - 91' : Light brown/light orange coarse sand, some medium sand and fine gravel, trace fine sand				86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft		dry	91' - 93' : Brown fine to medium sand, some coarse sand, trace fine gravel				91
92								92
93			dry	93' - 95' : Light brown/light orange coarse sand, some medium sand and fine gravel, trace fine sand				93
94								94
95			dry	95' - 96' : Gray mottled silty fine sand, little medium sand, heavily oxidized at 97.5 ft				95
96	95 ft to 100 ft							96
97			dry	97.5' - 100' : Gray mottled silty fine sand, little medium sand				97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**BR-2**	
Date	Thursday, September 16, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Thursday, September 16, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear	3.0	dry	0' - 1' : Topsoil with roots and gravel				1
	0 ft		dry	1' - 2' : Brown /dark brown fine to coarse sand, some silt, little fine gravel				
2	to		dry	2' - 3' : tan/light brown medium sand, some fine coarse sand, trace fine gravel				2
	6 ft							
3		12.0	dry	3' - 15' : Tan/light brown fine to medium sand, little coarse sand, fine gravel, trace silt				3
4								4
5								5
6	5 ft							6
	to							
7	10 ft							7
8								8
9								9
10								10
11	10 ft							11
	to							
12	15 ft							12
13								13
14								14
15		5.0	moist	15' - 20' : Tan fine to coarse sand, trace fine gravel, moist @ 20 ft				15
16	15 ft							16
	to							
17	20 ft							17
18								18
19								19
20			wet	20' - 26.5' : Tan/light brown fine to coarse sand, trace fine gravel, wet @ 21 ft				20
21	20 ft					▼		21
	to							
22	25 ft							22
23								23
24								24
25								25
26	25 ft		dry	26.5' - 38' : Light brown- orange fine to coarse sand, trace fine sand and fine gravel				26
	to							
27	30 ft							27
28								28
29								29
30								30
31	30 ft							31
	to							
32	35 ft							32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-2**
Date	Thursday, September 16, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 16, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38			dry	38' - 52' : Light brown-orange fine to coarse sand, little fine gravel, moderate oxidation				38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52			dry	52' - 52.5' : Tan-brown fine sand, mottled silt				52
			dry	52.5' - 56' : Tan/brown medium to coarse sand, some fine sand, mottled and oxidized				
53								53
54								54
55								55
56	55 ft to 60 ft		dry	56' - 58' : Mottled brown fine sand and silt, little medium sand, trace clay, non-plastic				56
57								57
58			dry	58' - 62' : Brown-slightly red fine to medium sand, little silt, trace coarse sand, slightly oxidized				58
59								59
60								60
61	60 ft to 65 ft							61
62			dry	62' - 63' : Brown-slightly red fine to medium sand, little silt, trace coarse sand, trace cly, non-plastic				62
63			dry	63' - 77' : Tan/light brown fine to coarse sand, trace fine gravel				63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-2**
Date	Thursday, September 16, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 16, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77			dry	77' - 86.5' : Brown fine to coarse sand, little fine gravel				77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft		dry	86.5' - 87' : 1" - 2" thik gray silt layer in this interval				86
87			dry	87' - 91' : Brown/gray medium to coarse sand and fine gravel, little fine sand, trace silt				87
88								88
89								89
90								90
91	90 ft to 95 ft		dry	91' - 92' : Red-brown (oxidized) fine to medium sand, some coarse sand, trace silt and fine gravel				91
92			dry	92' - 93' : Gray/tan silt and fine sand, some medium sand, trace coarse sand, weak (non-plastic)				92
93			dry	93' - 96' : Brown medium to coarse sand, some fine gravel and fine sand				93
94								94
95								95
96	95 ft to 100 ft		dry	96' - 100' : Gray silt and fine sand				96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-3**
Date	Wednesday, September 15, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, October 07, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' 8' : Topsoil and grass, then light brown fine to medium sand, some coarse sand, little fine gravel				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8		4.0	dry	8' - 18' : tan medium sand				8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18		1.0	dry	18' - 28' : tan to yellowish brown medium sand				18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28			dry	28' - 38' : Brown medium sand				28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-3**
Date	Wednesday, September 15, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, October 07, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft		dry	38' - 48' : Brown-Tan medium sand				36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42						▼		42
43								43
44								44
45								45
46	45 ft to 50 ft		dry	48' - 58' : Brown-yellowish brown medium sand				46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft		dry	58' - 68' : Brown medium sand				56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft		dry	68' - 78' : Brown fine to medium sand				66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-3**
Date	Wednesday, September 15, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, October 07, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78			dry	78' - 88' : medium silt and sand with clay layer				78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88			dry	88' - 94' : Medium red-brown sand with layers of clay and silt				88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94			dry	94' - 100' : Yellowish brown medium sand				94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Vac-Truck	***Boring Number:***	**BR-4**
Date	Wednesday, October 06, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, October 06, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 8' : Brown fine sand				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8			dry	8' - 12' : Dense gray silt and clay				8
9								9
10								10
11	10 ft to 15 ft		dry	12' - 18' : Medium to coarse brown and red sand				11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18			dry	18' - 28' : Medium to coarse brown sand with packed clay, gray				18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28			dry	28' - 38' : Medium to coarse sand, dense silt, coarse sand				28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Vac-Truck
Date	Wednesday, October 06, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Wednesday, October 06, 2021		

Boring Number:	**BR-4**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	100
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft		dry	38' - 42' : Fine to medium sand with gravel , brown to tan				36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft		dry	42' - 48' : Tan fine sand with dense silt				41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft		dry	48' - 58' : Brown medium to coarse sand				46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft					▼		51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft		dry	58' - 68' : Brown medium sand				56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft		dry	68' - 77' : Medium brown and red sand				66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Vac-Truck
Date	Wednesday, October 06, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Wednesday, October 06, 2021		

Boring Number:	**BR-4**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	100
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77			dry	77' 78' : Gray-brown dense silt				77
78			dry	78' - 85' : Gray-brown dense silt				78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85			dry	85' - 88' : Coarse sand and gravel				85
86	85 ft to 90 ft							86
87								87
88			dry	88' - 100' : Fine to medium sand				88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill
Date	Tuesday, August 31, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Saturday, October 02, 2021		

Boring Number:	**BR-5**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	100
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 5' : Very dense, hard-packed fine to medium silt, little medium sand, trace fine to coarse gravel				1
2			dry	5' - 6' : Brown-Light Orange dense fine to medium sand, some coarse sand, little fine gravel				2
3								3
4								4
5								5
6	5 ft to 10 ft		wet	6' - 10' : Brown/gray fine sand and silt, trace clay, medium sand, wet at 6 ft				6
7								7
8								8
9								9
10			dry dry	10' - 10.5' : Light brown fine to medium sand, little silt 10.5' - 15' : Gray clayey fine sand and silt, plastic, weak				10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15			dry	15' - 25' : Tan/light brown fine to coarse sand, little fine gravel, water at approximately 19 ft				15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22						▼		22
23								23
24								24
25			dry	25' - 27' : Gray clayey fine sand and silt, plastic, weak				25
26	25 ft to 30 ft							26
27			dry	27' - 31' : Tan/light brown fine to coarse sand, trace coarse gravel				27
28								28
29								29
30								30
31	30 ft to 35 ft		dry	31' - 36' : Gray clayey fine sand and silt, plastic, weak heavily oxidized for approximately 1 to 3 inches intervals				31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-5**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Saturday, October 02, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft		dry	36' - 46' : Tan/light brown fine to coarse sand, little fine gravel, very loose				36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft		dry	46' - 48' : Brown/ light gray fine sand and silt, mottled by oxidation (moderate)				46
47								47
48			dry	48' - 67' : Tan/light brown fine to coarse sand, trace coarse gravel, thin gray silt layer				48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67			dry	67' - 69' : Tan/light brown fine to coarse sand, trace coarse gravel				67
68								68
69			dry	69' - 69.5' : Tan/light brown fine to coarse sand, soft clayey gray silt				69
70			dry	70' - 77' : Tan/light brown fine to coarse sand, fine gravel				70

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**BR-5**	
Date	Tuesday, August 31, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Saturday, October 02, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77			dry	77' - 91' : Tan/light brown fine to coarse sand, trace coarse gravel				77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft		dry	91' - 99' : Gray fine sand, little silt, trace medium to coarse sand, medium dense to dense				91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99				99' 100' : Gray fine to coarse sand				99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-6**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Saturday, September 18, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft		dry	0 - 2.5' : Hard packed, dense tan fine to medium sand, trace coarse sand and fine gravel				1
2	to 6 ft		dry	2.5' - 6' : Very dense, hard-packed fine to medium silt, little medium sand, trace fine to coarse gravel				2
3								3
4								4
5								5
6	5 ft to		dry	6' - 23' : Brown/Gray silt, some fine sand, mottled with slight oxidationn, trace fine sand				6
7	10 ft							7
8								8
9								9
10								10
11	10 ft to							11
12	15 ft							12
13								13
14								14
15								15
16	15 ft to							16
17	20 ft							17
18								18
19								19
20								20
21	20 ft to							21
22	25 ft							22
23			dry	23' - 44' : Brown/tan fine to coarse sand, little fine gravel, wet at 40 ft				23
24								24
25								25
26	25 ft to							26
27	30 ft							27
28								28
29								29
30								30
31	30 ft to							31
32	35 ft							32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-6**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Saturday, September 18, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft					▼		41
42								42
43								43
44			dry	44' - 60' : Tan medium to coarse sand, little fine sand, trace fine to coarse gravel				44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60			dry	60' - 70.5' : Tan/light brown medium to coarse sand, some fine sand, trace fine gravel				60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70			dry	70.5' - 72' : Brown fine sand and silt, trace medium sand				70

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**BR-6**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Saturday, September 18, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft		dry	72' - 79' : Tan medium to coarse sand, little fine sand, trace fine to coarse gravel, mostly brown				71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79			dry	79' - 81.5' : Brown/tan medium sand, some fine to coarse sand, trace fine gravel				79
80								80
81	80 ft to 85 ft		dry	81.5' - 85' : Brown/light orange slightly oxidized medium to coarse sand, little fine sand and fine gravel, heavily-oxidized la				81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft		ry	85' - 89' : Brown fine to medium sand, little coarse sand, trace gravel				86
87								87
88								88
89			dry	89' - 95' : Brown/light orange slightly oxidized medium to coarse sand, little fine sand and fine				89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95			dry	95' - 100' : Brown/orange medium to coarse sand, some fine sand and gravel				95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**DU-1**	
Date	Monday, September 20, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Monday, September 20, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 7' : Brown -tan fine to coarse sand, little fine gravel and root fibers				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft		dry	7' - 24' : Brown-orange (slightly to moderately oxidized) fine to coarse sand, little fine gravel				6
7								7
8								8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22						▼		22
23								23
24			wet	24' - 40' : Tan medium to coarse sand, some fine sand, trace fine gravel, wet at 25 ft				24
25								25
26	25 ft to 30 ft							26
27								27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-1**
Date	Monday, September 20, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Monday, September 20, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40			dry	40' -42' : Brown/tan fine to medium sand, little coarse sand, trace fine gravel				40
41	40 ft to 45 ft							41
42			dry	42' - 45' : Brown-tan medium to coarse sand, some fine sand, trace fine gravel				42
43								43
44								44
45			dry	45' - 64' : brown-tan fine to medium sand, little coarse sand, trace fine gravel Brown mottled silt at 53' - 53.3'/ Brown mottled fine sand and silt at 57'- 58'				45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64			dry	64' - 67' : Light brown-tan mottled fine sand, some silt, little medium sand				64
65								65
66	65 ft to 70 ft							66
67			dry	67' - 72' : Tan medium to coarse sand, some fine sand, trace fine gravel				67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-1**
Date	Monday, September 20, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Monday, September 20, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft		dry	71' - 92' : Brown/tan fine to medium sand, little coarse sand, trace fine gravel, thin (<1.5") brown silt at 92 ft				71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft							91
92			dry	92' - 94' : Tan medium to coarse sand, some fine sand, trace fine gravel				92
93								93
94			dry	94' - 95.5' : Light brown-tan mottled fine sand, some silt, little medium sand				94
95			dry	95.5' - 96' : Brown mottled fine sand and silt				95
96	95 ft to 100 ft		dry	96' - 100' : Tan medium to coarse sand, some fine sand, trace fine gravel				96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drilling	***Boring Number:***	**DU-2**	
Date	Monday, September 20, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Monday, September 20, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 7' : Brown fine to coarse sand, some fine gravel, little roots				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7			dry	7' - 21' : Tan/brown fine to medium sand, some coarse sand, little fine gravel, slightly oxidized				7
8								8
9								9
10								10
11	10 ft to 15 ft					▼		11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft		dry	21' - 25' : Tan/light orange (slightly oxidized) medium to coarse sand, some fine sand, trace fine gravel thin brown silt layers a2 23' and 24'				21
22								22
23								23
24								24
25			dry	25' - 27' : Tan/brown fine to medium sand, some coarse sand, little fine gravel, slightly oxidized				25
26	25 ft to 30 ft							26
27			dry	27' -28' : Heavily oxidized brown fine sand and silt, very slightly plastic				27
28			dry	28' - 54' : Brown/ tan fine to medium sand, little coarse sand, trace fine gravel				28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drilling	***Boring Number:***	**DU-2**
Date	Monday, September 20, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Monday, September 20, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54			dry	54' - 60' : Brown silty fine sand, little medium sand				54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60			dry	60' - 62' : brown/tan silt and sand, trace medium sand, non-plastic				60
61	60 ft to 65 ft							61
62			dry	62' - 63.5' : Brown clayey silt, very plastic, trace fine sand				62
63			dry	63.5' - 64' : Oxidized moderately, fine sand				63
64			dry	64' - 65.5' : Brown clayey silt, very plastic, trace fine sand				64
65								65
66	65 ft to 70 ft		dry	66.5' - 68' : Mottled brown fine sand, little silt				66
67								67
68			dry	68' - 76' : tan/brown fine to emdium sand, little coarse sand				68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drilling	***Boring Number:***	**DU-2**
Date	Monday, September 20, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Monday, September 20, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft		dry	76' - 76.5' : rown clayey silt, very plastic, trace fine sand				76
			dry	76.5' - 78' : Brown fine sand, some silt, heavily oxidized, 2 " to 3 " thick clayey silt layer				
77								77
78			dry	78' - 85' : Tan fine to coarse sand, trace silt				78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85			dry	85' - 88' : brown/tan fine to medium sand, some coarse sand, trace silt				85
86	85 ft to 90 ft							86
87								87
88			dry	88' - 100' : Dark orange/brown medium to coarse sand, little fine sand, moderate to heavy oxidation				88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**DU-3**	
Date	Tuesday, August 31, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Wednesday, May 01, 2019		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 6' : Brown, loose to medium dense fine to coarse sand, little fine gravel, trace coarse gravel A note from 9/21/21: 0' - 10' : No sample collected due to multiple utilities nearby				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8								8
9								9
10			dry	10' - 18' : Brown-tan fine to coarse sand, little fine gravel				10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18			dry	18' - 50' : Brown-tan fine to coarse sand, little fine gravel, mottled , wet at 30 ft, trace large gravel from 40 ft				18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**DU-3**	
Date	Tuesday, August 31, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Wednesday, May 01, 2019		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft					▼		36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50			dry	50' - 54' : Brown-light tan fine to medium sand, mottled, trace coarse sand and fine gravel				50
51	50 ft to 55 ft							51
52								52
53								53
54			dry	54' - 60' : Brown fine to coarse sand, little fine gravel, trace coarse gravel				54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68			dry	68' - 70' : Brown-light tan fine to medium sand, mottled, trace coarse sand, 0.5" brown silt at 70 ft				68
69								69
70			dry	70' - 83' : Brown-tan fine to medium sand, little coarse sand, trace fine gravel				70

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-3**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, May 01, 2019			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83			dry	83' - 87.5' : Brown fine sand and silt, heavy oxidation for 84 ft to bottom				83
84								84
85								85
86	85 ft to 90 ft							86
87			dry	87.5' - 88' : Brown -orange medium to coarse sand				87
88			dry	88' - 94.5' : Brown fine sand and silt, mottled, Brown thin clayey silt layers, moderate to heavy oxidation observed at 92 ft to 94.5 ft				88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94			dry	94.5' - 100' : Brown fine sand, little silt, trace medium sand, moderate oxidation				94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-4**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, September 22, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 2' : Tan fine to medium sand, little coarse sand, fine gravel, trace coarse gravel, medium dense gravel				1
2				2' - 6' : Brown, dense fine to coarse sand, fine gravel, little coarse gravel, trace silt				2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8			dry	8' - 38' : Brown fine to coarse sand, some fine gravel, trace coarse gravel				8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-4**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, September 22, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37						▼		37
38			dry	38' - 52' : Light brown-tan (slightly oxidized) fine to medium sand, little coarse sand, trace fine gravel, wet at 39 ft				38
39				(50' - 51' : Brown fine sand and silt, trace clay, mottled)				39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52			dry	52' - 55' : Brown fine sand and silt, trace clay, mottled, moderately oxidized				52
53								53
54								54
55								55
56	55 ft to 60 ft		dry	55' - 60' : Tan medium to fine sand, little coarse sand, trace fine gravel				56
57								57
58								58
59								59
60			dry	60' - 62' : Light brown-tan fine to medium sand, little coarse sand, trace fine gravel,				60
61	60 ft to 65 ft							61
62			dry	62' - 66' : Brown silty fine sand, mottled				62
63								63
64								64
65								65
66	65 ft to 70 ft		dry	66' - 67' : Light brown-tan fine to medium sand, little coarse sand, trace fine gravel				66
67			dry	67' - 76' : Brown fine sand, some silt, mottled				67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-4**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, September 22, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft		dry	76' - 89' : Brown fine to medium sand, trace coarse sand and fine gravel				76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89			dry	89' - 96' : Brown fine sand, some silt, little medium sand				89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft		dry	96' - 100' : Dark brown-brown medium sand, little fine to coarse sand, trace fine gravel (97.5' - 98' : brown clayey silt)				96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**DU-5**	
Date	Tuesday, August 31, 2021		*Sheet:*	of	
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Thursday, September 23, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 3' : Brown, medium dense to dense, fine to coarse sand, little fine gravel, trace coarse gravel				1
2			dry	3' - 6' : Brown, loose to medium dense, fine to coarse sand, little fine gravel, trace coarse gravel				2
3								3
4								4
5								5
6	5 ft to 10 ft		dry	6' - 10' : Tan-light orange fine to medium sand, some coarse sand and fine gravel				6
7								7
8								8
9								9
10			dry	10' - 27' : Brown-tan-light orange mottled fine to coarse sand, some fine gravel, wet at 20 ft (1/8 " oxidized layer)				10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19						▼		19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27			dry	27' - 38' : Brown medium to coarse sand, some fine gravel, little fine sand and coarse gravel, moderately oxidized from 26.5' to 27.5'				27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**DU-5**	
Date	Tuesday, August 31, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Thursday, September 23, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38			dry	38' - 39' : Brown fine to medium sand, little coarse sand, trace fine gravel				38
39			dry	39' - 47.5' : Brown medium to coarse sand, some fine gravel, little fine sand and coarse gravel, medium to heavy oxidation				39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47			ry	47.5' - 50' : Brown fine to medium sand, little coarse sand, trace fine gravel				47
48								48
49								49
50			dry	50' - 55' : Brown silty fine sand, little medium sand				50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55			ry	55' - 60' : Brown fine to medium sand,, little coarse sand, trace fine gravel				55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60			dry	60' - 78' : Brown-tan medium to coarse sand, little fine sand, trace fine gravel (71.5' - 73.5' and 75.5' - 76' : Brown fine sand, some silt, trace medium sand)				60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-5**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 23, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78			dry	78' - 90' : Light brown fine sand, some silt, little medium sand, trace coarse sand				78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89								89
90			dry	90' - 100' : Brown/ light orange medium to coarse sand, some fine sand, trace silt and fnie gravel				90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill
Date	Tuesday, August 31, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Thursday, September 23, 2021		

Boring Number:	**DU-6**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	100
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft		dry	0' - 6' : Brown/tan medium to coarse sand, little fine sand, some fine gravel, trace coarse gravvel, cobble medium sende				1
2	to 6 ft							2
3								3
4								4
5								5
6	5 ft		dry	5' - 10' : Tan/light gray fine silty sand, little medium sand and coarse sand, Trace fine gravel, wet at 6 ft				6
7	to 10 ft							7
8								8
9								9
10			dry	10' - 30' : Brown/ light orange fine to medium sand, some coarse sand, little fine to coarse gravel (slight to moderate oxidized)				10
11	10 ft							11
12	to 15 ft							12
13								13
14								14
15								15
16	15 ft							16
17	to 20 ft							17
18						▼		18
19								19
20								20
21	20 ft							21
22	to 25 ft							22
23								23
24								24
25								25
26	25 ft							26
27	to 30 ft							27
28								28
29								29
30			dry dry	30' - 30.5' : Brown fine sand, some medium sand, trace coarse sand 30.5' - 46' : Brown/tan fine to coarse sand, little fine gravel				30
31	30 ft							31
32	to 35 ft							32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**DU-6**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 23, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40			dry	46' - 54' : Brown/tan fine to medium sand, some coarse sand, trace fine to coarse gravel, moderate oxidation				40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54			dry	54' - 74' : Brown-tan fine to medium sand, some coarse sand, little fine to coarse gravel				54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**DU-6**	
Date	Tuesday, August 31, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	100	
Date	Thursday, September 23, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft		ry	76' - 77' : Brown medium sand, some fine sand, trace coarse sand and fine gravel				76
77			dry	77' - 78' : Brown-tan fine sand, mottled, little silt				77
78			dry	78' - 83' : Brown-tan fine to medium sand, some coarse sand, little fine to coarse gravel				78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83			dry	83' - 100' : Brown fine to very fine sand, some silt, trace medium sand, clayey silt at 83.5 ft				83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**NA-1**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 30, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 6' : loose tan/light brown medium sand, little fine to coarse sand, trace fine gravel				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft		dry	6' - 46' : Tan fine sand, little medium sand, trace coarse sand and fine gravel				6
7								7
8								8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**NA-1**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 30, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft		drdy	46' - 58' : Brown-tan fine sand, some silt, little medium sand, trace coarse sand (54.75' to 55' and 55.5' to 56' : Gray-brown mottled sandy silt, dense)				46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58			dry	58' - 67' : Tan-light orange medium to coarse sand, some fine gravel, little fine sand, wet at 66 ft				58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64						▼		64
65								65
66	65 ft to 70 ft							66
67			dry	67' - 67.5' : Dense brown, slightly oxidized silt, some fine sand, little medium sand, trace gravel and cobble				67
68			dry	67.5' - 89' : Tan-light brown medium to coarse sand, trace fine gravel				68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**NA-1**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Thursday, September 30, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89			dry	89' - 92' : Brown very dense silt, little fine sand, trace clay, non plastic				89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonid Drill
Date	Wednesday, September 01, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Friday, October 01, 2021		

Boring Number:	**NA-2**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	100
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 6' : Tan fine to medium sand, trace fine to coarse gravel, cobble, little coarse sand				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft		dry	6' - 11' : Tan medium sand, some fine sand, trace coarse sand, wet at 10 ft		▼		6
7								7
8								8
9								9
10								10
11	10 ft to		dry	11' - 12' : Brown-dark orange coarse sand, some medium sand, trace fine sand				11
12	15 ft		dry	12' - 26' : Brown fine to medium sand, little coarse sand, trace fine gravel				12
13								13
14								14
15								15
16	15 ft to							16
17	20 ft							17
18								18
19								19
20								20
21	20 ft to							21
22	25 ft							22
23								23
24								24
25								25
26	25 ft to		dry dry	26' - 26.5' : Brown fine sand, little medium sand, trace coarse sand 26.5' - 55' : Dark brown medium to coarse sand, little fine sand and fine gravel (trace coarse gravel 50' - 55')				26
27	30 ft			(Dark brown coarse sand and fine gravel, some medium sand 53' - 55')				27
28								28
29								29
30								30
31	30 ft to							31
32	35 ft							32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonid Drill	***Boring Number:***	**NA-2**
Date	Wednesday, September 01, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Friday, October 01, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft		dry dry	55' - 56.5' : Dense brown-tan silt, some fine sand, mottled, ends on heavily oxidized 56.5' - 66.5' : Tan fine to medium sand, little coarse sand (57' - 57.5' : Brown fine sand-------65' - 66.5' : Heavy oxidation)				56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft		dry dry	66.5' - 67' : Brown fine sand and silt, dense 67' - 89' : Brown fine sand, some silt, little medium sand, trace coarse sand and fine gravel (67' - 73' : Slightly oxidized)				66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM
9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonid Drill	***Boring Number:***	**NA-2**
Date	Wednesday, September 01, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Friday, October 01, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89			dry	89' - 89.3' : Brown silt and clay, very plastic				89
90			dry	89.3' - 100' : Brown mottled fine sand and silt, dense				90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**PS-1**	
Date	Friday, September 24, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	58	
Date	Friday, September 24, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description				Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 8' : Tan fine to medium sand, little coarse sand, trace fine gravel				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8			dry	8' - 15' : Tan fine to medium sand, little coarse sand, trace fine gravel				8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15			dry	15' - 17' : Brown-light gray fine sand and silt, trace medium to coarse sand and gravel				15
16	15 ft to 20 ft							16
17			dry	17' - 23.5' : Brown fine to coarse sand, little fine gravel, trace coarse gravel, wet @ 23 ft				17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23			dry	23.5' - 26' : Tan fine to medium sand, little coarse sand and fine gravel				23
24								24
25								25
26	25 ft to 30 ft		dry	26' - 28' : Brown-gray fine sand and silt, little medium to coarse sand, trace fine gravel, very dense				26
27								27
28			dry	28' - 47' : Brown medium to coarse sand, some fine sand and gravel, trace coarse gravel and cobble				28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**PS-1**
Date	Friday, September 24, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	58
Date	Friday, September 24, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description				Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft		dry	47' - 56' : Brown fine sand, little medium sand, trace coarse sand and gravel				46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft		dry	56' - 57.5' : Brown silt, dense, trace fine sand				56
57			dry	57.5' - 58' : Gray, very dense clay, plastic				57
58				---------- End of Boring at 58' ----------				58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill
Date	Friday, September 24, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Friday, September 24, 2021		

Boring Number:	**PS-1**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	58
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description				Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100								100
101	100 ft to 105 ft							101
102								102
103								103
104								104
105								105

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**PS-2**
Date	Friday, September 24, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	58
Date	Friday, September 24, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description				Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 19' : Tan fine to medium sand, trace coarse sand and fine gravel				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8								8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19			dry	19' - 20' : Brown-gray fine sand, little medium sand, trace fine to coarse gravel				19
20			dry	20' - 24' : Gray-brown fine sand and silt, trace medium to coarse sand and gravel, wet @ 23 ft				20
21	20 ft to 25 ft							21
22								22
23								23
24			dry	24' - 26' : Brown fine to coarse sand, little fine gravel, trace coarse gravel				24
25								25
26	25 ft to 30 ft		dry	26' - 28' : Brown-light gray fine sand and silt, little medium to coarse sand, trace fine gravel, dense				26
27								27
28			dry	28' - 30' : Brown (slightly oxidized) medium to coarse sand, some fine sand and gravel				28
29								29
30			dry	30' - 34' : Very dense brown silt, some fine sand, trace medium to coarse sand, gray clay				30
31	30 ft to 35 ft							31
32								32
33								33
34			dry	34' - 37' : Heavily oxidized orange-red fine to medium sand, little coarse sand, trace fine gravel				34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**PS-2**
Date	Friday, September 24, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	58
Date	Friday, September 24, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description				Depth
36	35 ft to 40 ft		ry	37' - 49' : Brown medium to coarse sand, some fine gravel, loose (47' to 48' : Gray fine to medium sand)				36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49			dry	49' - 57' : Brown fine sand, little medium sand, trace coarse sand and gravel, gray clay at 57 ft (3" to 4")				49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft		dry	57' - 58' : Brown-orange moderately oxidized fine to medium sand, trace coarse sand				56
57								57
58				---------- End of Boring at 58' ----------				58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**PS-2**
Date	Friday, September 24, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	58
Date	Friday, September 24, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description				Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100								100
101	100 ft to 105 ft							101
102								102
103								103
104								104
105								105

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**RI-1**
Date	Tuesday, August 31, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	105
Date	Thursday, September 30, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry	0' - 6' : Fine to medium sand, tan				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft		dry	7' - 46' : Tan-light brown fine sand, little medium sand, trace coarse sand				6
7								7
8								8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:* Tom Parece	AECOM 9 Jonathan Bourne Drive Pocasset, Massachusetts (508)-833-6950
Client:	Town of Orleans, MA	*Field Tech(s):* CH/MO/DD	
Site Location:	Route 6A Orleans, MA		

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:* Sonic Drill	***Boring Number:***	**RI-1**	
Date	Tuesday, August 31, 2021		*Sheet:*		of
			Surface Elevation (ft-asl):	TBD	
Drill Contractor:	Redox Tech, LLC	*Equipment:* Geoprobe 8150LS	Boring Depth (ft):	105	
Date	Thursday, September 30, 2021		*Inside Diameter (inches):*	2	
			Screen Depth:	N/A	
			Screen Length:	N/A	

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40			dry	46' - 50' : Tan-light brown fine to medium sand, trace coarse sand				40
41	40 ft to 45 ft							41
42								42
43								43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50			dry	50' - 52' : Tan-light brown fine sand, little medium sand, trace coarse sand				50
51	50 ft to 55 ft							51
52			dry dry	52' - 52.5' : Brown, mottled dense fine sand and silt 52.5' - 54' : Loose tan fine sand				52
53								53
54			dry	54' - 58' : Loose tan fine sand				54
55								55
56	55 ft to 60 ft							56
57								57
58			dry	58' - 67' : Light brown fine sand, little silt, trace medium to coarse sand				58
59								59
60								60
61	60 ft to 65 ft							61
62								62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67			dry	67' - 76' : Brown-light brown fine sand, trace medium to coarse sand and silt				67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill
Date	Tuesday, August 31, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Thursday, September 30, 2021		

Boring Number:	**RI-1**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	105
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft		dry	76' - 94' : Dense brown-light gray silt, some fine sand, trace medium to coarse sand (93' - 93.5' : Medium sand, little fine sand)				76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft					▼		86
87								87
88								88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94			dry	94' - 94.5' : Tan fine to medium sand, trace coarse sand and silt				94
95			dry	94.5' - 99' : Very dense light gray-brown mottled silt, trace fine to coarse sand (96.5' - 97.5' : Fine to coarse sand)				95
96	95 ft to 100 ft							96
97								97
98								98
99			dry	99' - 105' : Light brown-tan medium to coarse sand, little fine sand, wet at 93 ft				99
100								100
101	100 ft to 105 ft							101
102								102
103								103
104								104
105				---------- End of Boring at 105' ----------				105

Project Number:	60476644	*Project Manager:*	Tom Parece
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD
Site Location:	Route 6A Orleans, MA		

AECOM

9 Jonathan Bourne Drive
Pocasset, Massachusetts
(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill
Date	Saturday, September 25, 2021		
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS
Date	Saturday, September 25, 2021		

Boring Number:	**RI-2**
Sheet:	of
Surface Elevation (ft-asl):	TBD
Boring Depth (ft):	100
Inside Diameter (inches):	2
Screen Depth:	N/A
Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear		dry	0' - 0.5' : Dark brown topsoil and grass				1
2	0 ft to 6 ft		dry	0.5' -22' : Tan-brown fine to medium sand, some coarse sand, little fine gravel, trace coarse gravel				2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8								8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22			dry	22'-26' : Brown mottled silty fine sand, little medium sand, slightly oxidized				22
23								23
24								24
25								25
26	25 ft to 30 ft		dry	26' - 28' : Heavily oxidized orange fine to medium sand, some silt				26
27								27
28			dry	28' - 32' : Brown fine to medium sand , little coarse sand and silt, trace fine gravel, wet at 29.5 ft				28
29						▼		29
30								30
31	30 ft to 35 ft							31
32			dry	32' 44' : Brown-tan medium to coarse sand, some fine gravel, little fine sand, trace coarse gravel				32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**RI-2**
Date	Saturday, September 25, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Saturday, September 25, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42								42
43								43
44			dry	44' - 60' : Tan fine to medium sand, little coarse sand, trace fine to coarse gravel and cobble (cobble at 55 ft)				44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62				60 - 63 Brown Fine Sand and Silt,Little medium to coarse Sand, 1" layer stiff plastic clay. @ 60 ft.				62
63								63
64								64
65								65
66	65 ft to 70 ft							66
67				63 - 88" Dark Grey Fine Sand and Silt, very dense, trace medium to coarse sand (72 to 75'), transitions to brown in color.				67
68								68
69								69
70								70

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**RI-2**
Date	Saturday, September 25, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Saturday, September 25, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78								78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87								87
88								88
89				---------- End of Boring at 88' ----------				89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100								100

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**RI-3**
Date	Wednesday, September 29, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, September 29, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
1	Pre-Clear 0 ft to 6 ft		dry dry	0' - 1.5' : topsoil 1.5' - 42' : Tan fine to medium sand, trace coarse sand and fine gravel, wet @ 41 ft				1
2								2
3								3
4								4
5								5
6	5 ft to 10 ft							6
7								7
8								8
9								9
10								10
11	10 ft to 15 ft							11
12								12
13								13
14								14
15								15
16	15 ft to 20 ft							16
17								17
18								18
19								19
20								20
21	20 ft to 25 ft							21
22								22
23								23
24								24
25								25
26	25 ft to 30 ft							26
27								27
28								28
29								29
30								30
31	30 ft to 35 ft							31
32								32
33								33
34								34
35								35

Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**RI-3**
Date	Wednesday, September 29, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, September 29, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
36	35 ft to 40 ft							36
37								37
38								38
39								39
40								40
41	40 ft to 45 ft							41
42			dry	42' - 64' : Tan-light brown fine to coarse sand, trace silt and fine gravel (1/2" gray fine sand and silt at 47 ft)				42
43				(Brown fine to medium sand, little coarse sand 61' - 61.5')				43
44								44
45								45
46	45 ft to 50 ft							46
47								47
48								48
49								49
50								50
51	50 ft to 55 ft							51
52								52
53								53
54								54
55								55
56	55 ft to 60 ft							56
57								57
58								58
59								59
60								60
61	60 ft to 65 ft							61
62						▼		62
63								63
64			dry	64' - 65' : Brown fine to medium sand, little coarse sand				64
65			dry	65' - 78' : Tan-light brown fine to coarse sand, trace silt and fine gravel				65
66	65 ft to 70 ft							66
67								67
68								68
69								69
70								70

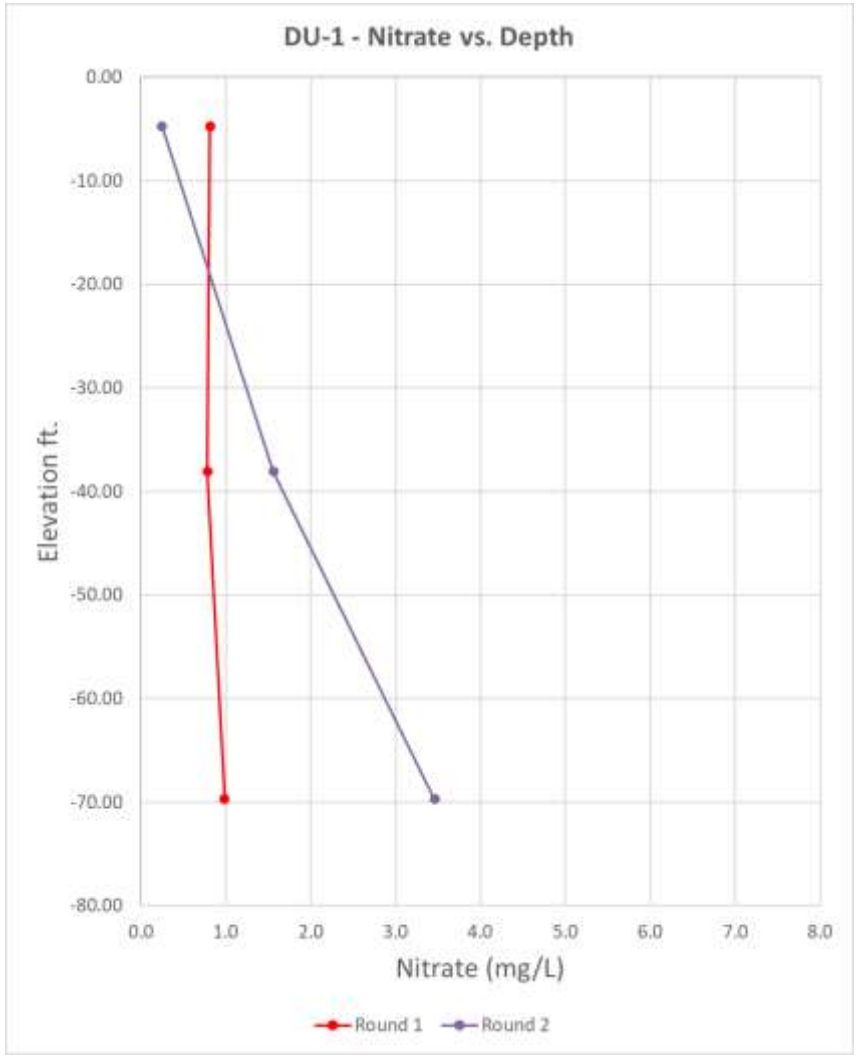
Project Number:	60476644	*Project Manager:*	Tom Parece	AECOM	9 Jonathan Bourne Drive
Client:	Town of Orleans, MA	*Field Tech(s):*	CH/MO/DD		Pocasset, Massachusetts
Site Location:	Route 6A Orleans, MA				(508)-833-6950

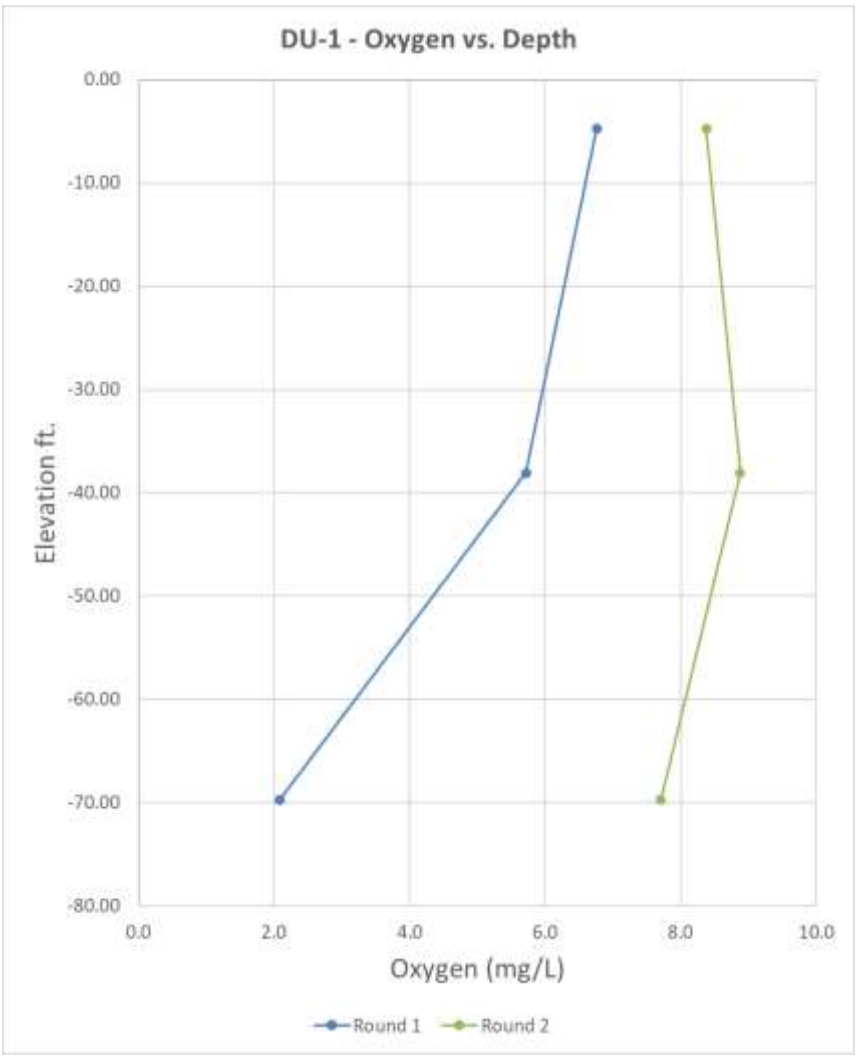
Pre-Clear Contractor:	Subsurface Exploration Services, LLC	*Equipment:*	Sonic Drill	***Boring Number:***	**RI-3**
Date	Wednesday, September 29, 2021			*Sheet:*	of
				Surface Elevation (ft-asl):	TBD
Drill Contractor:	Redox Tech, LLC	*Equipment:*	Geoprobe 8150LS	Boring Depth (ft):	100
Date	Wednesday, September 29, 2021			*Inside Diameter (inches):*	2
				Screen Depth:	N/A
				Screen Length:	N/A

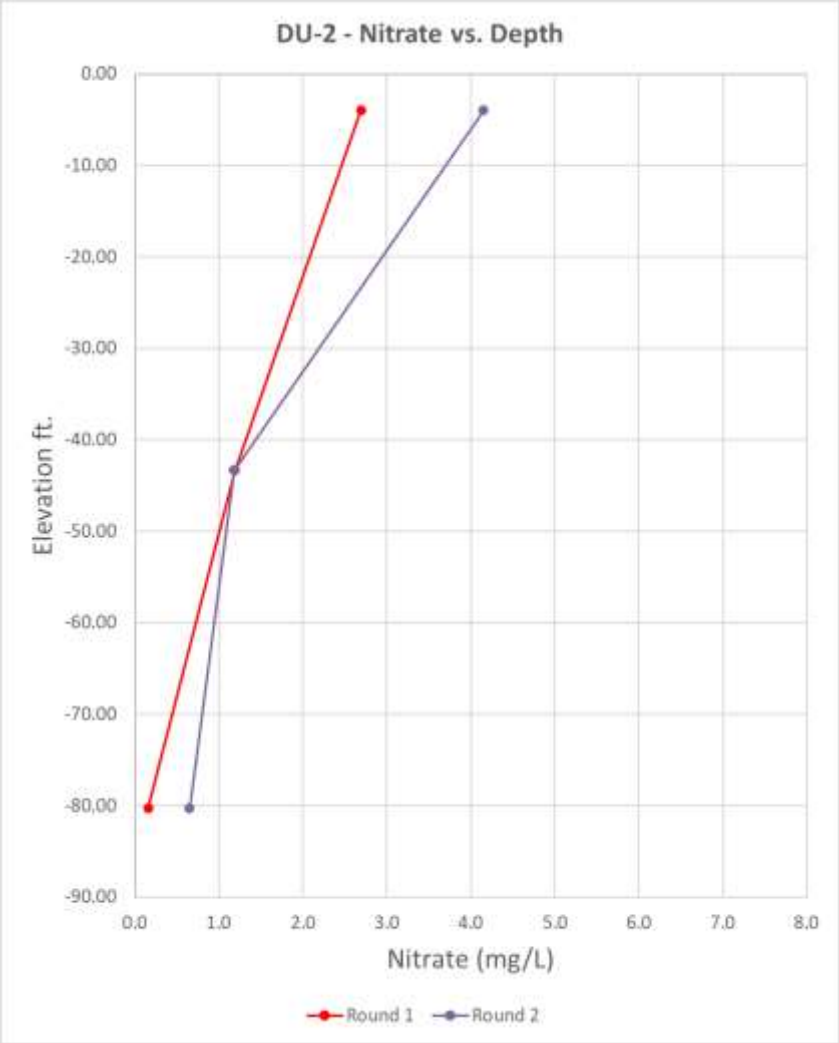
Depth	Sample Interval	Rec (ft)	Moisture	Field Identification / Description	Shallow	Interm.	Deep	Depth
71	70 ft to 75 ft							71
72								72
73								73
74								74
75								75
76	75 ft to 80 ft							76
77								77
78			dry	78' - 87' : Brown fine sand, some medium sand, trace coarse sand, little silt				78
79								79
80								80
81	80 ft to 85 ft							81
82								82
83								83
84								84
85								85
86	85 ft to 90 ft							86
87			ry	87' - 100' : Brown very fine to fine sand, little to some silt, fine to medium sand				87
88								88
89								89
90								90
91	90 ft to 95 ft							91
92								92
93								93
94								94
95								95
96	95 ft to 100 ft							96
97								97
98								98
99								99
100				---------- End of Boring at 100' ----------				100

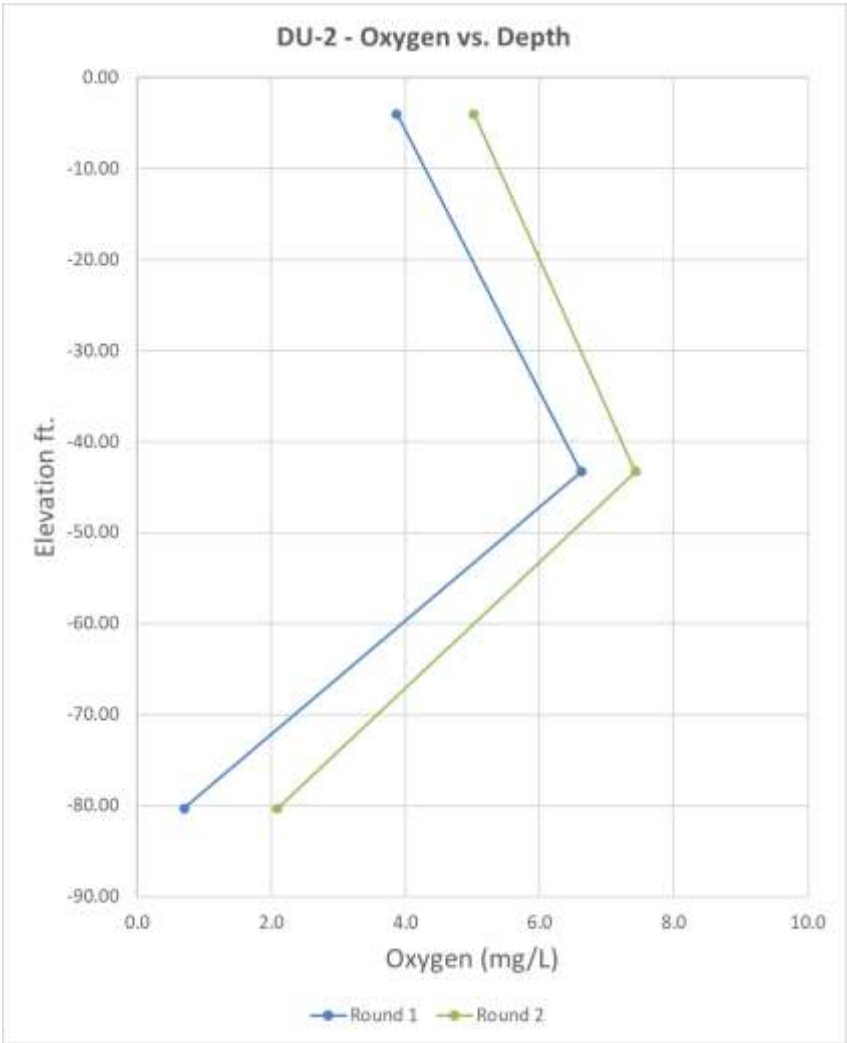
Appendix D: Charts

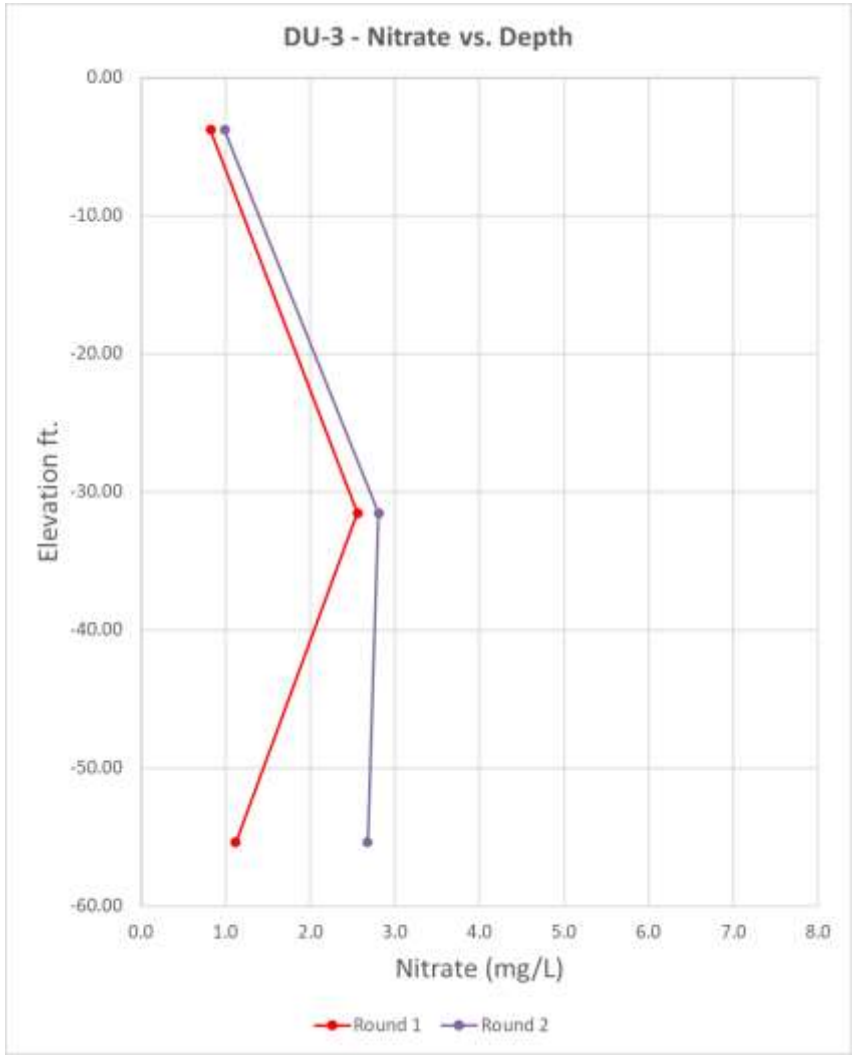
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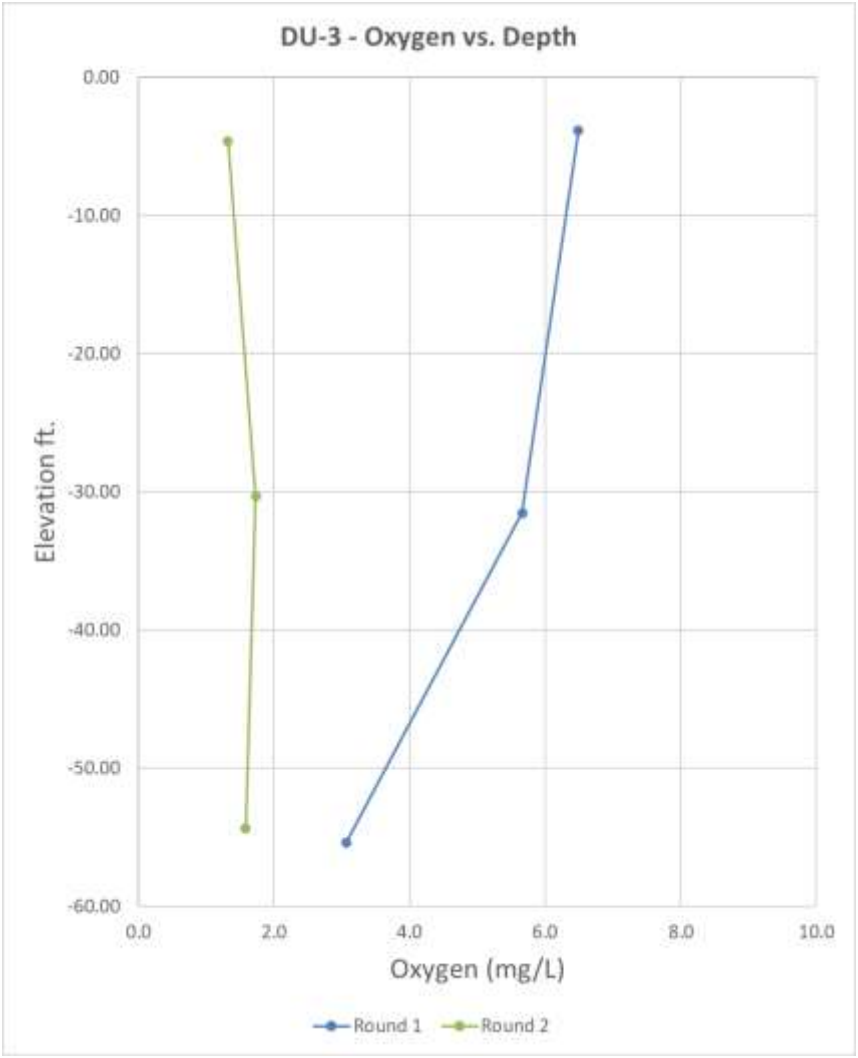

DU-1 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

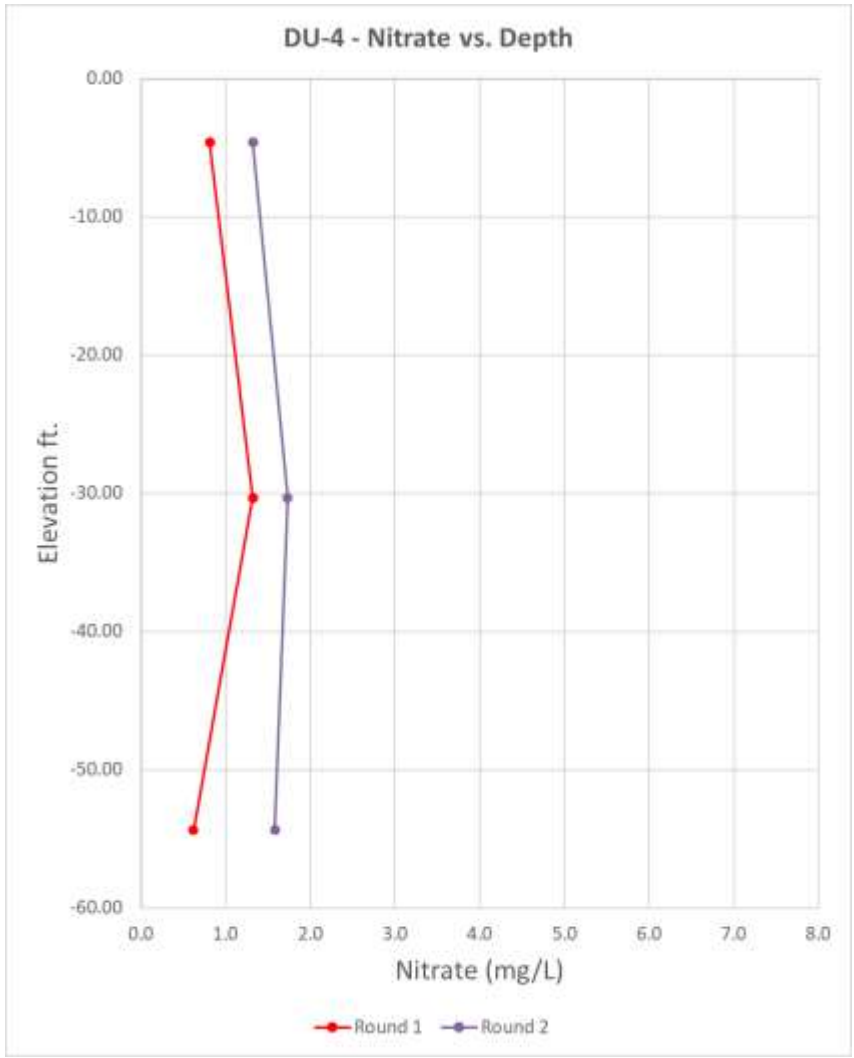

DU-1 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

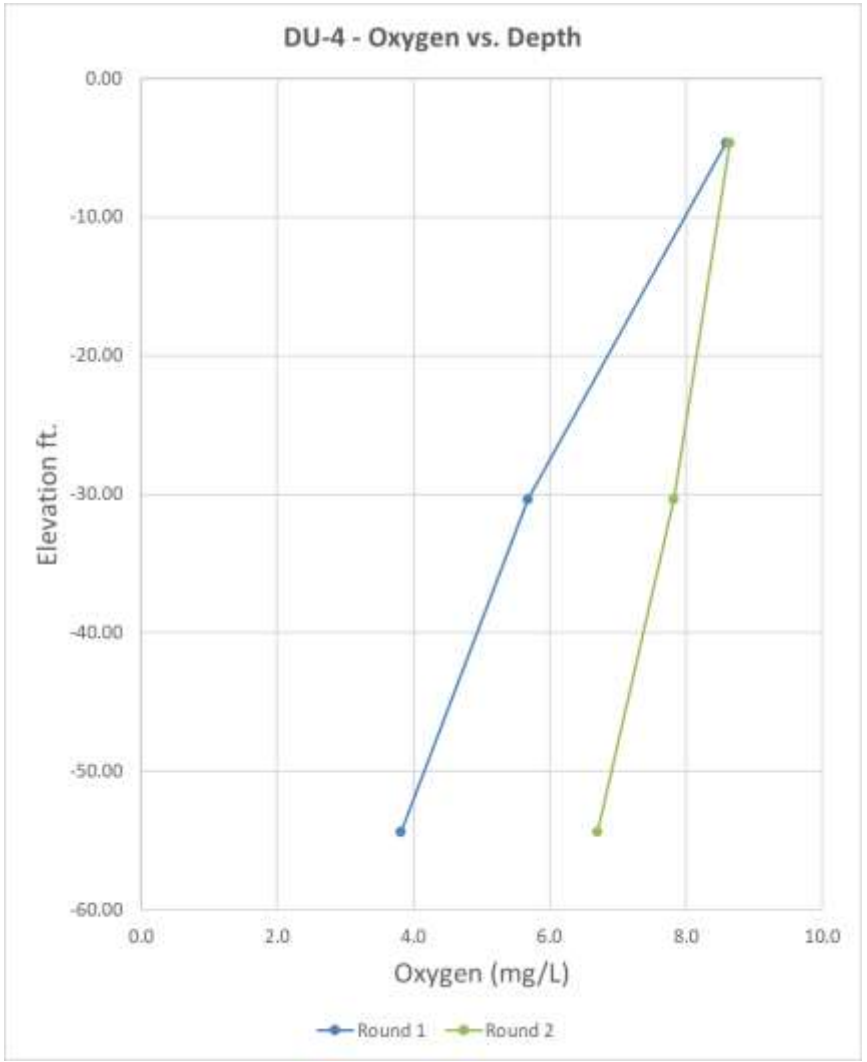

DU-2 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
-90.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

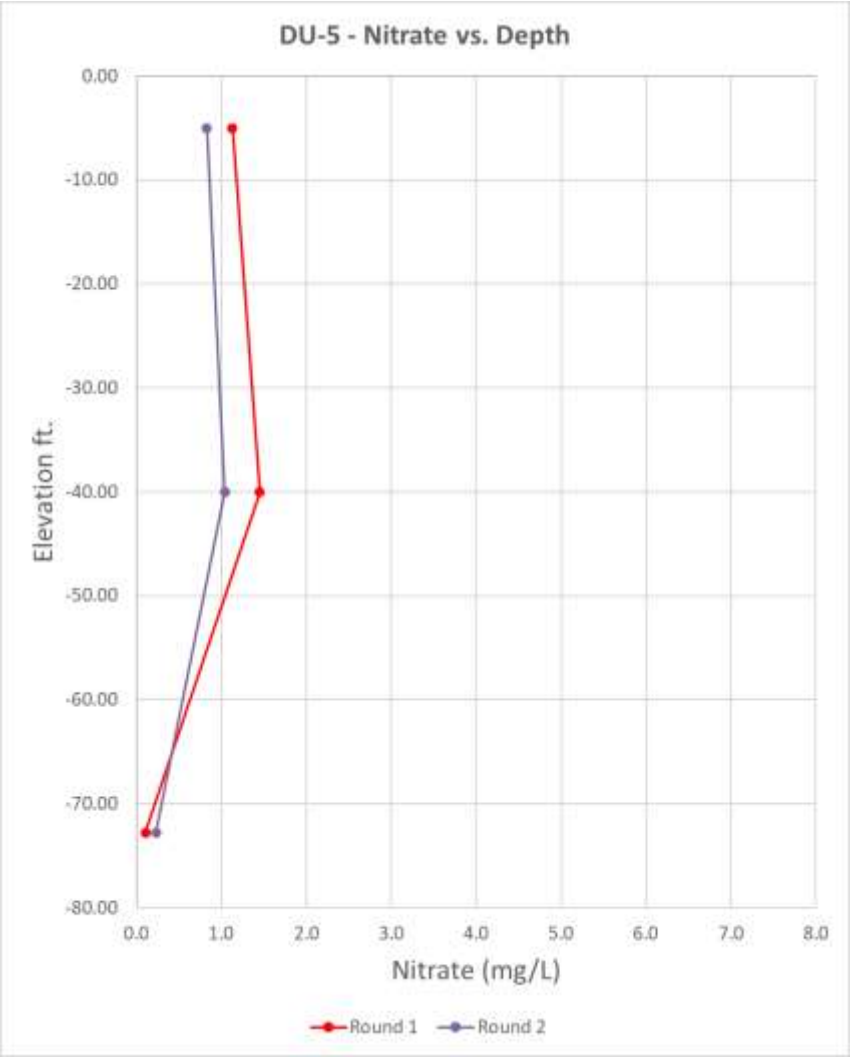

DU-2 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
-90.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

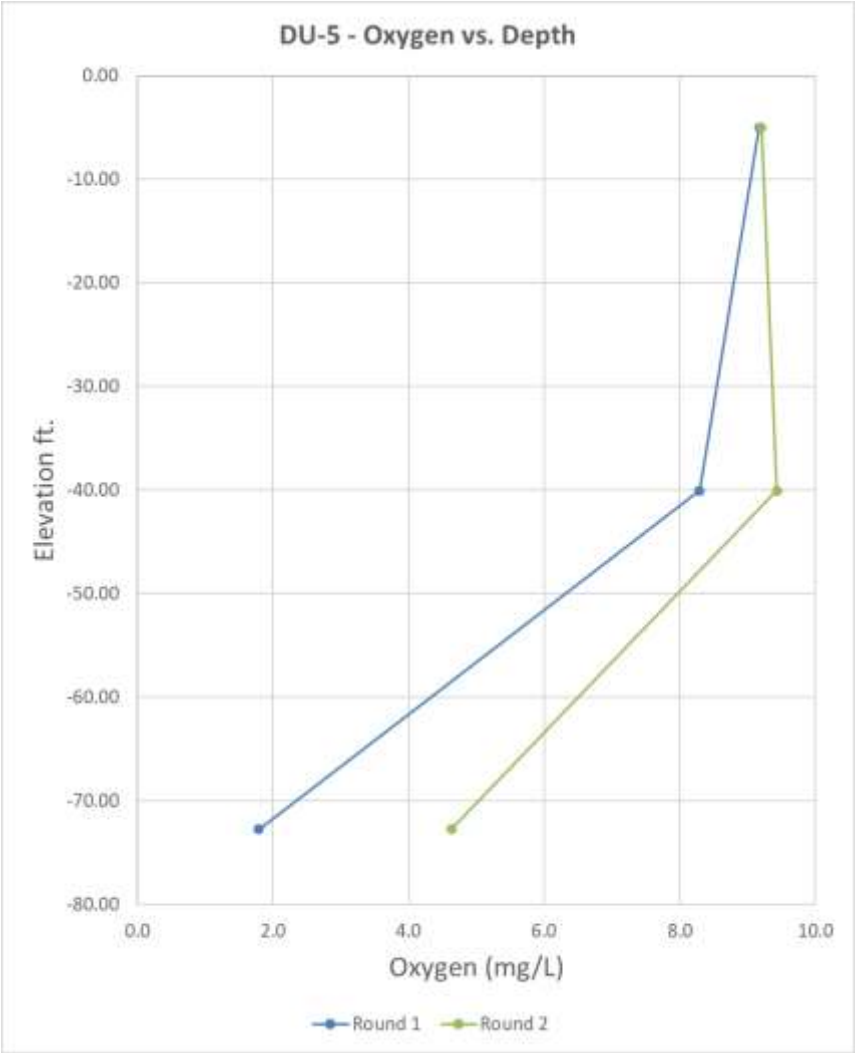

DU-3 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

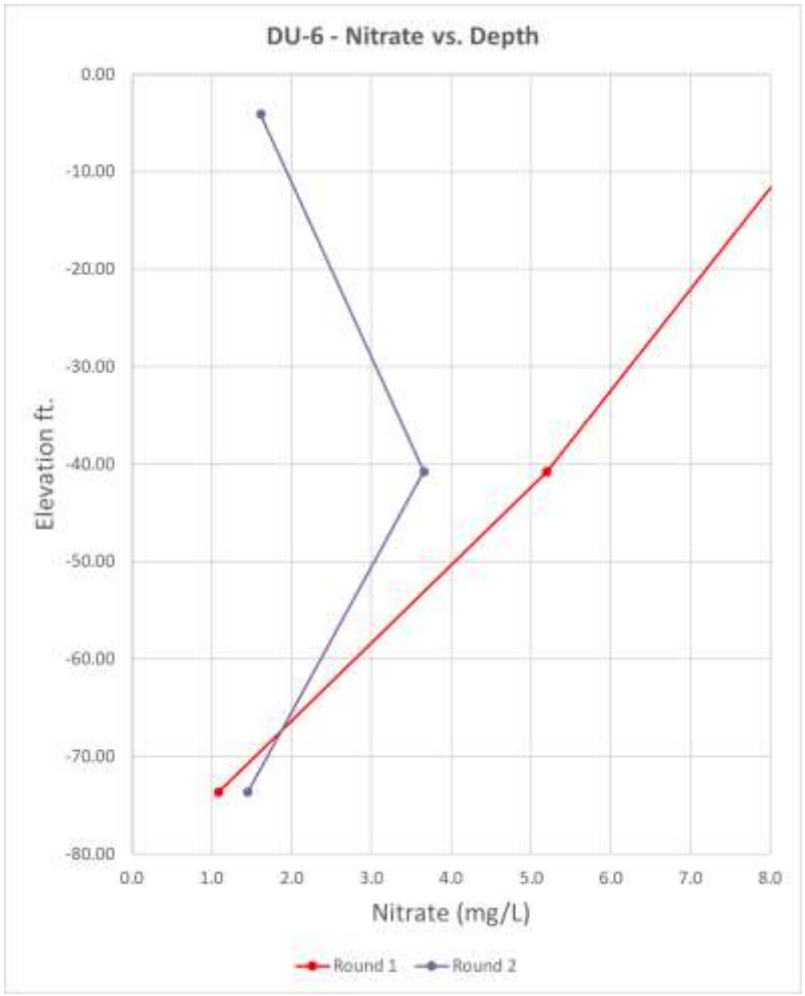

DU-3 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

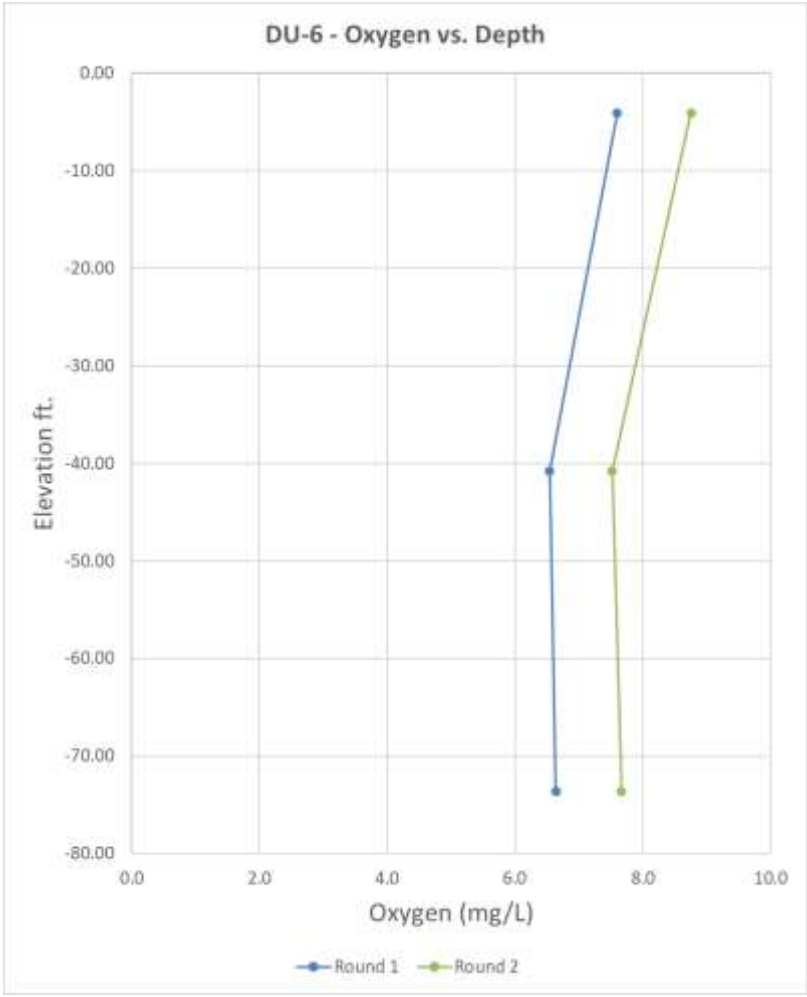

DU-4 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

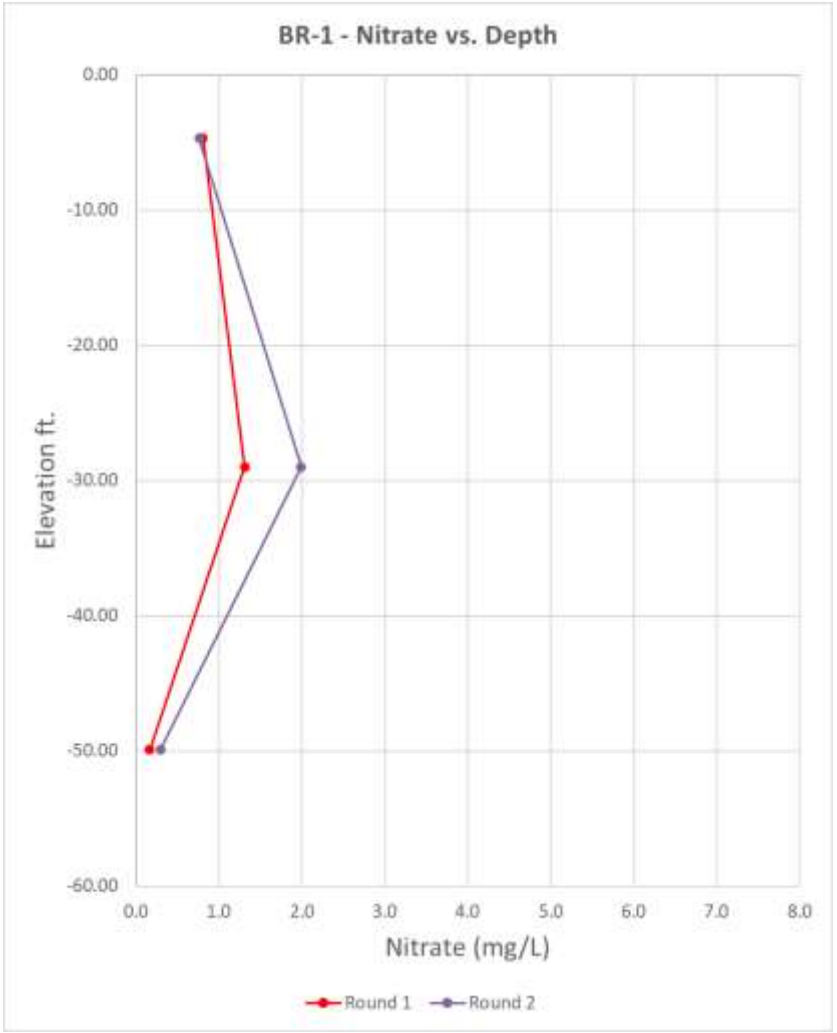

DU-4 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

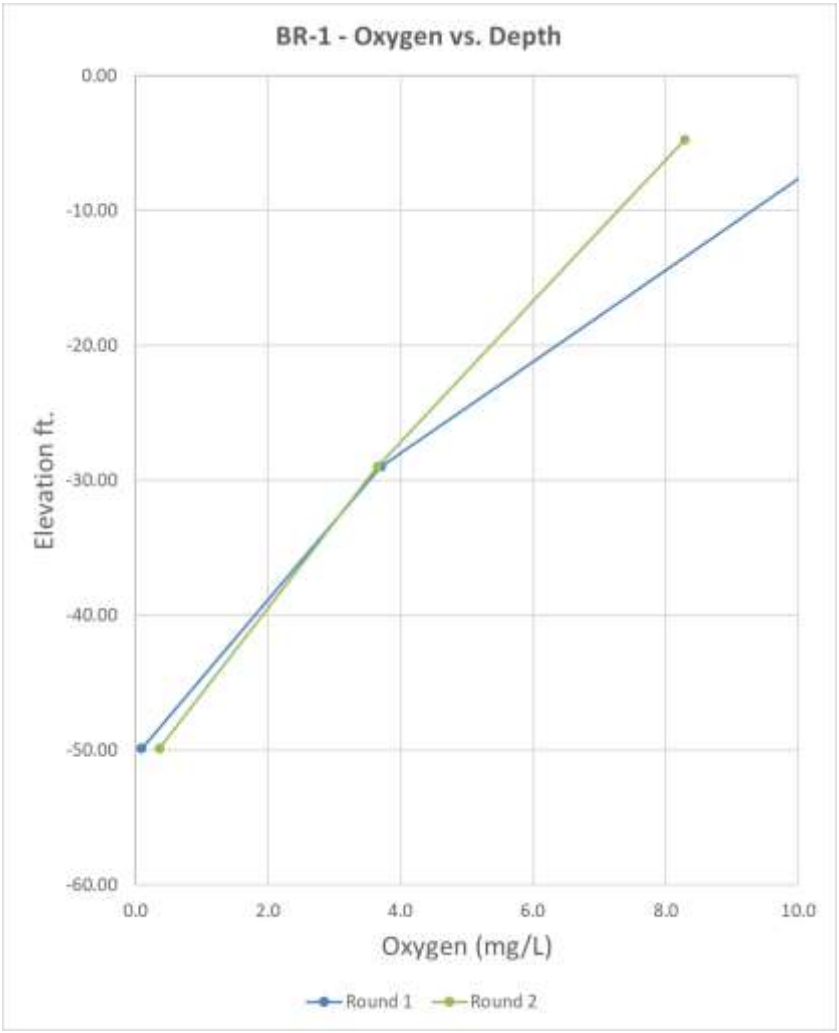

DU-5 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

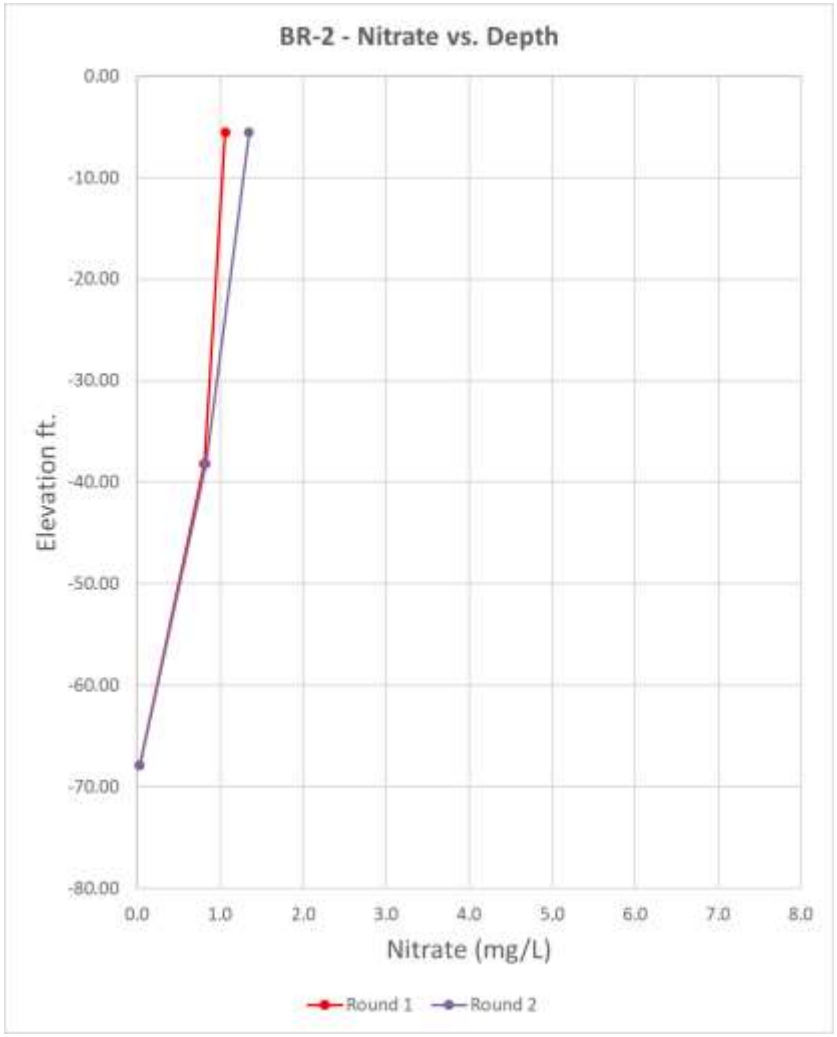

DU-5 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

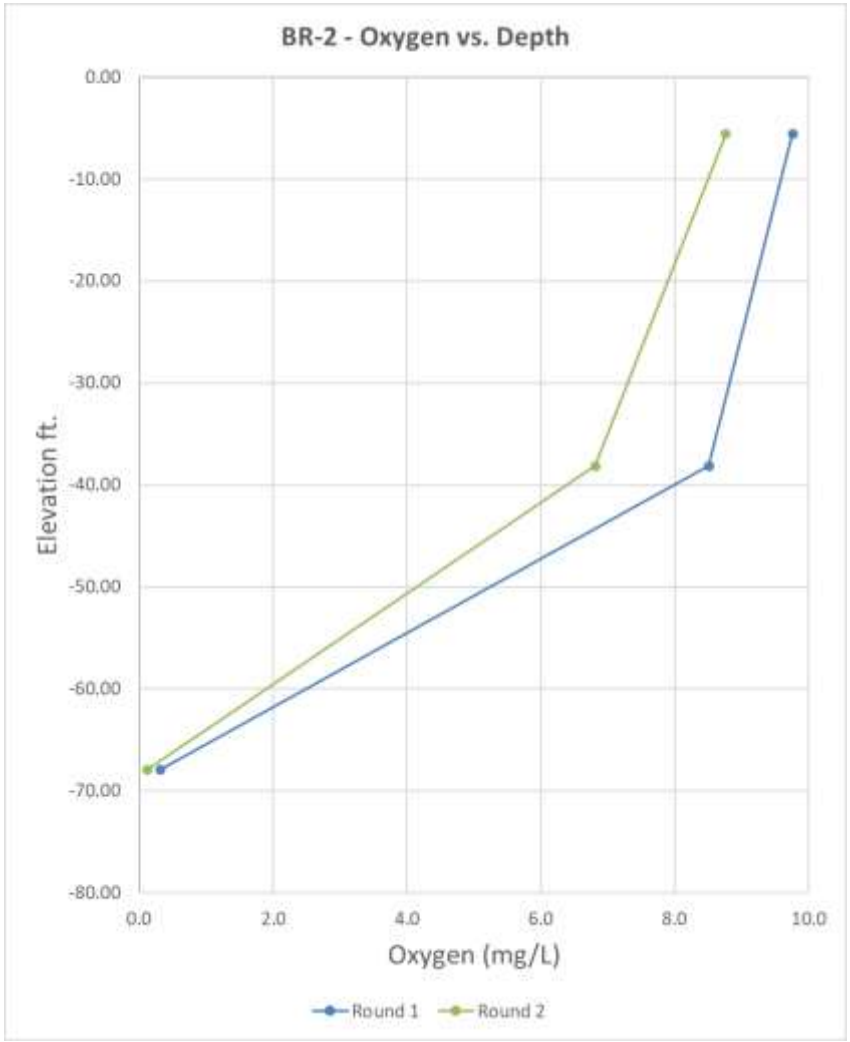

DU-6 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

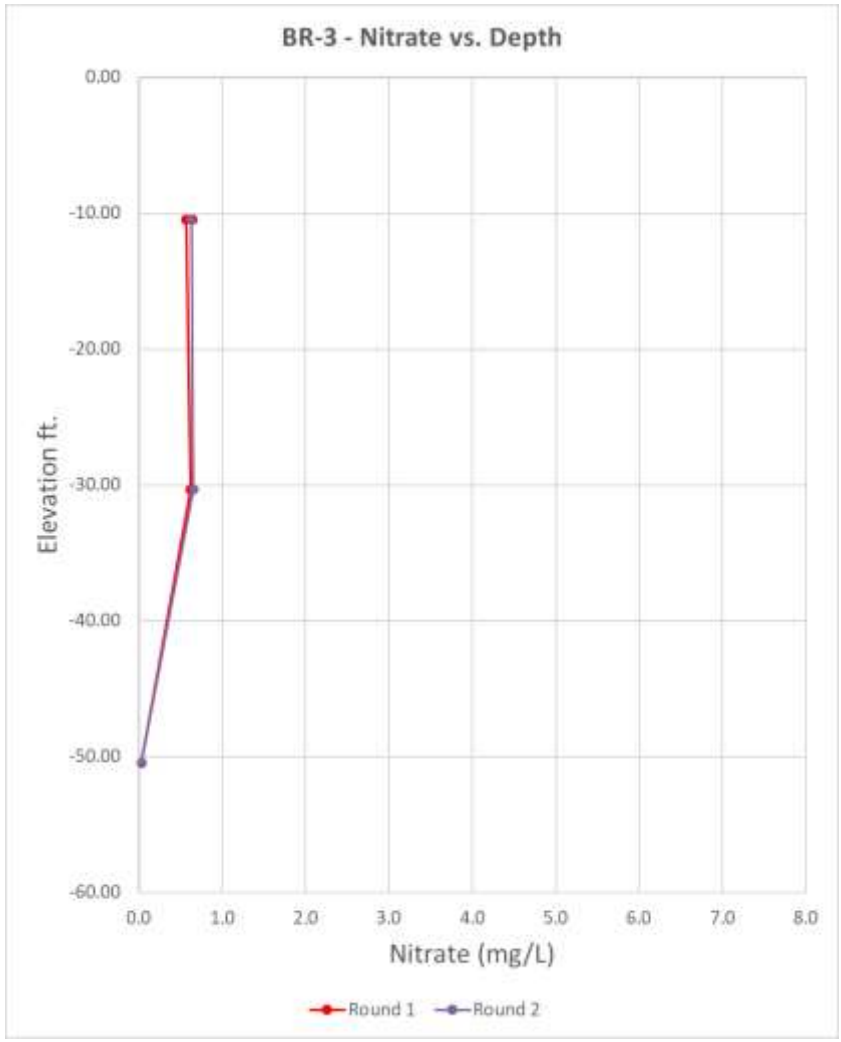

DU-6 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

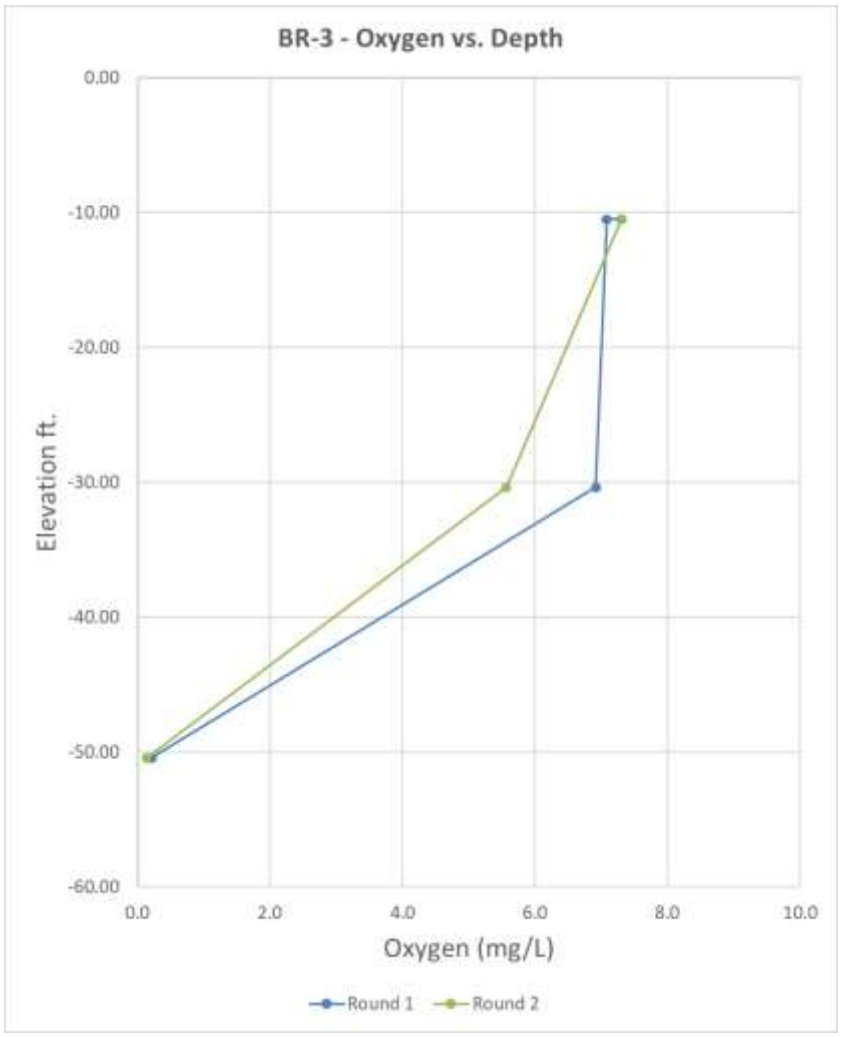

BR-1 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

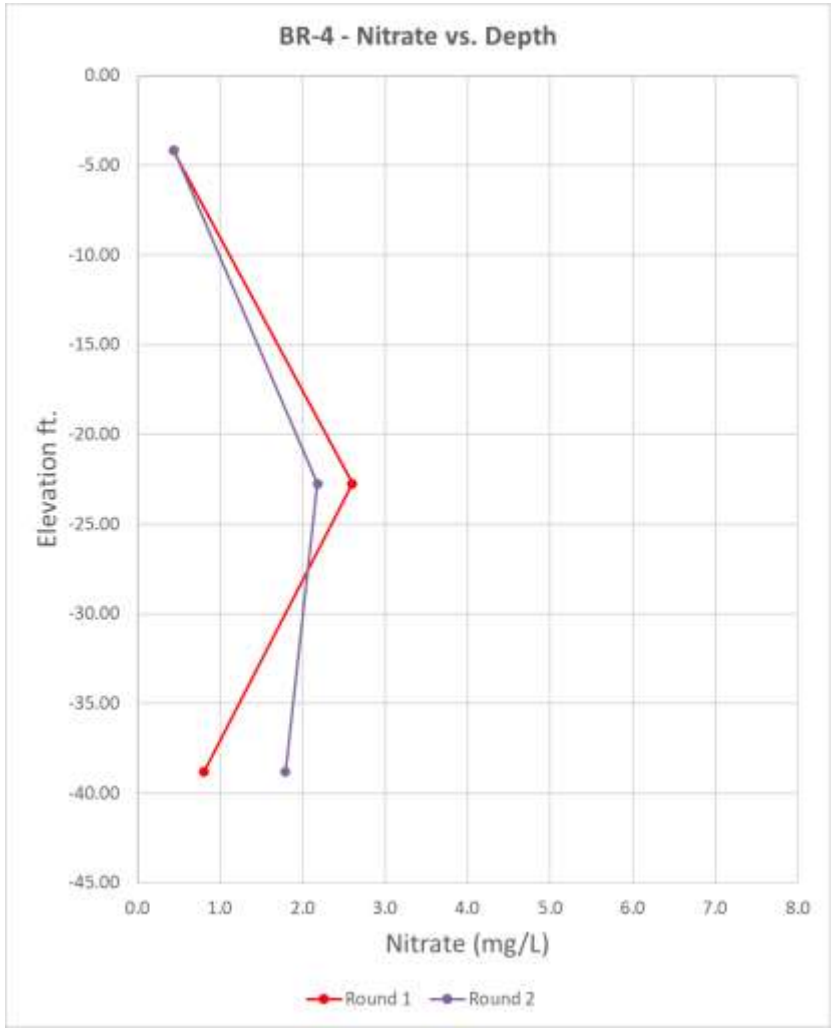

BR-1 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

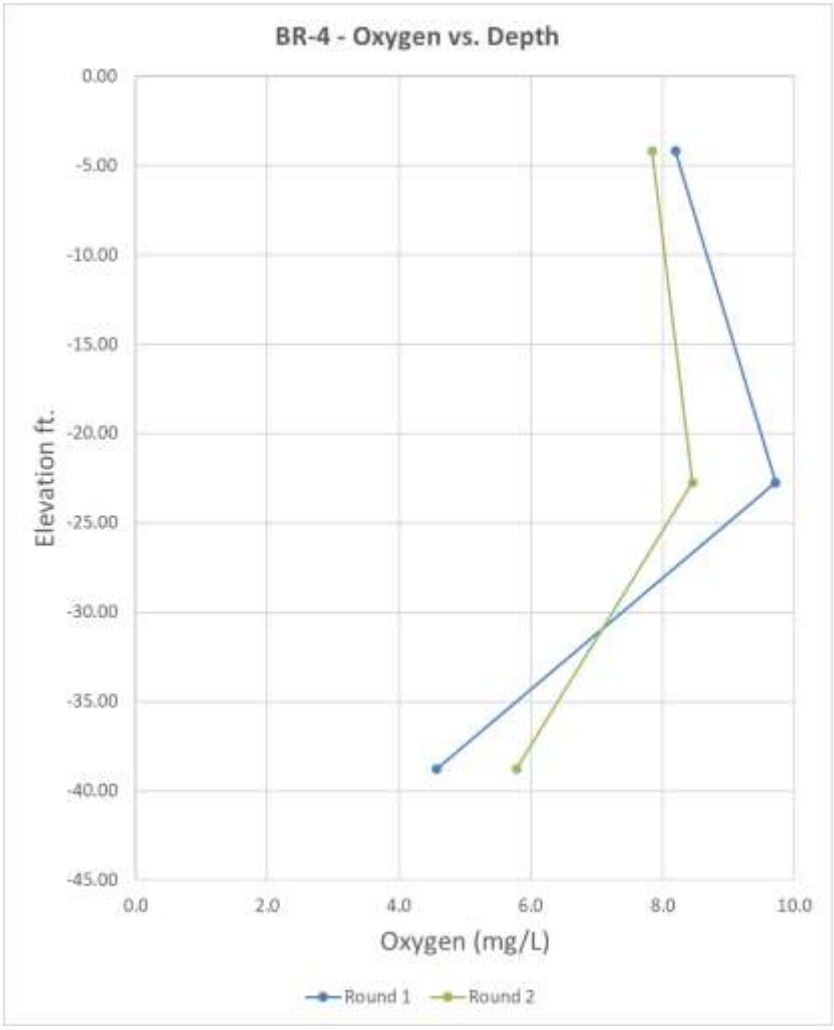

BR-2 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

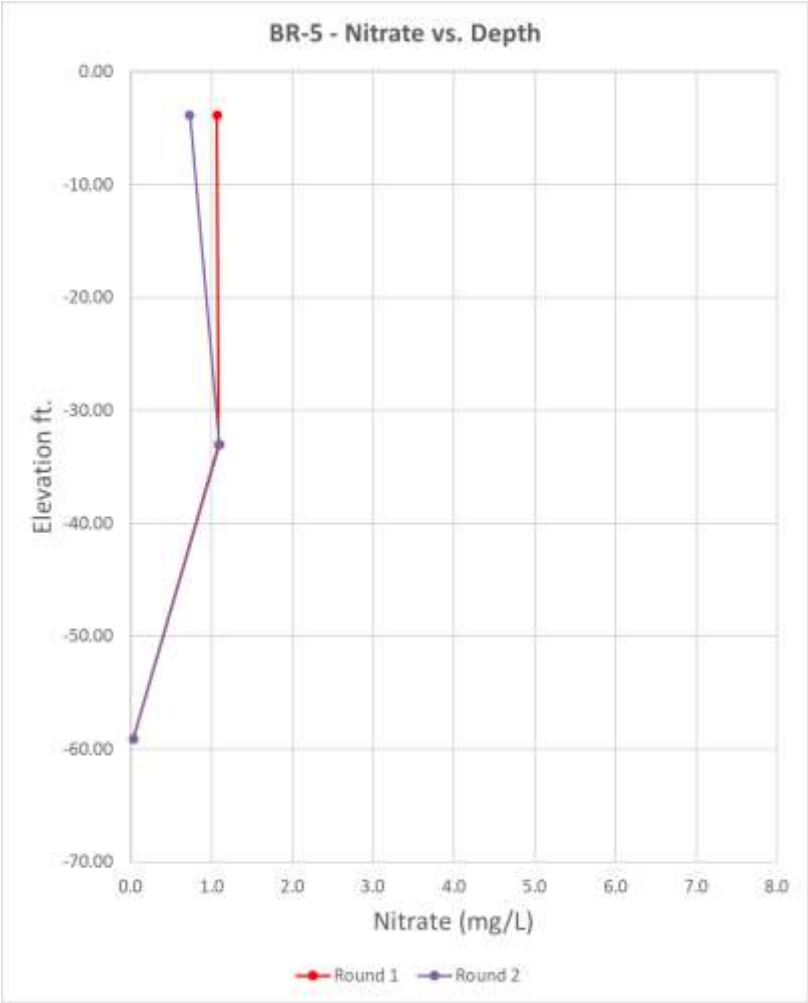

BR-2 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

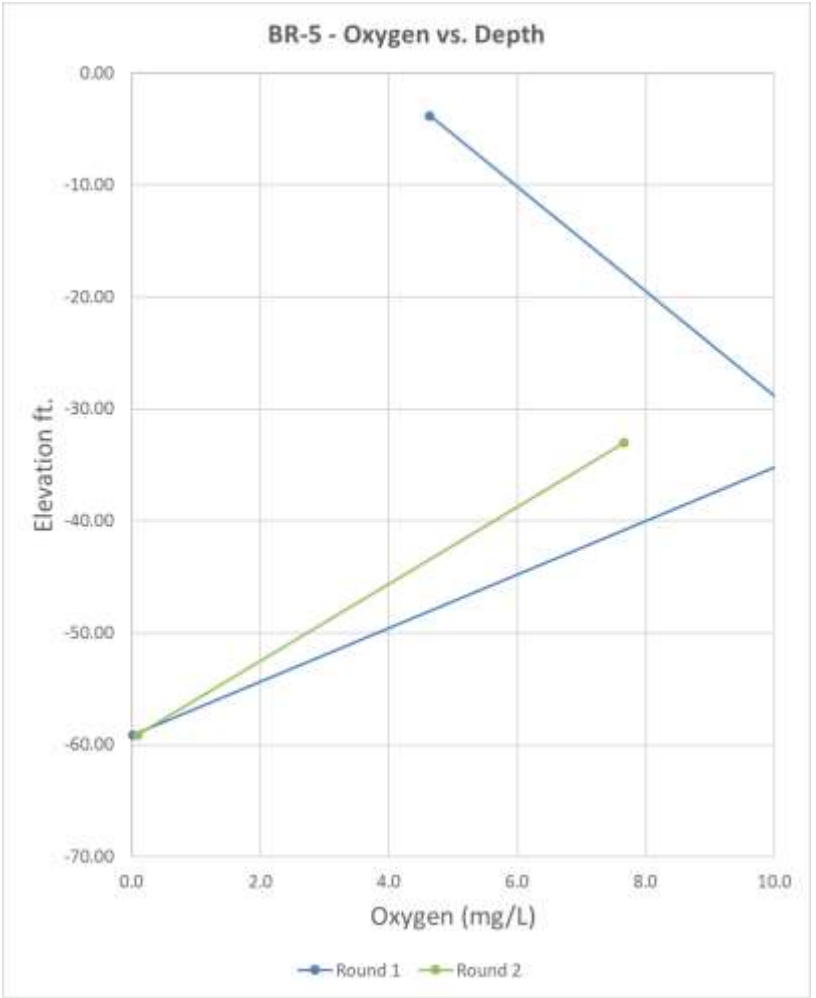

BR-3 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

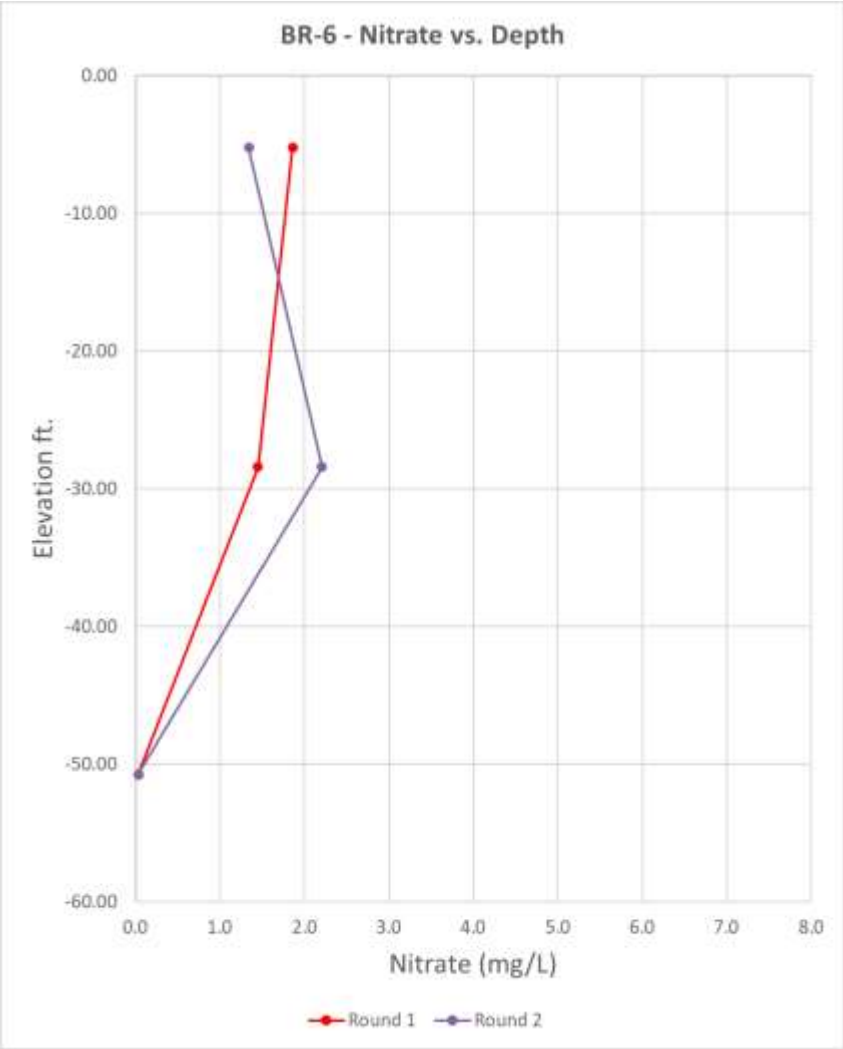

BR-3 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

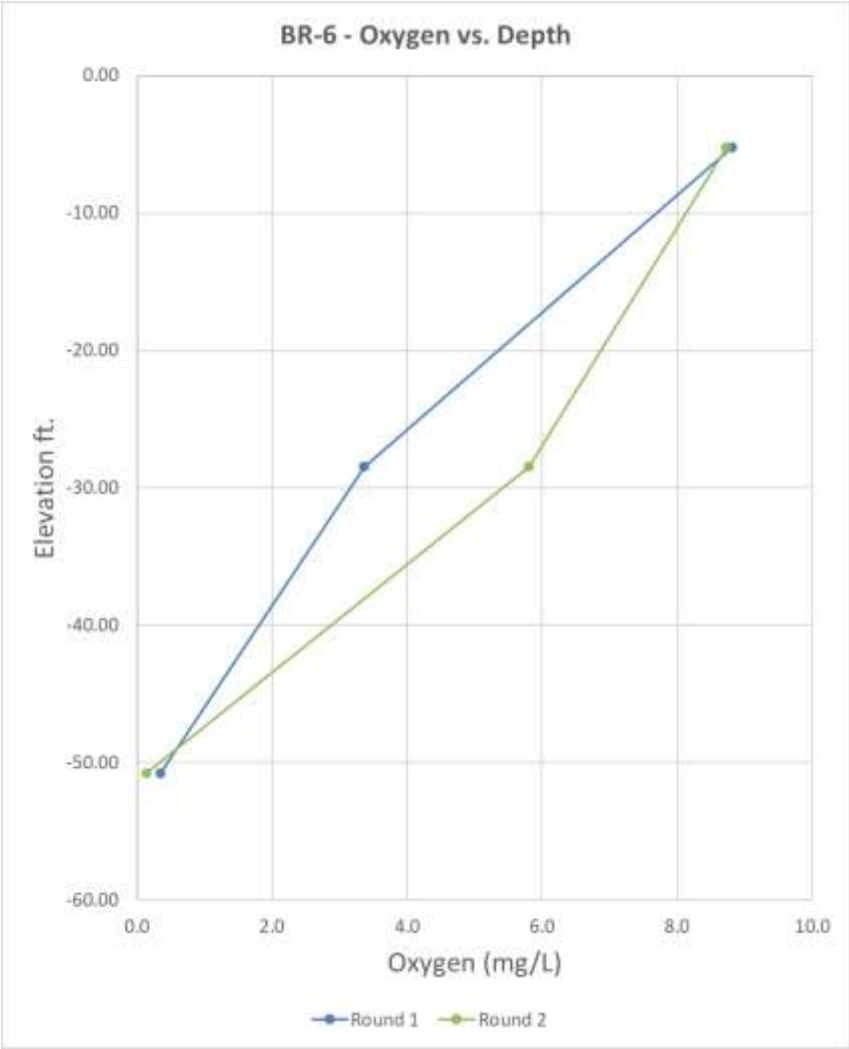

BR-4 - Nitrate vs. Depth
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

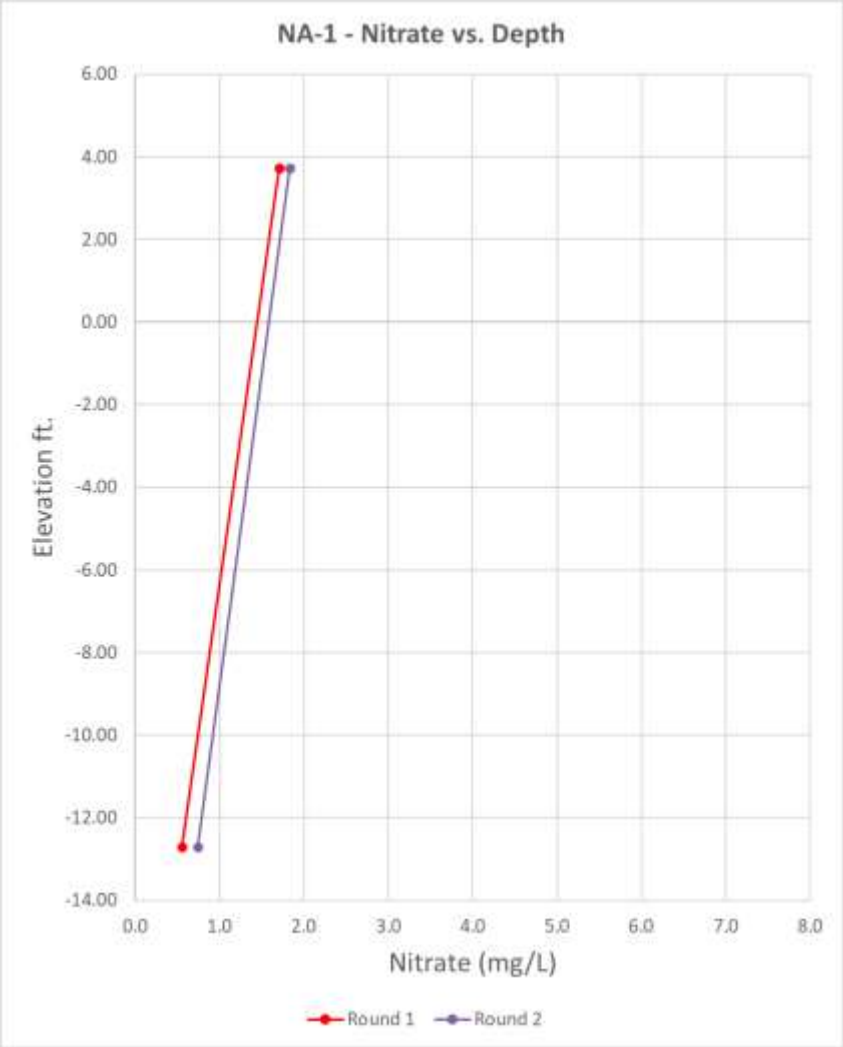

BR-4 - Oxygen vs. Depth
0.00
-5.00
-10.00
-15.00
-20.00
-25.00
-30.00
-35.00
-40.00
-45.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

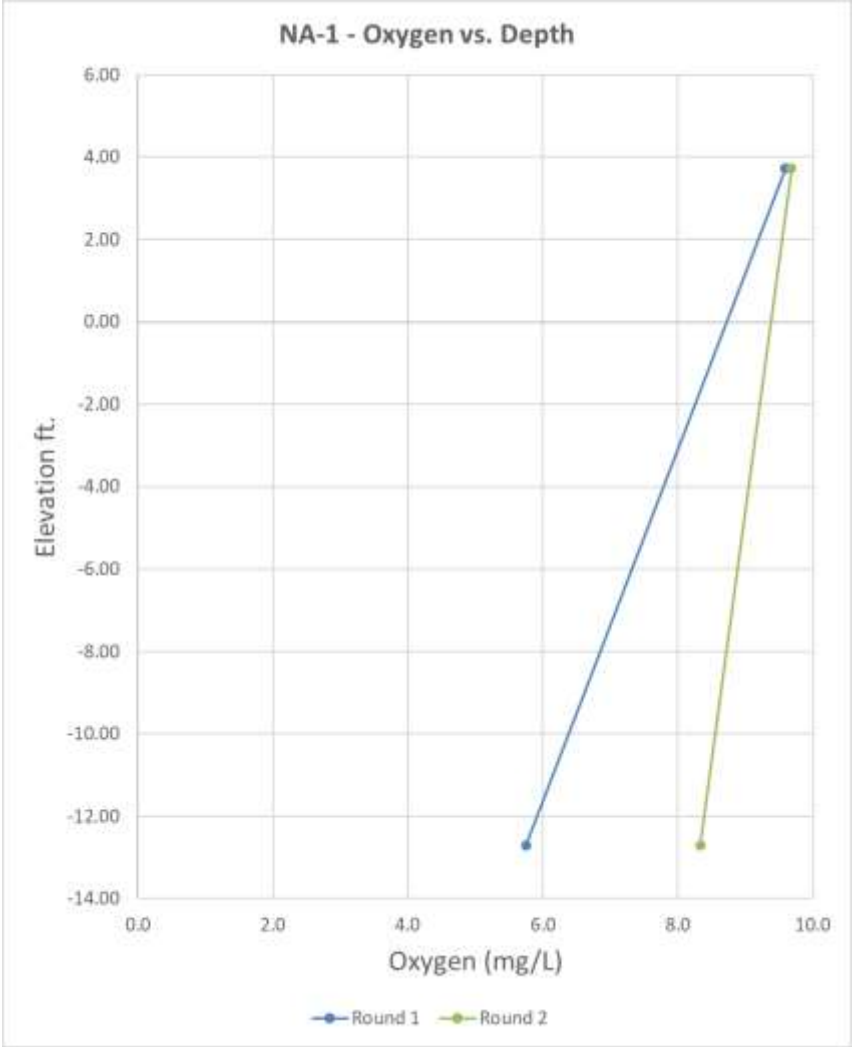

BR-5 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

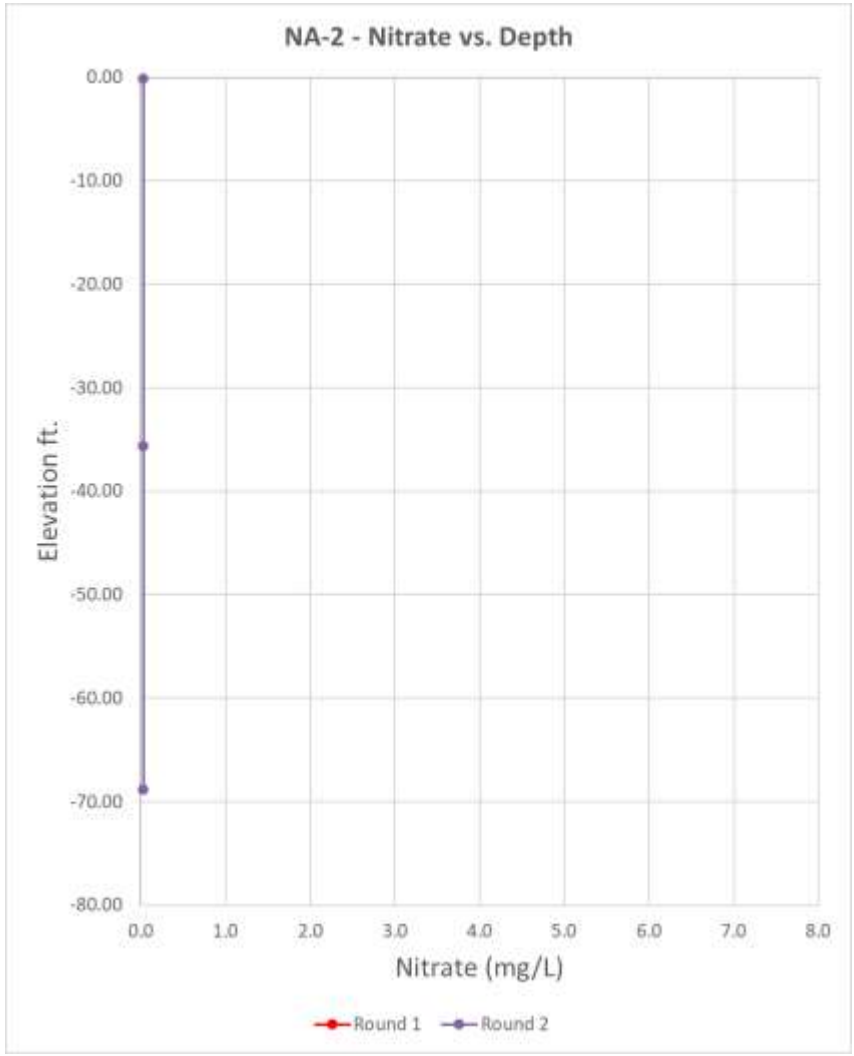

BR-5 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

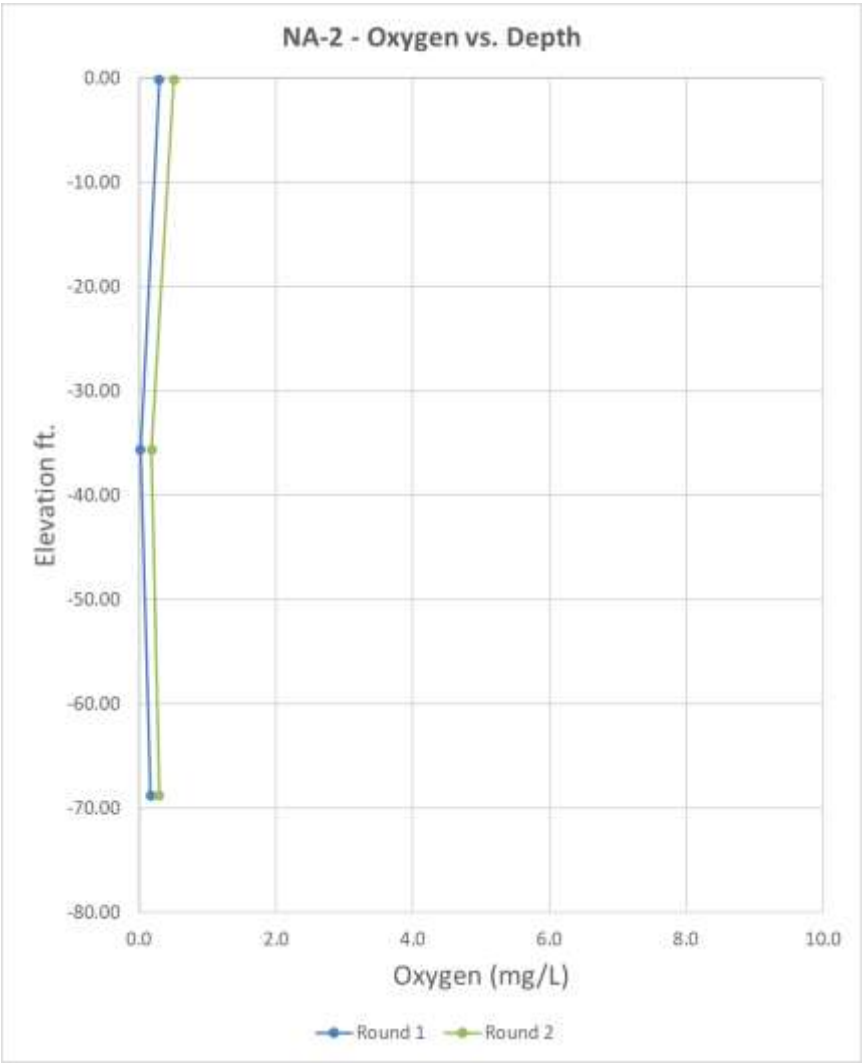

BR-6 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

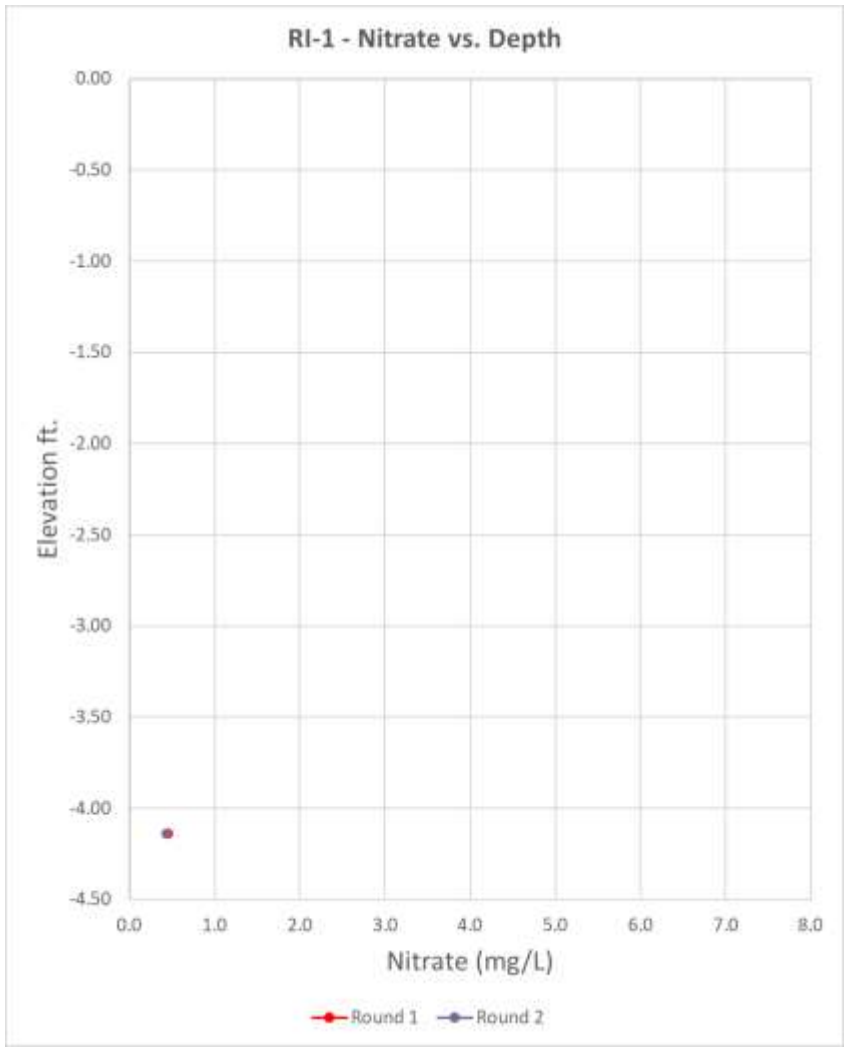

BR-6 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

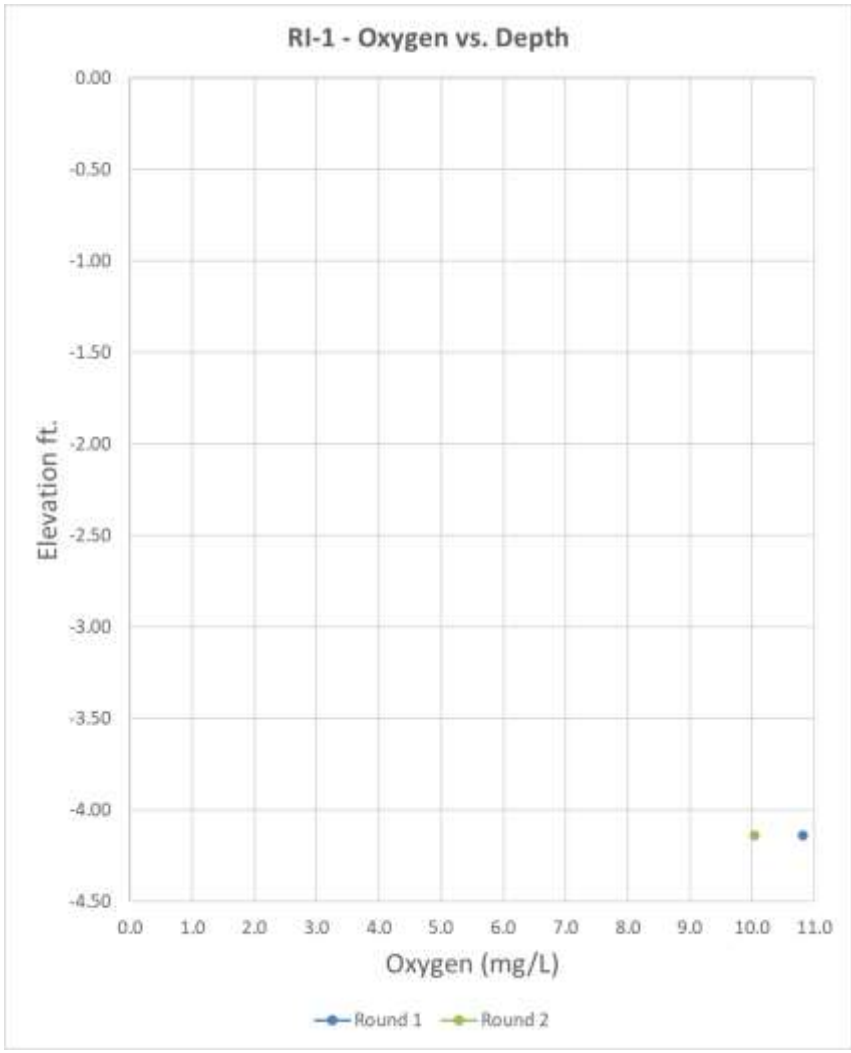

NA-1 - Nitrate vs. Depth
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

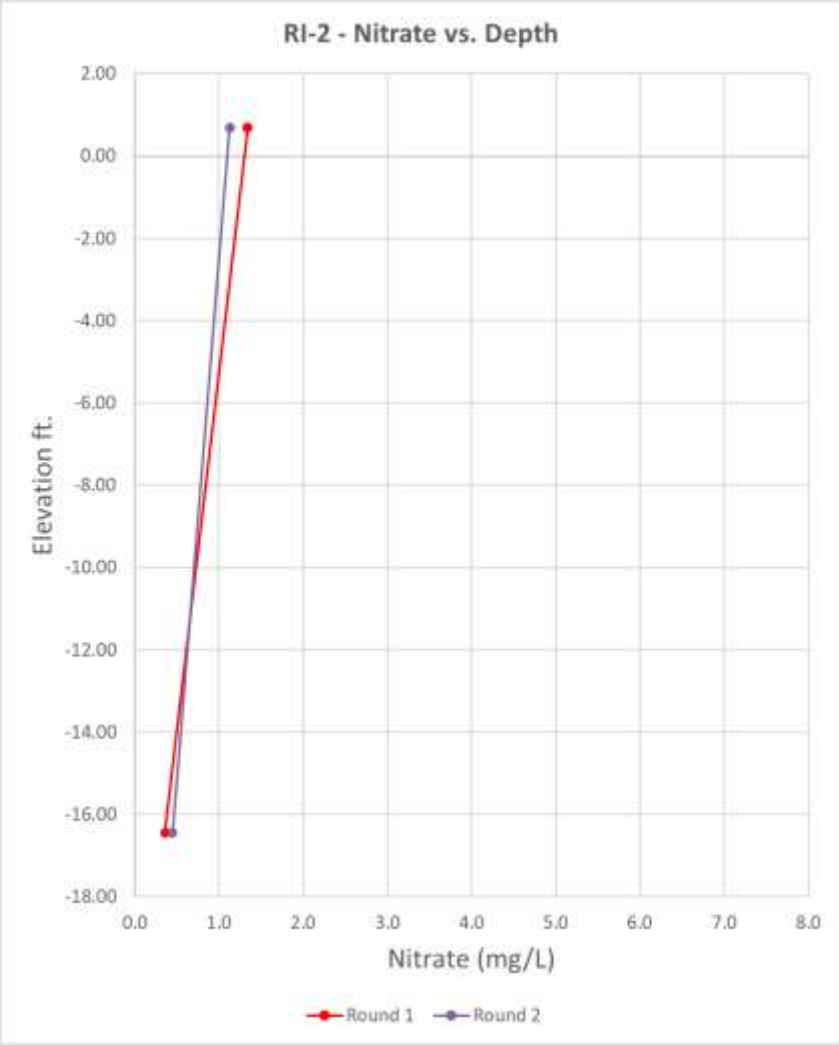

NA-1 - Oxygen vs. Depth
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

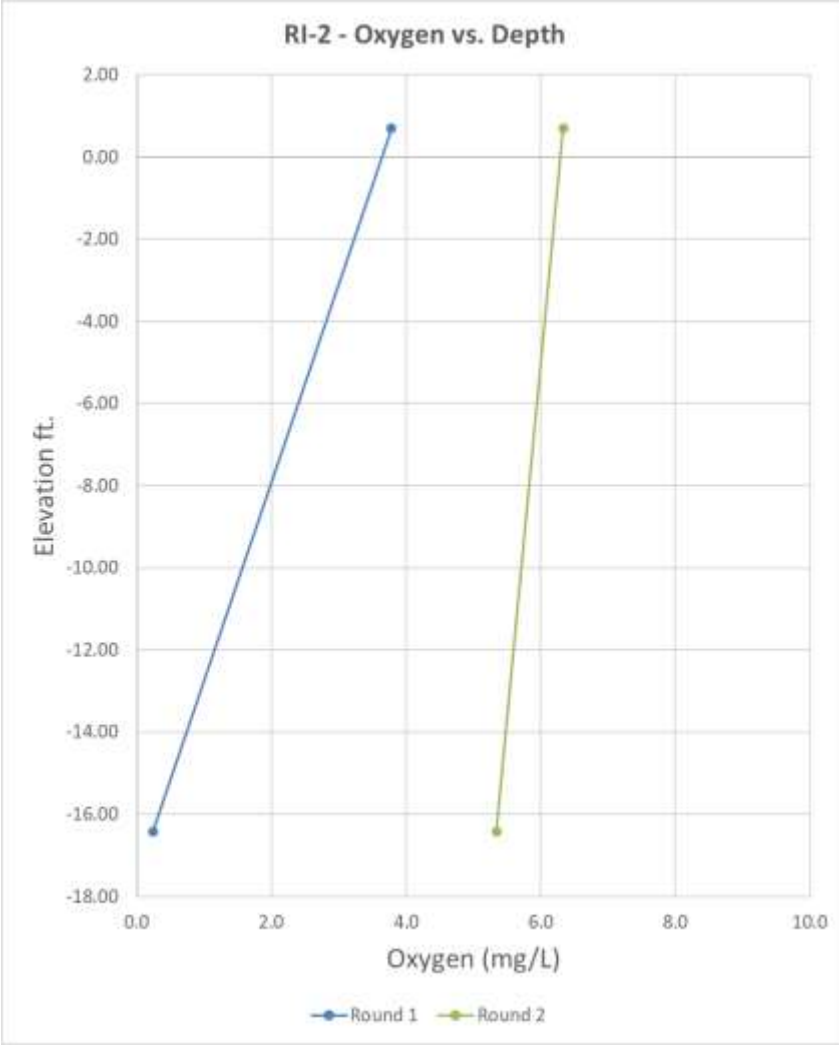

NA-2 - Nitrate vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2

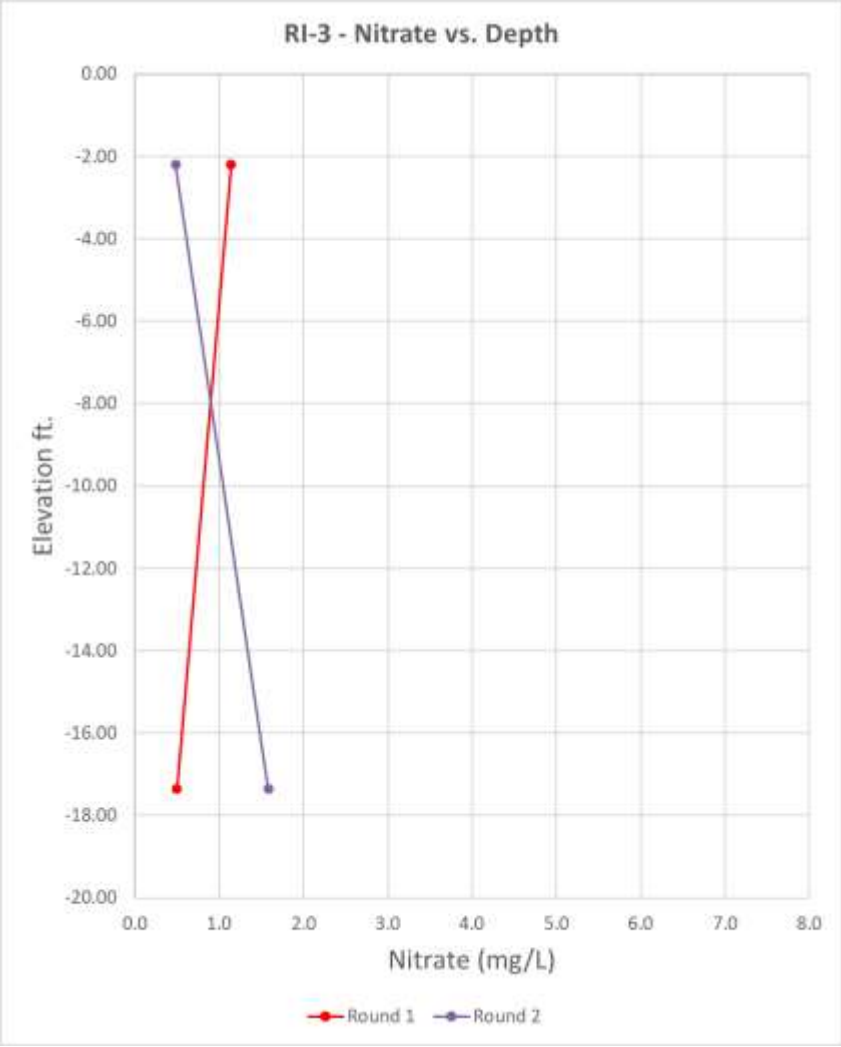

NA-2 - Oxygen vs. Depth
0.00
-10.00
-20.00
-30.00
-40.00
-50.00
-60.00
-70.00
-80.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2

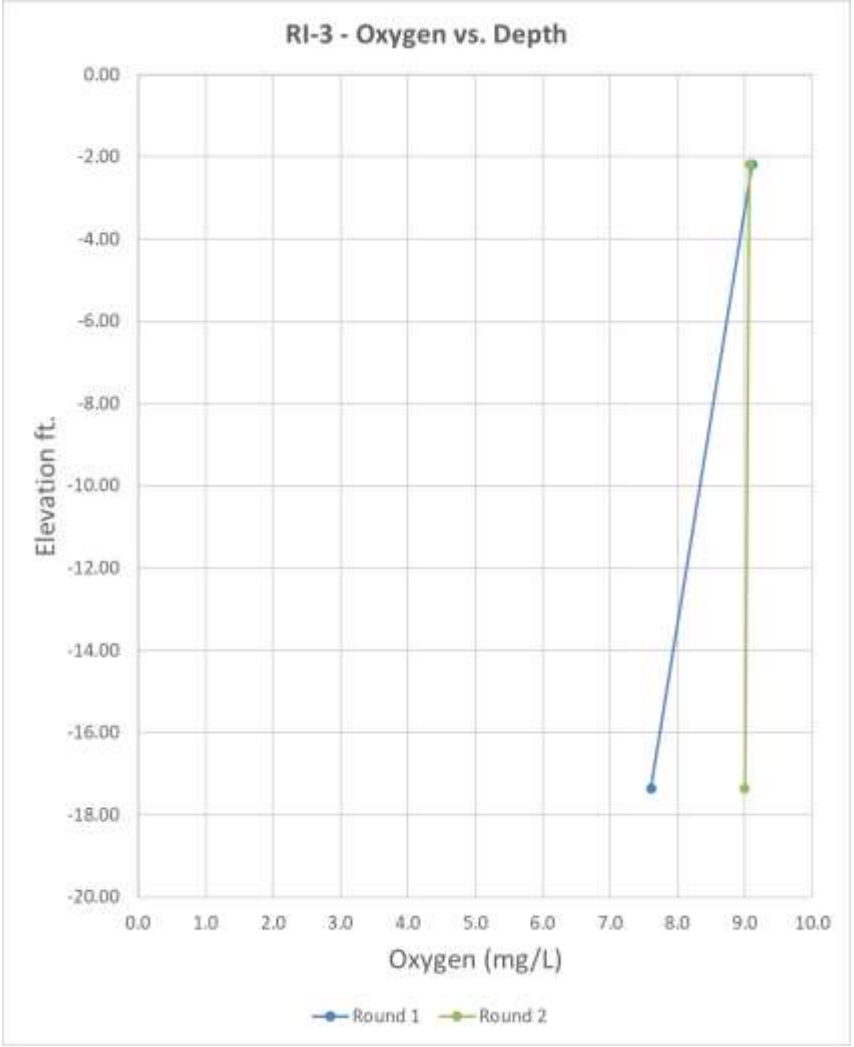

RI-1 - Nitrate vs. Depth
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2


RI-1 - Oxygen vs. Depth
0.00
-0.50
-1.00
-1.50
-2.00
-2.50
-3.00
-3.50
-4.00
-4.50
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
Oxygen (mg/L)
Round 1
Round 2


RI-2 - Nitrate vs. Depth
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2


RI-2 - Oxygen vs. Depth
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
Elevation ft.
0.0
2.0
4.0
6.0
8.0
10.0
Oxygen (mg/L)
Round 1
Round 2


RI-3 - Nitrate vs. Depth
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Nitrate (mg/L)
Round 1
Round 2


RI-3 - Oxygen vs. Depth
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-16.00
-18.00
-20.00
Elevation ft.
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
Oxygen (mg/L)
Round 1
Round 2

Appendix E: Laboratory Reports

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CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 21K0110

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.



Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:08 pm, Nov 09, 2021

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0110

SAMPLE RECEIPT

The following samples were received on November 02, 2021 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

The cooler temperature was not within the acceptance limit of <6°C, however, samples were delivered on ice and therefore meet regulatory criteria.

Lab Number	Sample Name	Matrix	Analysis
21K0110-01	MW-B12C	Ground Water	353.2, 4500N, 5310B
21K0110-02	MW-NA-1-92	Ground Water	200.7, 353.2, 4500N
21K0110-03	MW-B1020B	Ground Water	353.2, 4500N, 5310B
21K0110-04	MW-BX1B	Ground Water	353.2, 4500N, 5310B
21K0110-05	MW-RI-1-105	Ground Water	200.7, 353.2, 4500N
21K0110-06	MW-RI-3-90	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0110

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0110

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B12C
Date Sampled: 11/02/21 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**2.41** (0.500)		5310B		1	CCP	11/03/21 2:32	mg/L	[CALC]
Nitrate as N	**0.512** (0.0300)		353.2		1	JLK	11/03/21 18:39	mg/L	[CALC]
Nitrite as N	**0.011** (0.010)		353.2		1	JLK	11/03/21 16:56	mg/L	DK10337
Total Nitrogen	**0.929** (0.200)		4500N		1	JLK	11/08/21 16:59	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-NA-1-92
Date Sampled: 11/02/21 15:25
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.117** (0.100)		200.7		1	KJK	11/03/21 18:05	10	10	DK10346
Manganese	**0.207** (0.020)		200.7		1	KJK	11/03/21 18:05	10	10	DK10346

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-NA-1-92
Date Sampled: 11/02/21 15:25
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.552** (0.0300)		353.2		1	JLK	11/03/21 18:40	mg/L	[CALC]
Nitrite as N	**0.017** (0.010)		353.2		1	JLK	11/03/21 16:57	mg/L	DK10337
Total Nitrogen	**0.774** (0.200)		4500N		1	JLK	11/08/21 16:59	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1020B
Date Sampled: 11/02/21 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**5.12** (0.500)		5310B		1	CCP	11/03/21 2:44	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/03/21 18:41	mg/L	[CALC]
Nitrite as N	**0.060** (0.010)		353.2		1	JLK	11/03/21 16:58	mg/L	DK10337
Total Nitrogen	**0.814** (0.200)		4500N		1	JLK	11/08/21 17:00	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX1B
Date Sampled: 11/02/21 13:35
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**55.1** (2.00)		5310B		4	CCP	11/03/21 13:51	mg/L	[CALC]
Nitrate as N	**0.222** (0.0300)		353.2		1	JLK	11/03/21 18:42	mg/L	[CALC]
Nitrite as N	**0.088** (0.010)		353.2		1	JLK	11/03/21 16:59	mg/L	DK10337
Total Nitrogen	**0.906** (0.200)		4500N		1	JLK	11/08/21 17:01	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-RI-1-105
Date Sampled: 11/02/21 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	11/03/21 18:20	10	10	DK10346
Manganese	**0.130** (0.020)		200.7		1	KJK	11/03/21 18:20	10	10	DK10346

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-RI-1-105
Date Sampled: 11/02/21 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.449** (0.0300)		353.2		1	JLK	11/03/21 18:48	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/03/21 17:05	mg/L	DK10337
Total Nitrogen	**0.449** (0.200)		4500N		1	JLK	11/08/21 17:02	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-RI-3-90
Date Sampled: 11/02/21 16:40
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**2.19** (0.100)		200.7		1	KJK	11/03/21 18:22	10	10	DK10346
Manganese	**0.443** (0.020)		200.7		1	KJK	11/03/21 18:22	10	10	DK10346

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-RI-3-90
Date Sampled: 11/02/21 16:40
Percent Solids: N/A

ESS Laboratory Work Order: 21K0110
ESS Laboratory Sample ID: 21K0110-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.494** (0.0300)		353.2		1	JLK	11/03/21 18:49	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/03/21 17:06	mg/L	DK10337
Total Nitrogen	**0.494** (0.200)		4500N		1	JLK	11/08/21 17:08	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0110

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DK10346 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.57		mg/L	2.500		103	80-120			
Manganese	0.523		mg/L	0.5000		105	80-120			
Classical Chemistry										
Batch DK10243 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.71	0.500	mg/L	5.000		94	80-120			
Dissolved Organic Carbon (2)	4.79	0.500	mg/L	5.000		96	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	4.80	0.500	mg/L	5.000		96	80-120	2	20	
Dissolved Organic Carbon (2)	4.83	0.500	mg/L	5.000		97	80-120	0.8	20	
Batch DK10337 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.246		mg/L	0.2497		98	90-110			
Nitrite as N	0.246		mg/L	0.2497		98	90-110			
Batch DK10339 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.544		mg/L	0.5000		109	90-110			
Nitrate/Nitrite as N	0.544		mg/L	0.5000		109	90-110			
Batch DK10452 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	10.7	2.00	mg/L	10.30		104	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0110

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0110

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ~~ESS Courier~~ Client mm 11/2/21

ESS Project ID: 21K0110
Date Received: 11/2/2021
Project Due Date: 11/9/2021
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 8.3 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	225277	Yes	N/A	Yes	1L Poly	H2SO4	
1	225283	Yes	N/A	Yes	250 mL Poly	NP	
1	225289	Yes	N/A	Yes	250 mL Amber	NP	
2	225278	Yes	N/A	Yes	1L Poly	H2SO4	
2	225284	Yes	N/A	Yes	250 mL Poly	NP	
2	225292	Yes	N/A	Yes	250 mL Poly	NP	
3	225279	Yes	N/A	Yes	1L Poly	H2SO4	
3	225285	Yes	N/A	Yes	250 mL Poly	NP	
3	225290	Yes	N/A	Yes	250 mL Amber	NP	
4	225280	Yes	N/A	Yes	1L Poly	H2SO4	
4	225286	Yes	N/A	Yes	250 mL Poly	NP	
4	225291	Yes	N/A	Yes	250 mL Amber	NP	
5	225281	Yes	N/A	Yes	1L Poly	H2SO4	
5	225287	Yes	N/A	Yes	250 mL Poly	NP	
5	225293	Yes	N/A	Yes	250 mL Poly	NP	
6	225282	Yes	N/A	Yes	1L Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 21K0110
Date Received: 11/2/2021

6	225288	Yes	N/A	Yes	250 mL Poly	NP
6	225294	Yes	N/A	Yes	250 mL Poly	NP

2nd Review

Were all containers scanned into storage/lab? Initials TD

Are barcode labels on correct containers? Yes / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Taylor Davis Date & Time: 11/2/21 2005

Reviewed By: [signature] Date & Time: 11/2/21 2031

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 210110

Turn Time	5 Days
Regulatory State	Massachusetts
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP
Reporting Limits	
Electonic Deliverables	☐Data Checker ☐Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Julianne Marrion	Address: 250 Apollo Dr		
City: Chelmsford	State: MA	Zip Code: 01824	PO #
Telephone Number: 978-905-2419	FAX Number	Email Address: julianne.marrion@aecom.com	

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC	Methane
1	11/02/21	1305	Grab	Ground Water	MW-B12C	X	X		X	
2	11/02/21	1525	Grab	Ground Water	MW-NA-1-92	X	X	X		
3	11/02/21	1235	Grab	Ground Water	MW-B1020B	X	X		X	
4	11/02/21	1335	Grab	Ground Water	MW-BX1B	X	X		X	
5	11/02/21	1515	Grab	Ground Water	MW-RI-1-105	X	X	X		
6	11/02/21	1640	Grab	Ground Water	MW-RI-3-90	X	X	X		
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2
											Number of Containers per Sample:	1	1	1	1	2

Laboratory Use Only

Cooler Present: ✓ ○Drop Off
Seals Intact: ○Pickup
Cooler Temperature: 8.3 °C Ice

Sampled by : Briley Barra AECOM Briley Barra

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Briley Barra 11/02/21 1921	11/2/21 1921		
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 21K0192

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 5:20 pm, Nov 10, 2021

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

SAMPLE RECEIPT

The following samples were received on November 03, 2021 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
21K0192-01	MW-RI-2-58	Ground Water	200.7, 353.2, 4500N
21K0192-02	MW-NA-2-88	Ground Water	200.7, 353.2, 4500N
21K0192-03	MW-BR-2-96	Ground Water	200.7, 353.2, 4500N
21K0192-04	MW-BR-1-98	Ground Water	200.7, 353.2, 4500N
21K0192-05	MW-BR-3-100	Ground Water	200.7, 353.2, 4500N
21K0192-06	MW-BR-3-60	Ground Water	200.7, 353.2, 4500N
21K0192-07	MW-BR-5-90	Ground Water	200.7, 353.2, 4500N
21K0192-08	MW-BR-6-100	Ground Water	200.7, 353.2, 4500N
21K0192-09	MW-BR-4-100	Ground Water	200.7, 353.2, 4500N
21K0192-10	MW-B1050B	Ground Water	353.2, 4500N, 5310B, RSK175
21K0192-11	MW-BX2C	Ground Water	353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-RI-2-58
Date Sampled: 11/03/21 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	11/05/21 21:35	10	10	DK10535
Manganese	**1.23** (0.020)		200.7		1	KJK	11/05/21 21:35	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-RI-2-58
Date Sampled: 11/03/21 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.360** (0.0300)		353.2		1	JLK	11/04/21 20:29	mg/L	[CALC]
Nitrite as N	**0.366** (0.010)		353.2		1	JLK	11/04/21 19:28	mg/L	DK10448
Total Nitrogen	**1.42** (0.200)		4500N		1	JLK	11/08/21 17:09	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-NA-2-88
Date Sampled: 11/03/21 10:40
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.695** (0.100)		200.7		1	KJK	11/05/21 21:50	10	10	DK10535
Manganese	**0.445** (0.020)		200.7		1	KJK	11/05/21 21:50	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-NA-2-88
Date Sampled: 11/03/21 10:40
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/04/21 20:30	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:29	mg/L	DK10448
Total Nitrogen	**0.330** (0.200)		4500N		1	JLK	11/08/21 17:10	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-2-96
Date Sampled: 11/03/21 11:45
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**3.28** (0.100)		200.7		1	KJK	11/05/21 21:52	10	10	DK10535
Manganese	**0.368** (0.020)		200.7		1	KJK	11/05/21 21:52	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-2-96
Date Sampled: 11/03/21 11:45
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/04/21 20:31	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:30	mg/L	DK10448
Total Nitrogen	**1.09** (0.200)		4500N		1	JLK	11/08/21 17:11	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-1-98
Date Sampled: 11/03/21 13:30
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.701** (0.100)		200.7		1	KJK	11/05/21 21:54	10	10	DK10535
Manganese	**0.506** (0.020)		200.7		1	KJK	11/05/21 21:54	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-1-98
Date Sampled: 11/03/21 13:30
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.162** (0.0300)		353.2		1	JLK	11/04/21 20:32	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:31	mg/L	DK10448
Total Nitrogen	ND (0.200)		4500N		1	JLK	11/08/21 17:12	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-3-100
Date Sampled: 11/03/21 11:50
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.904** (0.100)		200.7		1	KJK	11/05/21 21:56	10	10	DK10535
Manganese	**0.349** (0.020)		200.7		1	KJK	11/05/21 21:56	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-3-100
Date Sampled: 11/03/21 11:50
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/04/21 20:33	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:32	mg/L	DK10448
Total Nitrogen	**0.325** (0.200)		4500N		1	JLK	11/08/21 17:12	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-3-60
Date Sampled: 11/03/21 12:25
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.151** (0.100)		200.7		1	KJK	11/05/21 21:58	10	10	DK10535
Manganese	**0.043** (0.020)		200.7		1	KJK	11/05/21 21:58	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-3-60
Date Sampled: 11/03/21 12:25
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.566** (0.0300)		353.2		1	JLK	11/04/21 21:55	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 21:55	mg/L	DK10448
Total Nitrogen	**0.566** (0.200)		4500N		1	JLK	11/08/21 17:13	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-5-90
Date Sampled: 11/03/21 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**3.71** (0.100)		200.7		1	KJK	11/05/21 22:00	10	10	DK10535
Manganese	**0.843** (0.020)		200.7		1	KJK	11/05/21 22:00	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-5-90
Date Sampled: 11/03/21 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/04/21 20:35	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:34	mg/L	DK10448
Total Nitrogen	**0.247** (0.200)		4500N		1	JLK	11/08/21 17:14	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-6-100
Date Sampled: 11/03/21 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**1.37** (0.100)		200.7		1	KJK	11/05/21 22:02	10	10	DK10535
Manganese	**0.401** (0.020)		200.7		1	KJK	11/05/21 22:02	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-6-100
Date Sampled: 11/03/21 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/04/21 20:41	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:39	mg/L	DK10448
Total Nitrogen	**0.412** (0.200)		4500N		1	JLK	11/08/21 17:15	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-4-100
Date Sampled: 11/03/21 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	11/05/21 22:11	10	10	DK10535
Manganese	**0.332** (0.020)		200.7		1	KJK	11/05/21 22:11	10	10	DK10535

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BR-4-100
Date Sampled: 11/03/21 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.804** (0.0300)		353.2		1	JLK	11/04/21 20:42	mg/L	[CALC]
Nitrite as N	**0.046** (0.010)		353.2		1	JLK	11/04/21 19:40	mg/L	DK10448
Total Nitrogen	**0.851** (0.200)		4500N		1	JLK	11/08/21 17:16	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050B
Date Sampled: 11/03/21 15:35
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**7.71** (0.500)		5310B		1	CCP	11/04/21 20:16	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	JLK	11/04/21 20:43	mg/L	[CALC]
Nitrite as N	**0.062** (0.010)		353.2		1	JLK	11/04/21 19:41	mg/L	DK10448
Total Nitrogen	**1.01** (0.200)		4500N		1	JLK	11/08/21 17:22	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-B1050B
Date Sampled: 11/03/21 15:35
Percent Solids: N/A
Initial Volume: 1
Final Volume: 1
Extraction Method: No Prep

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-10
Sample Matrix: Ground Water
Units: ug/L
Analyst: TLW
Prepared: 11/10/21 11:30

All methods used are in accordance with 40 CFR 136.

Methane / Ethane / Ethene by Headspace GCFID (RSK175)

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Sequence	Batch
Ethane	ND (3.0)		RSK175		1	TLW	11/10/21 14:45	D1K0225	DK11029
Ethene	ND (5.0)		RSK175		1	TLW	11/10/21 14:45	D1K0225	DK11029
Methane	**5630** (20.0)		RSK175		10	TLW	11/10/21 14:54	D1K0225	DK11029

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: MW-BX2C
Date Sampled: 11/03/21 16:25
Percent Solids: N/A

ESS Laboratory Work Order: 21K0192
ESS Laboratory Sample ID: 21K0192-11
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.94** (0.500)		5310B		1	CCP	11/04/21 20:53	mg/L	[CALC]
Nitrate as N	**6.82** (0.210)		353.2		10	JLK	11/04/21 20:50	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	11/04/21 19:42	mg/L	DK10448
Total Nitrogen	**6.82** (0.200)		4500N		10	JLK	11/08/21 17:23	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DK10535 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.498		mg/L	0.5000		100	80-120			
Classical Chemistry										
Batch DK10448 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.242		mg/L	0.2497		97	90-110			
Nitrite as N	0.242		mg/L	0.2497		97	90-110			
Batch DK10450 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.520		mg/L	0.5000		104	90-110			
Nitrate/Nitrite as N	0.520		mg/L	0.5000		104	90-110			
Batch DK10452 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	10.7	2.00	mg/L	10.30		104	80-120			
Batch DK10459 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.73	0.500	mg/L	5.000		95	80-120			
Dissolved Organic Carbon (2)	4.79	0.500	mg/L	5.000		96	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	4.57	0.500	mg/L	5.000		91	80-120	3	20	
Dissolved Organic Carbon (2)	4.61	0.500	mg/L	5.000		92	80-120	4	20	
Methane / Ethane / Ethene by Headspace GCFID (RSK175)										
Batch DK11029 - No Prep										

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Methane / Ethane / Ethene by Headspace GCFID (RSK175)										
Batch DK11029 - No Prep										
Blank										
Ethane	ND	3.0	ug/L							
Ethene	ND	5.0	ug/L							
Methane	ND	2.0	ug/L							
LCS										
Ethane	49.3	3.0	ug/L	68.00		72	60-140			
Ethene	44.7	5.0	ug/L	64.00		70	60-140			
Methane	23.5	2.0	ug/L	36.00		65	60-140			
LCS Dup										
Ethane	50.7	3.0	ug/L	68.00		74	60-140	3	30	
Ethene	45.9	5.0	ug/L	64.00		72	60-140	3	30	
Methane	23.9	2.0	ug/L	36.00		66	60-140	2	30	

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0192

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 21K0192
Date Received: 11/3/2021
Project Due Date: 11/10/2021
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 5 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	225874	Yes	N/A	Yes	1L Poly	H2SO4	
1	225885	Yes	N/A	Yes	250 mL Poly	NP	
1	225896	Yes	N/A	Yes	250 mL Poly	NP	
2	225875	Yes	N/A	Yes	1L Poly	H2SO4	
2	225886	Yes	N/A	Yes	250 mL Poly	NP	
2	225897	Yes	N/A	Yes	250 mL Poly	NP	
3	225876	Yes	N/A	Yes	1L Poly	H2SO4	
3	225887	Yes	N/A	Yes	250 mL Poly	NP	
3	225898	Yes	N/A	Yes	250 mL Poly	NP	
4	225877	Yes	N/A	Yes	1L Poly	H2SO4	
4	225888	Yes	N/A	Yes	250 mL Poly	NP	
4	225899	Yes	N/A	Yes	250 mL Poly	NP	
5	225878	Yes	N/A	Yes	1L Poly	H2SO4	
5	225889	Yes	N/A	Yes	250 mL Poly	NP	
5	225900	Yes	N/A	Yes	250 mL Poly	NP	
6	225879	Yes	N/A	Yes	1L Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 21K0192
Date Received: 11/3/2021

6	225890	Yes	N/A	Yes	250 mL Poly	NP
6	225901	Yes	N/A	Yes	250 mL Poly	NP
7	225880	Yes	N/A	Yes	1L Poly	H2SO4
7	225891	Yes	N/A	Yes	250 mL Poly	NP
7	225902	Yes	N/A	Yes	250 mL Poly	NP
8	225881	Yes	N/A	Yes	1L Poly	H2SO4
8	225892	Yes	N/A	Yes	250 mL Poly	NP
8	225903	Yes	N/A	Yes	250 mL Poly	NP
9	225882	Yes	N/A	Yes	1L Poly	H2SO4
9	225893	Yes	N/A	Yes	250 mL Poly	NP
9	225904	Yes	N/A	Yes	250 mL Poly	NP
10	225883	Yes	N/A	Yes	1L Poly	H2SO4
10	225894	Yes	N/A	Yes	250 mL Poly	NP
10	225926	Yes	N/A	Yes	250 mL Amber	NP
10	225928	Yes	No	Yes	VOA Vial	HCl
10	225929	Yes	No	Yes	VOA Vial	HCl
11	225884	Yes	N/A	Yes	1L Poly	H2SO4
11	225895	Yes	N/A	Yes	250 mL Poly	NP
11	225927	Yes	N/A	Yes	250 mL Amber	NP

2nd Review

Were all containers scanned into storage/lab? Initials _____ Yes / No

Are barcode labels on correct containers? Yes / No / NA

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: _____ Date & Time: 11/3/21 1943

Reviewed By: _____ Date & Time: 11/3/21 2016

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 210192

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP	
Reporting Limits		
Electonic Deliverables	☐Data Checker ☐Excel ☐Other (Please Specify →)	

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

	Address	
Julianne Marrion	250 Apollo Dr	

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC	Methane
1	11/03/21	1000	Grab	Ground Water	MW-RI-258	X	X	X		
2	11/03/21	1040	Grab	Ground Water	MW-NA-2-88	X	X	X		
3	11/03/21	1145	Grab	Ground Water	MW-BR-2-96	X	X	X		
4	11/03/21	1230	Grab	Ground Water	MW-BR-1-98	X	X	X		
5	11/03/21	1150	Grab	Ground Water	MW-BR-3-100	X	X	X		
6	11/03/21	1225	Grab	Ground Water	MW-BR-3-60	X	X	X		
7	11/03/21	1420	Grab	Ground Water	MW-BR-5-90	X	X	X		
8	11/03/21	1415	Grab	Ground Water	MW-BR-6-100	X	X	X		
9	11/03/21	1515	Grab	Ground Water	MW-BR-4-100	X	X	X		
10	11/03/21	1535	Grab	Ground Water	MW-B1050B	X	X		X	X

Container Type:	AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial	P	P	P	AG	V
Container Volume:	1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*	6	3	3	3	7
Preservation Code:	1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*	3	1	1	1	2
	Number of Containers per Sample:	1	1	1	1	2

Laboratory Use Only

Cooler Present: ✓ ○Drop Off
Seals Intact: ✓ ○Pickup
Cooler Temperature: ICE 5.0 °C

Sampled by : Briley Barra AECOM Briley Barra

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Briley Barra 11/03/21 1750	11/3/21 1750	11/3/21 18:45	Courtney Davis 1855 11/3/21
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

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www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 21K0192

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP	
Reporting Limits		
Electonic Deliverables	☐Data Checker ☐Excel ☐Other (Please Specify →)	

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB
Address		
Julianne Marrion	250 Apollo Dr	
City	**State**	**Zip Code** / **PO #**
Chelmsford	MA	01824
Telephone Number	**FAX Number**	**Email Address**
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC	Methane
11	11/03/21	1625	Grab	Ground Water	MW-3X2C	X	X		X	
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						

BR 1103 PM

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2
											Number of Containers per Sample:	1	1	1	1	2

Laboratory Use Only
Cooler Present: ✓ ○Drop Off
Seals Intact: ✓ ○Pickup
Cooler Temperature: FC 5.0 °C

Sampled by : Briley Bama AECOM Briley Bama

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Briley Bama 11/03/21 1750	11/04/21 17:50	11/3/21 18:55	Clayton Davis 11/4 855
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 21K0264

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 11:55 am, Nov 11, 2021

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

SAMPLE RECEIPT

The following samples were received on November 04, 2021 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
21K0264-01	MW-DV-1-100	Ground Water	200.7, 353.2, 4500N
21K0264-02	MW-DV-2-100	Ground Water	200.7, 353.2, 4500N
21K0264-03	MW-DV-3-100	Ground Water	200.7, 353.2, 4500N
21K0264-04	MW-DV-4-100	Ground Water	200.7, 353.2, 4500N
21K0264-05	MW-DV-5-100	Ground Water	200.7, 353.2, 4500N
21K0264-06	MW-DV-6-100	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

Dissolved Metals

Client Sample ID: MW-DV-1-100
Date Sampled: 11/04/21 12:00
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	**0.595**	mg/L	0.100	200.7	1	KJK	11/05/21 22:56	10	10
Manganese	**1.20**	mg/L	0.020	200.7	1	KJK	11/05/21 22:56	10	10

Client Sample ID: MW-DV-2-100
Date Sampled: 11/04/21 12:00
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	**2.48**	mg/L	0.100	200.7	1	KJK	11/05/21 23:11	10	10
Manganese	**1.08**	mg/L	0.020	200.7	1	KJK	11/05/21 23:11	10	10

Client Sample ID: MW-DV-3-100
Date Sampled: 11/04/21 11:15
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	**0.521**	mg/L	0.100	200.7	1	KJK	11/05/21 23:13	10	10
Manganese	**0.215**	mg/L	0.020	200.7	1	KJK	11/05/21 23:13	10	10

Client Sample ID: MW-DV-4-100
Date Sampled: 11/04/21 10:00
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	ND	mg/L	0.100	200.7	1	KJK	11/05/21 23:15	10	10
Manganese	**0.315**	mg/L	0.020	200.7	1	KJK	11/05/21 23:15	10	10

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

Dissolved Metals

Client Sample ID: MW-DV-5-100
Date Sampled: 11/04/21 11:10
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	**0.798**	mg/L	0.100	200.7	1	KJK	11/05/21 23:17	10	10
Manganese	**0.556**	mg/L	0.020	200.7	1	KJK	11/05/21 23:17	10	10

Client Sample ID: MW-DV-6-100
Date Sampled: 11/04/21 10:20
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed	I/V	F/V
Iron	ND	mg/L	0.100	200.7	1	KJK	11/05/21 23:19	10	10
Manganese	**0.755**	mg/L	0.020	200.7	1	KJK	11/05/21 23:19	10	10

Classical Chemistry

Client Sample ID: MW-DV-1-100
Date Sampled: 11/04/21 12:00
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Nitrate as N	**0.985**	mg/L	0.0500	353.2	2	JLK	11/04/21 22:55
Nitrite as N	**0.168**	mg/L	0.010	353.2	1	JLK	11/04/21 21:24
Total Nitrogen	**1.15**	mg/L	0.200	4500N	2	JLK	11/09/21 17:45

Client Sample ID: MW-DV-2-100
Date Sampled: 11/04/21 12:00
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Nitrate as N	**0.158**	mg/L	0.0300	353.2	1	JLK	11/04/21 22:24

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

Classical Chemistry

Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	11/04/21 21:25
Total Nitrogen	ND	mg/L	0.200	4500N	1	JLK	11/09/21 17:46

Client Sample ID: MW-DV-3-100
Date Sampled: 11/04/21 11:15
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Nitrate as N	**1.12**	mg/L	0.0500	353.2	2	JLK	11/04/21 22:56
Nitrite as N	**0.064**	mg/L	0.010	353.2	1	JLK	11/04/21 21:26
Total Nitrogen	**1.19**	mg/L	0.200	4500N	2	JLK	11/09/21 17:47

Client Sample ID: MW-DV-4-100
Date Sampled: 11/04/21 10:00
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Nitrate as N	**0.621**	mg/L	0.0300	353.2	1	JLK	11/04/21 22:26
Nitrite as N	**0.053**	mg/L	0.010	353.2	1	JLK	11/04/21 21:27
Total Nitrogen	**0.674**	mg/L	0.200	4500N	1	JLK	11/09/21 17:48

Client Sample ID: MW-DV-5-100
Date Sampled: 11/04/21 11:10
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Nitrate as N	**0.106**	mg/L	0.0300	353.2	1	JLK	11/04/21 22:27
Nitrite as N	ND	mg/L	0.010	353.2	1	JLK	11/04/21 21:28
Total Nitrogen	ND	mg/L	0.200	4500N	1	JLK	11/09/21 17:49

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

Classical Chemistry

Client Sample ID: MW-DV-6-100
Date Sampled: 11/04/21 10:20
Percent Solids: N/A

ESS Laboratory Sample ID: 21K0264-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Analyte	Results	Units	MRL	Method	DF	Analyst	Analyzed
Nitrate as N	**1.09**	mg/L	0.0500	353.2	2	JLK	11/04/21 22:57
Nitrite as N	**0.019**	mg/L	0.010	353.2	1	JLK	11/04/21 21:29
Total Nitrogen	**1.11**	mg/L	0.200	4500N	2	JLK	11/09/21 17:50

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DK10536 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.498		mg/L	0.5000		100	80-120			
Classical Chemistry										
Batch DK10449 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.242		mg/L	0.2497		97	90-110			
Nitrite as N	0.242		mg/L	0.2497		97	90-110			
Batch DK10451 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.529		mg/L	0.5000		106	90-110			
Nitrate/Nitrite as N	0.529		mg/L	0.5000		106	90-110			
Batch DK10860 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	11.6	2.00	mg/L	10.30		113	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21K0264

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

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www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 21K0264

Turn Time	5	Days	
Regulatory State	Massachusetts		
Is this project for any of the following?:	○CT RCP	○MA MCP	○RGP
Reporting Limits			
Electonic Deliverables	☐Data Checker	☐Excel	☐Other (Please Specify →)

Company Name: AECOM	Project #: 60476644	Project Name: Orleans PRB	
Julianne Marrion	Address: 250 Apollo Dr		
City: Chelmsford	State: MA	Zip Code: 01824	PO #:
Telephone Number: 978-905-2419	FAX Number:	Email Address: julianne.marrion@aecom.com	

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC	Methane
1	11/04/21	1200	Grab	Ground Water	MW-DU-1-100	X	X	X		
2	11/04/21	1200	Grab	Ground Water	MW-DU-2-100	X	X	X		
3	11/04/21	1115	Grab	Ground Water	MW-DU-3-100	X	X	X		
4	11/04/21	1000	Grab	Ground Water	MW-DU-4-100	X	X	X		
5	11/04/21	1110	Grab	Ground Water	MW-DU-5-100	X	X	X		
6	11/04/21	1020	Grab	Ground Water	MW-DU-6-100	X	X	X		
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						
			Grab	Ground Water						

BB 11/04/21

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*

Number of Containers per Sample:	P	P	P	AG	V
	6	3	3	3	7
	3	1	1	1	2
	1	1	1	1	2

Laboratory Use Only

Cooler Present: _____ ○Drop Off
Seals Intact: _____ ○Pickup
Cooler Temperature: -1.7 °C Ice

Sampled by: Briley Barra AECOM Briley-Barra

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Hallie Allen 11/04/21 1519	11.4.21 1519		
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Thomas Parece
AECOM Environment - ENSR
250 Apollo Drive
Chelmsford, MA 01824

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 21L0810

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 4:24 pm, Dec 29, 2021

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0810

SAMPLE RECEIPT

The following samples were received on December 21, 2021 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
21L0810-01	DU-1-68	Ground Water	200.7, 353.2, 4500N
21L0810-02	BR-6-78	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0810

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0810

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-68
Date Sampled: 12/21/21 09:45
Percent Solids: N/A

ESS Laboratory Work Order: 21L0810
ESS Laboratory Sample ID: 21L0810-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	12/22/21 18:46	10	10	DL12237
Manganese	**0.769** (0.020)		200.7		1	KJK	12/22/21 18:46	10	10	DL12237

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-68
Date Sampled: 12/21/21 09:45
Percent Solids: N/A

ESS Laboratory Work Order: 21L0810
ESS Laboratory Sample ID: 21L0810-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.782** (0.0300)		353.2		1	JLK	12/21/21 22:01	mg/L	[CALC]
Total Nitrogen	**1.09** (0.200)		4500N		1	JLK	12/27/21 16:46	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-78
Date Sampled: 12/21/21 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0810
ESS Laboratory Sample ID: 21L0810-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.347** (0.100)		200.7		1	KJK	12/22/21 18:58	10	10	DL12237
Manganese	**0.274** (0.020)		200.7		1	KJK	12/22/21 18:58	10	10	DL12237

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-78
Date Sampled: 12/21/21 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0810
ESS Laboratory Sample ID: 21L0810-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.45** (0.0500)		353.2		2	JLK	12/21/21 22:17	mg/L	[CALC]
Total Nitrogen	**1.45** (0.200)		4500N		2	JLK	12/27/21 16:47	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0810

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DL12237 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.49		mg/L	2.500		99	80-120			
Manganese	0.505		mg/L	0.5000		101	80-120			
Classical Chemistry										
Batch DL12140 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.251		mg/L	0.2497		101	90-110			
Batch DL12141 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.496		mg/L	0.5000		99	90-110			
Nitrate/Nitrite as N	0.496		mg/L	0.5000		99	90-110			
Batch DL12260 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.1	2.00	mg/L	19.90		101	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0810

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0810

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 21L0810
Date Received: 12/21/2021
Project Due Date: 12/29/2021
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	244572	Yes	N/A	Yes	250 mL Poly	NP	
1	244574	Yes	N/A	Yes	250 mL Poly	H2SO4	
1	244705	Yes	N/A	Yes	250 mL Poly	NP	
2	244573	Yes	N/A	Yes	250 mL Poly	NP	
2	244575	Yes	N/A	Yes	250 mL Poly	H2SO4	
2	244706	Yes	N/A	Yes	250 mL Poly	NP	

2nd Review
Were all containers scanned into storage/lab? Initials TD
Are barcode labels on correct containers? Yes / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA
Are all Hex Chrome stickers attached? Yes / No / NA
Are all QC stickers attached? Yes / No / NA
Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Taylor Davis Date & Time: 12/21/21 2010

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 21L0810

Date Received: 12/21/2021

Reviewed By: [signature]

Date & Time: 12/21/21 2034

CHAIN OF CUSTODY

185 Frances Avenue
Cranston, RI 02921
Phone: 401-461-7181
Fax: 401-461-4486
www.esslaboratory.com

ESS Lab # 210810 | Page of

Turn Time: ☐ >5 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Same Day

Regulatory State: Criteria:

Is this project for any of the following?: ☐ CT RCP ☒ MA MCP ☐ RGP ☐ Permit ☐ 401 WQ

ELECTRONIC DELIVERABLES (Final Reports are PDF)
☐ Limit Checker ☐ State Forms ☐ EQuIS
☐ Excel ☐ Hard Copy ☐ Enviro Data
☐ CLP-Like Package ☐ Other (Specify) →

CLIENT INFORMATION

Client: AECOM
Address: 250 Apollo Dr
Chelmsford MA
Phone:
Email Distribution List:

PROJECT INFORMATION

Project Name: Orleans
Project Location:
Project Number: 60476644
Project Manager: Tom Parece
Bill to:
PO#:
Quote#:

Client acknowledges that sampling is compliant with all EPA / State regulatory programs

REQUESTED ANALYSES

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Total N	Nitrate	Dissolved Mn	Total Number of Bottles
1	12/21/21	0945	GW	GW	DU-1-68	X	X	X	
2	12/21/21	1415	GW	GW	BR-6-78	X	X	X	

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial — P P P

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other* — 3 3 3

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other* — 3 1 1

Sampled by: Briley Barra AECOM

Chain needs to be filled out neatly and completely for on time delivery.

Laboratory Use Only
Cooler Temperature (°C): 2.1
ice

Comments: * Please specify "Other" preservative and containers types in this space

All samples submitted are subject to ESS Laboratory's payment terms and conditions.

Dissolved Filtration
☐ Lab Filter

Relinquished by (Signature)	Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)
Briley Barra	12/21/21	1740	[signature] 12/21/21 17:41	[signature]	12/22/21	19:09	Mayor Davis

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 21L0889

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 1:40 pm, Jan 03, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0889

SAMPLE RECEIPT

The following samples were received on December 22, 2021 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
21L0889-01	DU-3-76	Ground Water	200.7, 353.2, 4500N, 5310B
21L0889-02	DU-3-51	Ground Water	200.7, 353.2, 4500N
21L0889-03	DU-2-63	Ground Water	200.7, 353.2, 4500N
21L0889-04	DU-2-26	Ground Water	200.7, 353.2, 4500N
21L0889-05	DU-4-76	Ground Water	200.7, 353.2, 4500N
21L0889-06	DU-4-52	Ground Water	200.7, 353.2, 4500N
21L0889-07	DU-5-67	Ground Water	200.7, 353.2, 4500N
21L0889-08	DU-5-34	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0889

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0889

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-76
Date Sampled: 12/22/21 13:10
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.308** (0.100)		200.7		1	KJK	12/23/21 16:56	10	10	DL12339
Manganese	**0.492** (0.020)		200.7		1	KJK	12/23/21 16:56	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-76
Date Sampled: 12/22/21 13:10
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.37** (0.500)		5310B		1	CCP	12/28/21 0:26	mg/L	[CALC]
Nitrate as N	**2.56** (0.210)		353.2		10	JLK	12/23/21 22:02	mg/L	[CALC]
Total Nitrogen	**2.57** (0.200)		4500N		10	JLK	12/27/21 17:42	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-51
Date Sampled: 12/22/21 13:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	12/23/21 16:58	10	10	DL12339
Manganese	**0.101** (0.020)		200.7		1	KJK	12/23/21 16:58	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-51
Date Sampled: 12/22/21 13:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.821** (0.0300)		353.2		1	JLK	12/23/21 21:33	mg/L	[CALC]
Total Nitrogen	**1.07** (0.200)		4500N		1	JLK	12/27/21 17:43	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-63
Date Sampled: 12/22/21 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	12/23/21 17:01	10	10	DL12339
Manganese	**0.174** (0.020)		200.7		1	KJK	12/23/21 17:01	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-63
Date Sampled: 12/22/21 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.19** (0.0500)		353.2		2	JLK	12/23/21 22:06	mg/L	[CALC]
Total Nitrogen	**1.21** (0.200)		4500N		2	JLK	12/27/21 17:44	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-26
Date Sampled: 12/22/21 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.107** (0.100)		200.7		1	KJK	12/23/21 17:03	10	10	DL12339
Manganese	ND (0.020)		200.7		1	KJK	12/23/21 17:03	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-26
Date Sampled: 12/22/21 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**2.69** (0.110)		353.2		5	JLK	12/23/21 22:12	mg/L	[CALC]
Total Nitrogen	**3.43** (0.200)		4500N		5	JLK	12/27/21 17:50	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-76
Date Sampled: 12/22/21 15:20
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.798** (0.100)		200.7		1	KJK	12/23/21 17:05	10	10	DL12339
Manganese	**0.399** (0.020)		200.7		1	KJK	12/23/21 17:05	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-76
Date Sampled: 12/22/21 15:20
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.32** (0.0500)		353.2		2	JLK	12/23/21 22:13	mg/L	[CALC]
Total Nitrogen	**1.35** (0.200)		4500N		2	JLK	12/27/21 17:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-52
Date Sampled: 12/22/21 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	12/23/21 17:07	10	10	DL12339
Manganese	**0.151** (0.020)		200.7		1	KJK	12/23/21 17:07	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-52
Date Sampled: 12/22/21 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.810** (0.0300)		353.2		1	JLK	12/23/21 21:36	mg/L	[CALC]
Total Nitrogen	**0.824** (0.200)		4500N		1	JLK	12/27/21 17:52	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-67
Date Sampled: 12/22/21 16:10
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.128** (0.100)		200.7		1	KJK	12/23/21 17:09	10	10	DL12339
Manganese	**0.048** (0.020)		200.7		1	KJK	12/23/21 17:09	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-67
Date Sampled: 12/22/21 16:10
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.45** (0.0500)		353.2		2	JLK	12/23/21 22:14	mg/L	[CALC]
Total Nitrogen	**1.73** (0.200)		4500N		2	JLK	12/27/21 17:52	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-34
Date Sampled: 12/22/21 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	12/23/21 17:12	10	10	DL12339
Manganese	**0.035** (0.020)		200.7		1	KJK	12/23/21 17:12	10	10	DL12339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-34
Date Sampled: 12/22/21 16:15
Percent Solids: N/A

ESS Laboratory Work Order: 21L0889
ESS Laboratory Sample ID: 21L0889-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.13** (0.0500)		353.2		2	JLK	12/23/21 22:15	mg/L	[CALC]
Total Nitrogen	**1.13** (0.200)		4500N		2	JLK	12/27/21 17:53	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0889

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DL12339 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.51		mg/L	2.500		100	80-120			
Manganese	0.509		mg/L	0.5000		102	80-120			
Classical Chemistry										
Batch DL12336 - General Preparation										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	19.3	2.00	mg/L	19.90		97	80-120			
Batch DL12341 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.255		mg/L	0.2497		102	90-110			
Batch DL12343 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.505		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.505		mg/L	0.5000		101	90-110			
Batch DL12761 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.10	0.500	mg/L	5.000		102	80-120			
Dissolved Organic Carbon (2)	4.94	0.500	mg/L	5.000		99	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	4.83	0.500	mg/L	5.000		97	80-120	5	20	
Dissolved Organic Carbon (2)	4.80	0.500	mg/L	5.000		96	80-120	3	20	

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0889

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 21L0889

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 21L0889
Date Received: 12/22/2021
Project Due Date: 12/30/2021
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.9 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) No / NA
10. Were any analyses received outside of hold time? Yes (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	245228	Yes	N/A	Yes	250 mL Poly	NP	
1	245229	Yes	N/A	Yes	250 mL Poly	NP	
1	245244	Yes	N/A	Yes	250 mL Poly	H2SO4	
1	245252	Yes	N/A	Yes	1L Amber	NP	
2	245230	Yes	N/A	Yes	250 mL Poly	NP	
2	245231	Yes	N/A	Yes	250 mL Poly	NP	
2	245245	Yes	N/A	Yes	250 mL Poly	H2SO4	
3	245232	Yes	N/A	Yes	250 mL Poly	NP	
3	245233	Yes	N/A	Yes	250 mL Poly	NP	
3	245246	Yes	N/A	Yes	250 mL Poly	H2SO4	
4	245234	Yes	N/A	Yes	250 mL Poly	NP	
4	245235	Yes	N/A	Yes	250 mL Poly	NP	
4	245247	Yes	N/A	Yes	250 mL Poly	H2SO4	
5	245236	Yes	N/A	Yes	250 mL Poly	NP	
5	245237	Yes	N/A	Yes	250 mL Poly	NP	
5	245248	Yes	N/A	Yes	250 mL Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 21L0889

Date Received: 12/22/2021

6	245238	Yes	N/A	Yes	250 mL Poly	NP
6	245239	Yes	N/A	Yes	250 mL Poly	NP
6	245249	Yes	N/A	Yes	250 mL Poly	H2SO4
7	245240	Yes	N/A	Yes	250 mL Poly	NP
7	245241	Yes	N/A	Yes	250 mL Poly	NP
7	245250	Yes	N/A	Yes	250 mL Poly	H2SO4
8	245242	Yes	N/A	Yes	250 mL Poly	NP
8	245243	Yes	N/A	Yes	250 mL Poly	NP
8	245251	Yes	N/A	Yes	250 mL Poly	H2SO4

2nd Review

Were all containers scanned into storage/lab? Initials KL

Are barcode labels on correct containers? Yes / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: [signature] Date & Time: 12-22-21 19:14

Reviewed By: [signature] Date & Time: 12/22/21 1926

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.essiaboratory.com

CHAIN OF CUSTODY

ESS Lab # 21L0989

Turn Time	5 Days
Regulatory State	Massachusetts
Is this project for any of the following?	○CT RCP ○MA MCP ○RGP
Reporting Limits	
Electonic Deliverables	☐Data Checker ☐Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Contact Person	Address
Julianne Marrion	250 Apollo Dr

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: NO2, NO3, Sulfate	TN, Ammonia	Lab Filter Dissolved Fe, Mn	DOC	Lab Filtered Dissolved Arsenic	Methane	TOT N	Nitrate
1	12/22/21	1310	Grab	Ground Water	DU-3-76			X	X			X	X
2	12/22/21	1315	Grab	Ground Water	DU-3-51			X				X	X
3	12/22/21	1410	Grab	Ground Water	DU-2-63			X				X	X
4	12/22/21	1415	Grab	Ground Water	DU-2-26			X				X	X
5	12/22/21	1520	Grab	Ground Water	DU-4-76			X				X	X
6	12/22/21	1515	Grab	Ground Water	DU-4-52			X				X	X
7	12/22/21	1610	Grab	Ground Water	DU-5-67			X				X	X
8	12/22/21	1615	GRAB	GW	DU-5-34			X				X	X
Container Type:	AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial							P	AG			P	P
Container Volume:	1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*							3	6			3	3
Preservation Code:	1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-MeOH 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*							1	1			3	1
					Number of Containers per Sample:			1	1			1	1

Laboratory Use Only

Cooler Present: yes ○Drop Off
Seals Intact: ○Pickup
Cooler Temperature: 3.8 °C IR

Sampled by : Briley Barra

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Briley Barra AECOM 12/22/21 1740	12/22/21 17:40	12/22/21 18:53	12-22-21 1852
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22A0694

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 1:07 pm, Jan 31, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0694

SAMPLE RECEIPT

The following samples were received on January 24, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22A0694-01	DU-6-67	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0694

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0694

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-67
Date Sampled: 01/24/22 15:05
Percent Solids: N/A

ESS Laboratory Work Order: 22A0694
ESS Laboratory Sample ID: 22A0694-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.456** (0.100)		200.7		1	KJK	01/26/22 2:09	10	10	DA22446
Manganese	**0.080** (0.020)		200.7		1	KJK	01/26/22 2:09	10	10	DA22446

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-67
Date Sampled: 01/24/22 15:05
Percent Solids: N/A

ESS Laboratory Work Order: 22A0694
ESS Laboratory Sample ID: 22A0694-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**5.20** (0.210)		353.2		10	JLK	01/25/22 20:56	mg/L	[CALC]
Total Nitrogen	**5.80** (0.200)		4500N		10	EEM	01/26/22 14:58	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0694

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DA22446 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.51		mg/L	2.500		100	80-120			
Manganese	0.500		mg/L	0.5000		100	80-120			
Classical Chemistry										
Batch DA22531 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.257		mg/L	0.2497		103	90-110			
Batch DA22532 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.518		mg/L	0.5000		104	90-110			
Nitrate/Nitrite as N	0.518		mg/L	0.5000		104	90-110			
Batch DA22533 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	22.0	2.00	mg/L	19.90		110	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0694

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0694

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22A0694
Date Received: 1/24/2022
Project Due Date: 1/31/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	252752	Yes	N/A	Yes	250 mL Poly	H2SO4	
1	252753	Yes	N/A	Yes	250 mL Poly	NP	
1	252754	Yes	N/A	Yes	250 mL Poly	NP	

2nd Review
Were all containers scanned into storage/lab? Initials KL Yes / No
Are barcode labels on correct containers? Yes / No / NA
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA
Are all Hex Chrome stickers attached? Yes / No / NA
Are all QC stickers attached? Yes / No / NA
Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Date & Time: 1-24-22 1719
Reviewed By: Date & Time: 1/24/22 1721

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22A0694

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP	

Reporting Limits

Electonic Deliverables ☐Data Checker ☐Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Contact Person	Address
Julianne Marrion	250 Apollo Dr

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: NO2, NO3, SO4, Cl	TN, Ammonia	Lab Filter Dissolved Fe, Mn	DOC	Lab Filtered Dissolved Arsenic	Methane	TOT N	N-Nitrate
1	1/24/22	1505	Grab	Ground Water	DV-6-67			X				X	X
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial			P	P
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	3	3
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-MeOH	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1
											Number of Containers per Sample:	1	1

Laboratory Use Only

Cooler Present: YES ○Drop Off
Seals Intact: ○Pickup
Cooler Temperature: 2.1 °C IR

Sampled by : C Hayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C Hayden AECOM 1/24/22 1505	1/24/22 16:25	1/24/22 17:13	1-24-22 1713
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22A0724

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 12:39 pm, Feb 01, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0724

SAMPLE RECEIPT

The following samples were received on January 25, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22A0724-01	DV-6-33	Ground Water	200.7, 353.2, 4500N
22A0724-02	DV-1-37	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0724

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0724

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DV-6-33
Date Sampled: 01/25/22 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 22A0724
ESS Laboratory Sample ID: 22A0724-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/26/22 14:56	10	10	DA22615
Manganese	**0.091** (0.020)		200.7		1	KJK	01/26/22 14:56	10	10	DA22615

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DV-6-33
Date Sampled: 01/25/22 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 22A0724
ESS Laboratory Sample ID: 22A0724-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**8.72** (0.210)		353.2		10	JLK	01/25/22 20:59	mg/L	[CALC]
Total Nitrogen	**8.72** (0.200)		4500N		10	EEM	01/28/22 15:19	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DV-1-37
Date Sampled: 01/25/22 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 22A0724
ESS Laboratory Sample ID: 22A0724-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/26/22 14:58	10	10	DA22615
Manganese	**0.025** (0.020)		200.7		1	KJK	01/26/22 14:58	10	10	DA22615

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DV-1-37
Date Sampled: 01/25/22 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 22A0724
ESS Laboratory Sample ID: 22A0724-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.813** (0.0300)		353.2		1	JLK	01/25/22 20:53	mg/L	[CALC]
Total Nitrogen	**1.21** (0.200)		4500N		1	EEM	01/28/22 15:20	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0724

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DA22615 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.504		mg/L	0.5000		101	80-120			
Classical Chemistry										
Batch DA22531 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.257		mg/L	0.2497		103	90-110			
Batch DA22532 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.518		mg/L	0.5000		104	90-110			
Nitrate/Nitrite as N	0.518		mg/L	0.5000		104	90-110			
Batch DA22716 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.6	2.00	mg/L	19.90		104	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0724

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0724

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22A0724
Date Received: 1/25/2022
Project Due Date: 2/1/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.9 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	253052	Yes	N/A	Yes	250 mL Poly	NP	
1	253053	Yes	N/A	Yes	250 mL Poly	NP	
1	253056	Yes	N/A	Yes	250 mL Poly	H2SO4	
2	253054	Yes	N/A	Yes	250 mL Poly	NP	
2	253055	Yes	N/A	Yes	250 mL Poly	NP	
2	253057	Yes	N/A	Yes	250 mL Poly	H2SO4	

2nd Review
Initials KC
Were all containers scanned into storage/lab? Yes / No
Are barcode labels on correct containers? Yes / No / NA
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA
Are all Hex Chrome stickers attached? Yes / No / NA
Are all QC stickers attached? Yes / No / NA
Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Date & Time: 1-25-22 1806

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22A0724

Date Received: 1/25/2022

Reviewed By: Taylor Davis

Date & Time: 1/25/22 1809

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22A0724

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP	

Reporting Limits

Electonic Deliverables ☐Data Checker ☐Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Contact Person	Address
Julianne Marrion	250 Apollo Dr

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: NO2, NO3, SO4, Cl	TN, Ammonia	Lab Filter Dissolved Fe, Mn	DOC	Lab Filtered Dissolved Arsenic	Methane	Total Nitrate
1	1/25/22	1425	Grab	Ground Water	DV-6-33			X				X X
2	1/25/22	1530	Grab	Ground Water	DV-1-37			X				X X
			Grab	Ground Water								
			Grab	Ground Water								
			Grab	Ground Water								
			Grab	Ground Water								
			Grab	Ground Water								
Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial								P	AG			P P
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*								3	G			3 3
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-MeOH 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*								1	1			3 1
Number of Containers per Sample:								1	0			1 1

Laboratory Use Only

Cooler Present: Yes ○Drop Off
Seals Intact: ○Pickup
Cooler Temperature: 3.9 °C IR

Sampled by : C. Hayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C. Hayden AECOM 1/25/22 1705	1/25/22 17:05	1/25/22 17:58	1/25-22 1758
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22A0769

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:53 pm, Feb 03, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0769

SAMPLE RECEIPT

The following samples were received on January 26, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22A0769-01	NA-1-78	Ground Water	200.7, 353.2, 4500N
22A0769-02	RI-2-44	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0769

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0769

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-1-78
Date Sampled: 01/26/22 09:50
Percent Solids: N/A

ESS Laboratory Work Order: 22A0769
ESS Laboratory Sample ID: 22A0769-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/27/22 12:03	10	10	DA22615
Manganese	ND (0.020)		200.7		1	KJK	01/27/22 12:03	10	10	DA22615

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-1-78
Date Sampled: 01/26/22 09:50
Percent Solids: N/A

ESS Laboratory Work Order: 22A0769
ESS Laboratory Sample ID: 22A0769-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.71** (0.110)		353.2		5	JLK	01/26/22 21:04	mg/L	[CALC]
Total Nitrogen	**1.93** (0.200)		4500N		5	EEM	01/28/22 15:21	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-2-44
Date Sampled: 01/26/22 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0769
ESS Laboratory Sample ID: 22A0769-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/27/22 12:12	10	10	DA22615
Manganese	ND (0.020)		200.7		1	KJK	01/27/22 12:12	10	10	DA22615

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-2-44
Date Sampled: 01/26/22 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0769
ESS Laboratory Sample ID: 22A0769-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.34** (0.110)		353.2		5	JLK	01/26/22 21:05	mg/L	[CALC]
Total Nitrogen	**1.34** (0.200)		4500N		5	EEM	01/28/22 15:21	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0769

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DA22615 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.504		mg/L	0.5000		101	80-120			
Classical Chemistry										
Batch DA22649 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.257		mg/L	0.2497		103	90-110			
Batch DA22650 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.498		mg/L	0.5000		100	90-110			
Nitrate/Nitrite as N	0.498		mg/L	0.5000		100	90-110			
Batch DA22716 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	20.6	2.00	mg/L	19.90		104	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0769

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0769

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22A0769
Date Received: 1/26/2022
Project Due Date: 2/2/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 5.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? Date: Time: By:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	253313	Yes	N/A	Yes	250 mL Poly	H2SO4	
1	253315	Yes	N/A	Yes	250 mL Poly	NP	
1	253317	Yes	N/A	Yes	250 mL Poly	NP	
2	253314	Yes	N/A	Yes	250 mL Poly	H2SO4	
2	253316	Yes	N/A	Yes	250 mL Poly	NP	
2	253318	Yes	N/A	Yes	250 mL Poly	NP	

2nd Review
Were all containers scanned into storage/lab? Initials
Are barcode labels on correct containers? (Yes) / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / (NA)
Are all Hex Chrome stickers attached? Yes / No / (NA)
Are all QC stickers attached? Yes / No / (NA)
Are VOA stickers attached if bubbles noted? Yes / No / (NA)

Completed By: Date & Time: 1/26/22 1032

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22A0769

Date Received: 1/26/2022

Reviewed By: [signature]

Date & Time: 1/26/22 1646

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22A0769

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP	

Reporting Limits

Electonic Deliverables ☐Data Checker ☐Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Contact Person	Address
Julianne Marrion	250 Apollo Dr

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: NO2, NO3, SO4, Cl	TN, Ammonia	Lab Filter Dissolved Fe, Mn	DOC	Lab Filtered Dissolved Arsenic	Methane	Tot N	NH3N
1	1/26/22	0950	Grab	Ground Water	NA-1-78			X				X	X
2	1/26/22	1055	Grab	Ground Water	RI-2-44			X				X	X
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									
			Grab	Ground Water									
Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial								P	AG			P	P
Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*								3	6			3	3
Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-MeOH 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*								1	1			3	1
Number of Containers per Sample:								2	0			2	2

Laboratory Use Only

Cooler Present: Yes ○Drop Off
Seals Intact: ○Pickup
Cooler Temperature: 5.1 °C IR

Sampled by :

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C Hanyan 1/26/22 1450	1/26/22 14:34	1/26/22 15:58	Taylor Dawes 1558 1/26/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22A0844

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 4:45 pm, Feb 07, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0844

SAMPLE RECEIPT

The following samples were received on January 27, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22A0844-01	BR-3-80	Ground Water	200.7, 353.2, 4500N
22A0844-02	BR-3-60	Ground Water	200.7, 353.2, 4500N
22A0844-03	BR-2-36	Ground Water	200.7, 353.2, 4500N
22A0844-04	BR-2-66	Ground Water	200.7, 353.2, 4500N
22A0844-05	BR-1-55	Ground Water	200.7, 353.2, 4500N
22A0844-06	BR-1-77	Ground Water	200.7, 353.2, 4500N, 5310B
22A0844-07	BR-6-56	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0844

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0844

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-80
Date Sampled: 01/27/22 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/28/22 17:58	10	10	DA22823
Manganese	**0.152** (0.020)		200.7		1	KJK	01/28/22 17:58	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-80
Date Sampled: 01/27/22 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.620** (0.0300)		353.2		1	JLK	01/27/22 22:11	mg/L	[CALC]
Total Nitrogen	**0.620** (0.200)		4500N		1	JLK	02/02/22 17:28	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-60
Date Sampled: 01/27/22 12:08
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.465** (0.100)		200.7		1	KJK	01/28/22 18:00	10	10	DA22823
Manganese	ND (0.020)		200.7		1	KJK	01/28/22 18:00	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-60
Date Sampled: 01/27/22 12:08
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.646** (0.0300)		353.2		1	JLK	01/27/22 22:12	mg/L	[CALC]
Total Nitrogen	**0.861** (0.200)		4500N		1	JLK	02/02/22 17:29	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-36
Date Sampled: 01/27/22 13:15
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/28/22 18:02	10	10	DA22823
Manganese	ND (0.020)		200.7		1	KJK	01/28/22 18:02	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-36
Date Sampled: 01/27/22 13:15
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.06** (0.0500)		353.2		2	JLK	01/27/22 22:38	mg/L	[CALC]
Total Nitrogen	**1.06** (0.200)		4500N		2	JLK	02/02/22 17:30	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-66
Date Sampled: 01/27/22 13:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.150** (0.100)		200.7		1	KJK	01/28/22 18:04	10	10	DA22823
Manganese	**0.053** (0.020)		200.7		1	KJK	01/28/22 18:04	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-66
Date Sampled: 01/27/22 13:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.807** (0.0300)		353.2		1	JLK	01/27/22 22:13	mg/L	[CALC]
Total Nitrogen	**0.807** (0.200)		4500N		1	JLK	02/02/22 17:30	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-55
Date Sampled: 01/27/22 14:50
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/28/22 18:07	10	10	DA22823
Manganese	**0.025** (0.020)		200.7		1	KJK	01/28/22 18:07	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-55
Date Sampled: 01/27/22 14:50
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.806** (0.0300)		353.2		1	JLK	01/27/22 22:14	mg/L	[CALC]
Total Nitrogen	**0.806** (0.200)		4500N		1	JLK	02/02/22 17:37	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-77
Date Sampled: 01/27/22 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.155** (0.100)		200.7		1	KJK	01/28/22 18:09	10	10	DA22823
Manganese	**0.068** (0.020)		200.7		1	KJK	01/28/22 18:09	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-77
Date Sampled: 01/27/22 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.47** (0.500)		5310B		1	CCP	01/31/22 22:11	mg/L	[CALC]
Nitrate as N	**1.31** (0.110)		353.2		5	JLK	01/27/22 22:39	mg/L	[CALC]
Total Nitrogen	**1.31** (0.200)		4500N		5	JLK	02/02/22 17:38	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-56
Date Sampled: 01/27/22 15:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	01/28/22 18:11	10	10	DA22823
Manganese	ND (0.020)		200.7		1	KJK	01/28/22 18:11	10	10	DA22823

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-56
Date Sampled: 01/27/22 15:55
Percent Solids: N/A

ESS Laboratory Work Order: 22A0844
ESS Laboratory Sample ID: 22A0844-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.86** (0.110)		353.2		5	JLK	01/27/22 22:40	mg/L	[CALC]
Total Nitrogen	**2.11** (0.200)		4500N		5	JLK	02/02/22 17:38	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0844

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DA22823 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.49		mg/L	2.500		99	80-120			
Manganese	0.508		mg/L	0.5000		102	80-120			
Classical Chemistry										
Batch DA22746 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.257		mg/L	0.2497		103	90-110			
Batch DA22747 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.460		mg/L	0.5000		92	90-110			
Nitrate/Nitrite as N	0.460		mg/L	0.5000		92	90-110			
Batch DA23143 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.75	0.500	mg/L	5.000		95	80-120			
Dissolved Organic Carbon (2)	4.82	0.500	mg/L	5.000		96	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	4.99	0.500	mg/L	5.000		100	80-120	5	20	
Dissolved Organic Carbon (2)	4.96	0.500	mg/L	5.000		99	80-120	3	20	
Batch DB20122 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	22.5	2.00	mg/L	19.90		113	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0844

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22A0844

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22A0844
Date Received: 1/27/2022
Project Due Date: 2/3/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 4.7 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? ~~Yes~~ No mlh 1/31/22
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

No tests marked for Sample 7. Reid bottles consistent with other samples

14. Was there a need to contact Project Manager? (Yes) / No mlh 1/31/22
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Chris Hayden Date: 1/28/22 Time: 1725 By: ML

Sample 07 needs sames tests as other samples (sans DOC)

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	253802	Yes	N/A	Yes	250 mL Poly	NP	
1	253803	Yes	N/A	Yes	250 mL Poly	NP	
1	253814	Yes	N/A	Yes	250 mL Poly	H2SO4	
2	253804	Yes	N/A	Yes	250 mL Poly	NP	
2	253805	Yes	N/A	Yes	250 mL Poly	NP	
2	253815	Yes	N/A	Yes	250 mL Poly	H2SO4	
3	253806	Yes	N/A	Yes	250 mL Poly	NP	
3	253807	Yes	N/A	Yes	250 mL Poly	NP	
3	253816	Yes	N/A	Yes	250 mL Poly	H2SO4	
4	253808	Yes	N/A	Yes	250 mL Poly	NP	
4	253809	Yes	N/A	Yes	250 mL Poly	NP	
4	253817	Yes	N/A	Yes	250 mL Poly	H2SO4	
5	253810	Yes	N/A	Yes	250 mL Poly	NP	
5	253811	Yes	N/A	Yes	250 mL Poly	NP	
5	253818	Yes	N/A	Yes	250 mL Poly	H2SO4	
6	253812	Yes	N/A	Yes	250 mL Poly	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22A0844

Date Received: 1/27/2022

6	253813	Yes	N/A	Yes	250 mL Poly	NP
6	253819	Yes	N/A	Yes	250 mL Poly	H2SO4
6	253820	Yes	N/A	Yes	1L Amber	NP
7	253893	Yes	N/A	Yes	250 mL Poly	NP
7	253894	Yes	N/A	Yes	250 mL Poly	NP
7	253895	Yes	N/A	Yes	250 mL Poly	H2SO4

2nd Review

Were all containers scanned into storage/lab? Initials KL

Are barcode labels on correct containers? Yes / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: KZ Date & Time: 1.27.22 1903

Reviewed By: [signature] Date & Time: 1/27/22 1908

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
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CHAIN OF CUSTODY

ESS Lab # 22A0844

Turn Time: 5 Days
Regulatory State: Massachusetts
Is this project for any of the following?: ○CT RCP ○MA MCP ○RGP
Reporting Limits:
Electonic Deliverables: ☐Data Checker ☐Excel ☐Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Contact Person	Address		
Julianne Marrion	250 Apollo Dr		
City	**State**	**Zip Code**	**PO #**
Chelmsford	MA	01824	
Telephone Number	**FAX Number**	**Email Address**	
978-905-2419		julianne.marrion@aecom.com	

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: NO2, NO3, SO4, Cl	TN, Ammonia	Lab Filter Dissolved Fe, Mn	DOC	Lab Filtered Dissolved Arsenic	Methane	TKN	NH3-N
1	1/27/22	1205	Grab	Ground Water	BR-3-80			X				X	X
2		1258	Grab	Ground Water	BR-3-60			X				X	X
3		1316	Grab	Ground Water	BR-2-86			X				X	X
4		1355	Grab	Ground Water	BR-2-46			X				X	X
5		1450	Grab	Ground Water	BR-1-55			X				X	X
6		1455	Grab	Ground Water	BR-1-77			X	X			X	X
7	↓	1555	Grab	Ground Water	BR-6-56			X				X	X
					ML -1/31/22								
Container Type:					AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial			P	AG			P	P
Container Volume:					1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*			3	6			3	3
Preservation Code:					1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-MeOH 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*			1	1			3	1
					Number of Containers per Sample:			1	1			1	1

Laboratory Use Only
Cooler Present: Yes ○Drop Off
Seals Intact: ○Pickup
Cooler Temperature: 1.7 °C IC

Sampled by : CHayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
1/27/22 1645	1/27/22 16:45	1/27/22 18:24	1-27-22 18:24
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22B0131

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 4:29 pm, Feb 10, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22B0131

SAMPLE RECEIPT

The following samples were received on February 03, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22B0131-01	BR-4-84	Ground Water	200.7, 353.2, 4500N
22B0131-02	BR-4-68	Ground Water	200.7, 353.2, 4500N
22B0131-03	BR-5-64	Ground Water	200.7, 353.2, 4500N
22B0131-04	BR-5-37	Ground Water	200.7, 353.2, 4500N
22B0131-05	NA-2-55	Ground Water	200.7, 353.2, 4500N, 5310B
22B0131-06	NA-2-22	Ground Water	200.7, 353.2, 4500N
22B0131-07	RI-3-77	Ground Water	200.7, 353.2, 4500N

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22B0131

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22B0131

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-84
Date Sampled: 02/03/22 11:20
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.181** (0.100)		200.7		1	KJK	02/08/22 18:54	10	10	DB20831
Manganese	**0.183** (0.020)		200.7		1	KJK	02/08/22 18:54	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-84
Date Sampled: 02/03/22 11:20
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**2.60** (0.110)		353.2		5	JLK	02/03/22 22:13	mg/L	[CALC]
Total Nitrogen	**2.62** (0.200)		4500N		5	JLK	02/07/22 16:47	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-68
Date Sampled: 02/03/22 11:17
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.223** (0.100)		200.7		1	KJK	02/08/22 19:03	10	10	DB20831
Manganese	**0.045** (0.020)		200.7		1	KJK	02/08/22 19:03	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-68
Date Sampled: 02/03/22 11:17
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**0.435** (0.0300)		353.2		1	JLK	02/03/22 21:58	mg/L	[CALC]
Total Nitrogen	**0.824** (0.200)		4500N		1	JLK	02/07/22 16:48	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-64
Date Sampled: 02/03/22 12:40
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.133** (0.100)		200.7		1	KJK	02/08/22 19:05	10	10	DB20831
Manganese	**0.044** (0.020)		200.7		1	KJK	02/08/22 19:05	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-64
Date Sampled: 02/03/22 12:40
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.09** (0.0500)		353.2		2	JLK	02/03/22 22:14	mg/L	[CALC]
Total Nitrogen	**1.45** (0.200)		4500N		2	JLK	02/07/22 16:49	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-37
Date Sampled: 02/03/22 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/08/22 19:07	10	10	DB20831
Manganese	**0.449** (0.020)		200.7		1	KJK	02/08/22 19:07	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-37
Date Sampled: 02/03/22 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.07** (0.0500)		353.2		2	JLK	02/03/22 22:15	mg/L	[CALC]
Total Nitrogen	**1.43** (0.200)		4500N		2	JLK	02/07/22 16:50	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-55
Date Sampled: 02/03/22 14:30
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**1.17** (0.100)		200.7		1	KJK	02/08/22 19:10	10	10	DB20831
Manganese	**1.38** (0.020)		200.7		1	KJK	02/08/22 19:10	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-55
Date Sampled: 02/03/22 14:30
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.00** (0.500)		5310B		1	CCP	02/07/22 21:13	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	JLK	02/03/22 22:01	mg/L	[CALC]
Total Nitrogen	**0.695** (0.200)		4500N		1	JLK	02/07/22 16:50	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-22
Date Sampled: 02/03/22 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**3.00** (0.100)		200.7		1	KJK	02/08/22 19:12	10	10	DB20831
Manganese	**0.096** (0.020)		200.7		1	KJK	02/08/22 19:12	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-22
Date Sampled: 02/03/22 14:10
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	ND (0.0300)		353.2		1	JLK	02/03/22 22:02	mg/L	[CALC]
Total Nitrogen	**0.758** (0.200)		4500N		1	JLK	02/07/22 16:51	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-3-77
Date Sampled: 02/03/22 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	02/08/22 19:14	10	10	DB20831
Manganese	**0.058** (0.020)		200.7		1	KJK	02/08/22 19:14	10	10	DB20831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-3-77
Date Sampled: 02/03/22 15:30
Percent Solids: N/A

ESS Laboratory Work Order: 22B0131
ESS Laboratory Sample ID: 22B0131-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Nitrate as N	**1.14** (0.0500)		353.2		2	JLK	02/03/22 22:16	mg/L	[CALC]
Total Nitrogen	**1.34** (0.200)		4500N		2	JLK	02/07/22 16:52	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22B0131

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DB20831 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.54		mg/L	2.500		102	80-120			
Manganese	0.510		mg/L	0.5000		102	80-120			
Classical Chemistry										
Batch DB20331 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.255		mg/L	0.2497		102	90-110			
Batch DB20332 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.538		mg/L	0.5000		108	90-110			
Nitrate/Nitrite as N	0.538		mg/L	0.5000		108	90-110			
Batch DB20422 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	22.3	2.00	mg/L	19.90		112	80-120			
Batch DB20748 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.86	0.500	mg/L	5.000		97	80-120			
Dissolved Organic Carbon (2)	4.94	0.500	mg/L	5.000		99	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	4.79	0.500	mg/L	5.000		96	80-120	2	20	
Dissolved Organic Carbon (2)	4.78	0.500	mg/L	5.000		96	80-120	3	20	

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22B0131

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22B0131

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22B0131
Date Received: 2/3/2022
Project Due Date: 2/10/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.2 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? ~~Yes~~ No
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

Samples 1+2 times are swapped on bottles when comparing it to the COC

14. Was there a need to contact Project Manager? (Yes) / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Juli Marrion Date: 2/4/22 Time: By: ML

Sample jars are correct. COC corrected

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	255004	Yes	N/A	Yes	250 mL Poly	NP	
1	255005	Yes	N/A	Yes	250 mL Poly	NP	
1	255018	Yes	N/A	Yes	250 mL Poly	H2SO4	
2	255006	Yes	N/A	Yes	250 mL Poly	NP	
2	255007	Yes	N/A	Yes	250 mL Poly	NP	
2	255019	Yes	N/A	Yes	250 mL Poly	H2SO4	
3	255008	Yes	N/A	Yes	250 mL Poly	NP	
3	255009	Yes	N/A	Yes	250 mL Poly	NP	
3	255020	Yes	N/A	Yes	250 mL Poly	H2SO4	
4	255010	Yes	N/A	Yes	250 mL Poly	NP	
4	255011	Yes	N/A	Yes	250 mL Poly	NP	
4	255021	Yes	N/A	Yes	250 mL Poly	H2SO4	
5	255012	Yes	N/A	Yes	250 mL Poly	NP	
5	255013	Yes	N/A	Yes	250 mL Poly	NP	
5	255022	Yes	N/A	Yes	250 mL Poly	H2SO4	
5	255025	Yes	N/A	Yes	1L Amber	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22B0131
Date Received: 2/3/2022

6	255014	Yes	N/A	Yes	250 mL Poly	NP
6	255015	Yes	N/A	Yes	250 mL Poly	NP
6	255023	Yes	N/A	Yes	250 mL Poly	H2SO4
7	255016	Yes	N/A	Yes	250 mL Poly	NP
7	255017	Yes	N/A	Yes	250 mL Poly	NP
7	255024	Yes	N/A	Yes	250 mL Poly	H2SO4

2nd Review

Were all containers scanned into storage/lab? Initials

Are barcode labels on correct containers? Yes / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Date & Time: 1812 2/3/22

Reviewed By: Date & Time: 2/3/22 1821

ML - 2/4/22

TD 2/3/22

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # ~~22B00~~ 22B0131

Reporting Limits

Electonic Deliverables ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○CT RCP ○MA MCP ○RGP	

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Contact Person	Address
Julianne Marrion	250 Apollo Dr

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: NO2, NO3, SO4, Cl	TN, Ammonia	Lab Filter Dissolved Fe, Mn	DOC	Lab Filtered Dissolved Arsenic	Methane	TKN	Nitrate-N
1	2/3/22	~~1117~~	1120 Grab	Ground Water	BR-21-84			X				X	X
2	↓	~~1120~~	1117 Grab	Ground Water	BR-21-68			X				X	X
3		1240	Grab	Ground Water	BR-5-64			X				X	X
4		1235	Grab	Ground Water	BR-5-37			X				X	X
5		1430	Grab	Ground Water	NA-2-55			X	X			X	X
6		1410	Grab	Ground Water	NA-2-22			X				X	X
7		1530	Grab	Ground Water	RI-3-77			X				X	X

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-MeOH 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*

Number of Containers per Sample:								
			P	AG			P	P
			3	C			3	3
			1	1			3	1
			1	1			1	1

Laboratory Use Only

Cooler Present: Yes ○Drop Off

Seals Intact: ○Pickup

Cooler Temperature: 3.2 °C / Ice

Sampled by : B. Young

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
2-3-22 1635	2/3/22 16:35	2/3/22 18:00	Taylor Davies 2/3/22 1800
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0314

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 7:31 pm, May 18, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0314

SAMPLE RECEIPT

The following samples were received on May 10, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0314-01	NA-1-78	Ground Water	200.7, 353.2, 4500N, 5310B
22E0314-02	NA-1-92	Ground Water	200.7, 353.2, 4500N, 5310B
22E0314-03	RI-2-44	Ground Water	200.7, 353.2, 4500N, 5310B
22E0314-04	RI-2-58	Ground Water	200.7, 353.2, 4500N, 5310B
22E0314-05	RI-3-77	Ground Water	200.7, 353.2, 4500N, 5310B
22E0314-06	RI-3-90	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0314

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0314

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-1-78
Date Sampled: 05/09/22 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/14/22 15:53	10	10	DE21146
Manganese	ND (0.020)		200.7		1	KJK	05/12/22 15:58	10	10	DE21146

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-1-78
Date Sampled: 05/09/22 14:20
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.650** (0.500)		5310B		1	CCP	05/10/22 22:19	mg/L	[CALC]
Nitrate as N	**1.83** (0.110)		353.2		5	JLK	05/10/22 19:44	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/10/22 18:23	mg/L	DE21030
Total Nitrogen	**1.83** (0.200)		4500N		5	JLK	05/18/22 15:21	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-1-92
Date Sampled: 05/09/22 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/14/22 16:08	10	10	DE21146
Manganese	ND (0.020)		200.7		1	KJK	05/12/22 16:13	10	10	DE21146

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-1-92
Date Sampled: 05/09/22 14:25
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.648** (0.500)		5310B		1	CCP	05/11/22 15:08	mg/L	[CALC]
Nitrate as N	**0.739** (0.0300)		353.2		1	JLK	05/10/22 19:21	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/10/22 18:24	mg/L	DE21030
Total Nitrogen	**1.39** (0.200)		4500N		1	JLK	05/18/22 15:21	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-2-44
Date Sampled: 05/09/22 11:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/14/22 16:10	10	10	DE21146
Manganese	**0.028** (0.020)		200.7		1	KJK	05/12/22 16:15	10	10	DE21146

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-2-44
Date Sampled: 05/09/22 11:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	ND (0.500)		5310B		1	CCP	05/11/22 15:20	mg/L	[CALC]
Nitrate as N	**1.13** (0.0500)		353.2		2	JLK	05/10/22 19:45	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/10/22 18:25	mg/L	DE21030
Total Nitrogen	**1.67** (0.200)		4500N		2	JLK	05/18/22 15:22	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-2-58
Date Sampled: 05/09/22 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**2.16** (0.100)		200.7		1	KJK	05/14/22 16:12	10	10	DE21146
Manganese	**0.419** (0.020)		200.7		1	KJK	05/12/22 16:17	10	10	DE21146

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-2-58
Date Sampled: 05/09/22 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.751** (0.500)		5310B		1	CCP	05/11/22 15:32	mg/L	[CALC]
Nitrate as N	**0.451** (0.0300)		353.2		1	JLK	05/10/22 19:23	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/10/22 18:26	mg/L	DE21030
Total Nitrogen	**0.882** (0.200)		4500N		1	JLK	05/18/22 15:29	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-3-77
Date Sampled: 05/09/22 13:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/14/22 16:15	10	10	DE21146
Manganese	**0.065** (0.020)		200.7		1	KJK	05/12/22 16:19	10	10	DE21146

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-3-77
Date Sampled: 05/09/22 13:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.776** (0.500)		5310B		1	CCP	05/11/22 15:44	mg/L	[CALC]
Nitrate as N	**0.481** (0.0300)		353.2		1	JLK	05/10/22 19:29	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/10/22 18:32	mg/L	DE21030
Total Nitrogen	**0.481** (0.200)		4500N		1	JLK	05/18/22 15:29	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-3-90
Date Sampled: 05/09/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.157** (0.100)		200.7		1	KJK	05/17/22 18:11	10	10	DE21146
Manganese	**0.105** (0.020)		200.7		1	KJK	05/12/22 16:21	10	10	DE21146

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-3-90
Date Sampled: 05/09/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0314
ESS Laboratory Sample ID: 22E0314-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.690** (0.500)		5310B		1	CCP	05/11/22 15:57	mg/L	[CALC]
Nitrate as N	**1.58** (0.110)		353.2		5	JLK	05/10/22 19:46	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/10/22 18:32	mg/L	DE21030
Total Nitrogen	**1.58** (0.200)		4500N		5	JLK	05/18/22 15:30	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0314

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE21146 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
LCS										
Iron	2.54		mg/L	2.500		102	80-120			
Manganese	0.515		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE21030 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.249		mg/L	0.2497		100	90-110			
Nitrite as N	0.249		mg/L	0.2497		100	90-110			
Batch DE21031 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.504		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.504		mg/L	0.5000		101	90-110			
Batch DE21047 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.62	0.500	mg/L	5.000		92	80-120			
Dissolved Organic Carbon (2)	4.75	0.500	mg/L	5.000		95	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	4.66	0.500	mg/L	5.000		93	80-120	0.8	20	
Dissolved Organic Carbon (2)	4.67	0.500	mg/L	5.000		93	80-120	2	20	
Batch DE21737 - General Preparation										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	11.7	2.00	mg/L	13.20		88	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0314

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0314

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0314
Date Received: 5/10/2022
Project Due Date: 5/17/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 4.4 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? (Yes) / No
    ESS Sample IDs: 1-10
    Analysis: TN Nitrogen
    TAT: 5 Day
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: ____ Time: ____ By/Acid Lot#: ____
    b. Low Level VOA vials frozen: Date: ____ Time: ____ By: ____

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? ____ Date: ____ Time: ____ By: ____

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	289747	Yes	N/A	Yes	1L Poly	H2SO4	
1	289753	Yes	N/A	Yes	250 mL Poly	NP	
1	289759	Yes	N/A	Yes	250 mL Amber	NP	
1	290229	Yes	N/A	Yes	250 mL Poly	NP	
2	289748	Yes	N/A	Yes	1L Poly	H2SO4	
2	289754	Yes	N/A	Yes	250 mL Poly	NP	
2	289760	Yes	N/A	Yes	250 mL Amber	NP	
2	290230	Yes	N/A	Yes	250 mL Poly	NP	
3	289749	Yes	N/A	Yes	1L Poly	H2SO4	
3	289755	Yes	N/A	Yes	250 mL Poly	NP	
3	289761	Yes	N/A	Yes	250 mL Amber	NP	
3	290231	Yes	N/A	Yes	250 mL Poly	NP	
4	289750	Yes	N/A	Yes	1L Poly	H2SO4	
4	289756	Yes	N/A	Yes	250 mL Poly	NP	
4	289762	Yes	N/A	Yes	250 mL Amber	NP	
4	290232	Yes	N/A	Yes	250 mL Poly	NP	
5	289751	Yes	N/A	Yes	1L Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0314
Date Received: 5/10/2022

5	289757	Yes	N/A	Yes	250 mL Poly	NP
5	289763	Yes	N/A	Yes	250 mL Amber	NP
5	290233	Yes	N/A	Yes	250 mL Poly	NP
6	289752	Yes	N/A	Yes	1L Poly	H2SO4
6	289758	Yes	N/A	Yes	250 mL Poly	NP
6	289764	Yes	N/A	Yes	250 mL Amber	NP
6	290234	Yes	N/A	Yes	250 mL Poly	NP

2nd Review

Were all containers scanned into storage/lab? Initials KL

Are barcode labels on correct containers? (Yes) / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: KL Date & Time: 5.10.22 1702

Reviewed By: Taylor Davis Date & Time: 5/10/22 1718.

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22E0314

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○ CT RCP ○ MA MCP ○ RGP	
Reporting Limits		
Electonic Deliverables	☐ Data Checker ☐ Excel ☐ Other (Please Specify →)	

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

	Address	
Julianne Marrion	250 Apollo Dr	

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC
1	5.9.22	1420	Grab	Ground Water	NA-1-78	X	X	X	X
2	↓	1425	Grab	Ground Water	NA-1-92	X	X	X	X
3		1150	Grab	Ground Water	RI-2-44	X	X	X	X
4		1205	Grab	Ground Water	RI-2-58	X	X	X	X
5		1310	Grab	Ground Water	RI-3-77	X	X	X	X
6	↓	1305	Grab	Ground Water	RI-3-90	X	X	X	X
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2
											Number of Containers per Sample:	1	1	1	1	2

Laboratory Use Only

Cooler Present: Yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 4.4 °C Ice

Sampled by : C Hayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C Hayden 5.9.22 1615	5/9 16:17	5/10 11:29	5/10/22 11:29
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
5/10/22 16:38	5.10.22 1638		

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0397

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:08 pm, May 19, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0397

SAMPLE RECEIPT

The following samples were received on May 11, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0397-01	DU-2-26	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-02	DU-2-63	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-03	DU-2-100	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-04	DU-1-37	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-05	DU-1-68	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-06	DU-1-100	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-07	DU-3-51	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-08	DU-3-76	Ground Water	200.7, 353.2, 4500N, 5310B
22E0397-09	DU-3-100	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0397

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0397

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-26
Date Sampled: 05/10/22 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:11	10	10	DE21338
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 20:11	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-26
Date Sampled: 05/10/22 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**5.23** (0.500)		5310B		1	CCP	05/12/22 19:53	mg/L	[CALC]
Nitrate as N	**4.15** (0.210)		353.2		10	JLK	05/11/22 20:22	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:20	mg/L	DE21128
Total Nitrogen	**4.65** (0.200)		4500N		10	JLK	05/18/22 15:31	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-63
Date Sampled: 05/10/22 10:20
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:20	10	10	DE21338
Manganese	**0.049** (0.020)		200.7		1	KJK	05/17/22 20:20	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-63
Date Sampled: 05/10/22 10:20
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.794** (0.500)		5310B		1	CCP	05/12/22 20:30	mg/L	[CALC]
Nitrate as N	**1.18** (0.110)		353.2		5	JLK	05/11/22 20:25	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:23	mg/L	DE21128
Total Nitrogen	**1.43** (0.200)		4500N		5	JLK	05/18/22 15:32	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-100
Date Sampled: 05/10/22 10:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**1.09** (0.100)		200.7		1	KJK	05/17/22 20:22	10	10	DE21338
Manganese	**0.433** (0.020)		200.7		1	KJK	05/17/22 20:22	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-2-100
Date Sampled: 05/10/22 10:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.554** (0.500)		5310B		1	CCP	05/12/22 20:42	mg/L	[CALC]
Nitrate as N	**0.654** (0.0300)		353.2		1	JLK	05/11/22 19:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:24	mg/L	DE21128
Total Nitrogen	**0.654** (0.200)		4500N		1	JLK	05/18/22 15:33	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-37
Date Sampled: 05/10/22 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:24	10	10	DE21338
Manganese	**0.038** (0.020)		200.7		1	KJK	05/17/22 20:24	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-37
Date Sampled: 05/10/22 12:35
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**2.13** (0.500)		5310B		1	CCP	05/12/22 20:54	mg/L	[CALC]
Nitrate as N	**0.246** (0.0300)		353.2		1	JLK	05/11/22 20:00	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:25	mg/L	DE21128
Total Nitrogen	**0.483** (0.200)		4500N		1	JLK	05/18/22 15:34	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-68
Date Sampled: 05/10/22 11:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:27	10	10	DE21338
Manganese	**0.088** (0.020)		200.7		1	KJK	05/17/22 20:27	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-68
Date Sampled: 05/10/22 11:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.05** (0.500)		5310B		1	CCP	05/12/22 21:07	mg/L	[CALC]
Nitrate as N	**1.56** (0.110)		353.2		5	JLK	05/11/22 20:26	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:26	mg/L	DE21128
Total Nitrogen	**1.56** (0.200)		4500N		5	JLK	05/18/22 15:34	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-100
Date Sampled: 05/10/22 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:29	10	10	DE21338
Manganese	**0.199** (0.020)		200.7		1	KJK	05/17/22 20:29	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-1-100
Date Sampled: 05/10/22 12:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.588** (0.500)		5310B		1	CCP	05/12/22 21:19	mg/L	[CALC]
Nitrate as N	**3.46** (0.210)		353.2		10	JLK	05/11/22 20:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:27	mg/L	DE21128
Total Nitrogen	**3.69** (0.200)		4500N		10	JLK	05/18/22 15:35	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-51
Date Sampled: 05/10/22 15:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:31	10	10	DE21338
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 20:31	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-51
Date Sampled: 05/10/22 15:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.83** (0.500)		5310B		1	CCP	05/12/22 21:56	mg/L	[CALC]
Nitrate as N	**0.990** (0.0300)		353.2		1	JLK	05/11/22 20:08	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:33	mg/L	DE21128
Total Nitrogen	**1.30** (0.200)		4500N		1	JLK	05/18/22 15:36	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-76
Date Sampled: 05/10/22 13:37
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.143** (0.100)		200.7		1	KJK	05/17/22 20:33	10	10	DE21338
Manganese	**0.087** (0.020)		200.7		1	KJK	05/17/22 20:33	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-76
Date Sampled: 05/10/22 13:37
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.16** (0.500)		5310B		1	CCP	05/12/22 22:08	mg/L	[CALC]
Nitrate as N	**2.81** (0.110)		353.2		5	JLK	05/11/22 20:29	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:34	mg/L	DE21128
Total Nitrogen	**3.72** (0.200)		4500N		5	JLK	05/18/22 15:43	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-100
Date Sampled: 05/10/22 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:35	10	10	DE21338
Manganese	**0.043** (0.020)		200.7		1	KJK	05/17/22 20:35	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-3-100
Date Sampled: 05/10/22 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0397
ESS Laboratory Sample ID: 22E0397-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.974** (0.500)		5310B		1	CCP	05/12/22 22:20	mg/L	[CALC]
Nitrate as N	**2.68** (0.110)		353.2		5	JLK	05/11/22 20:30	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 19:34	mg/L	DE21128
Total Nitrogen	**2.68** (0.200)		4500N		5	JLK	05/18/22 15:43	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0397

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE21338 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.52		mg/L	2.500		101	80-120			
Manganese	0.516		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE21128 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.252		mg/L	0.2497		101	90-110			
Nitrite as N	0.252		mg/L	0.2497		101	90-110			
Batch DE21130 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.507		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.507		mg/L	0.5000		101	90-110			
Batch DE21242 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.62	0.500	mg/L	5.000		112	80-120			
Dissolved Organic Carbon (2)	5.72	0.500	mg/L	5.000		114	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.68	0.500	mg/L	5.000		114	80-120	1	20	
Dissolved Organic Carbon (2)	5.65	0.500	mg/L	5.000		113	80-120	1	20	
Batch DE21737 - General Preparation										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	11.7	2.00	mg/L	13.20		88	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0397

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0397

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0397
Date Received: 5/11/2022
Project Due Date: 5/18/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 1.9 Iced with: Ice
5. Was COC signed and dated by client? Yes

6. Does COC match bottles? ~~Yes~~ NO (MM 5/11/22)
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:

12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

COC = DU-2-22 collected 1055 ; Labels = DU-2-26 collected 1055

14. Was there a need to contact Project Manager? Yes / No (MM 5/11/22)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? ~~Julianne Marrion~~ Date: 5/12/22 Time: 1700 By: ML

Resolution:

Bottle are correct

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	290557	Yes	N/A	Yes	1L Poly	H2SO4	
1	290566	Yes	N/A	Yes	250 mL Poly	NP	
1	290575	Yes	N/A	Yes	250 mL Amber	NP	
1	290584	Yes	N/A	Yes	250 mL Poly	NP	
2	290558	Yes	N/A	Yes	1L Poly	H2SO4	
2	290567	Yes	N/A	Yes	250 mL Poly	NP	
2	290576	Yes	N/A	Yes	250 mL Amber	NP	
2	290585	Yes	N/A	Yes	250 mL Poly	NP	
3	290559	Yes	N/A	Yes	1L Poly	H2SO4	
3	290568	Yes	N/A	Yes	250 mL Poly	NP	
3	290577	Yes	N/A	Yes	250 mL Amber	NP	
3	290586	Yes	N/A	Yes	250 mL Poly	NP	
4	290560	Yes	N/A	Yes	1L Poly	H2SO4	
4	290569	Yes	N/A	Yes	250 mL Poly	NP	
4	290578	Yes	N/A	Yes	250 mL Amber	NP	
4	290587	Yes	N/A	Yes	250 mL Poly	NP	
5	290561	Yes	N/A	Yes	1L Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0397
Date Received: 5/11/2022

5	290570	Yes	N/A	Yes	250 mL Poly	NP
5	290579	Yes	N/A	Yes	250 mL Amber	NP
5	290588	Yes	N/A	Yes	250 mL Poly	NP
6	290562	Yes	N/A	Yes	1L Poly	H2SO4
6	290571	Yes	N/A	Yes	250 mL Poly	NP
6	290580	Yes	N/A	Yes	250 mL Amber	NP
6	290589	Yes	N/A	Yes	250 mL Poly	NP
7	290563	Yes	N/A	Yes	1L Poly	H2SO4
7	290572	Yes	N/A	Yes	250 mL Poly	NP
7	290581	Yes	N/A	Yes	250 mL Amber	NP
7	290590	Yes	N/A	Yes	250 mL Poly	NP
8	290564	Yes	N/A	Yes	1L Poly	H2SO4
8	290573	Yes	N/A	Yes	250 mL Poly	NP
8	290582	Yes	N/A	Yes	250 mL Amber	NP
8	290591	Yes	N/A	Yes	250 mL Poly	NP
9	290565	Yes	N/A	Yes	1L Poly	H2SO4
9	290574	Yes	N/A	Yes	250 mL Poly	NP
9	290583	Yes	N/A	Yes	250 mL Amber	NP
9	290592	Yes	N/A	Yes	250 mL Poly	NP

2nd Review

Were all containers scanned into storage/lab? Initials KL

Are barcode labels on correct containers? Yes / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: [signature] Date & Time: 5.11.22 1721

Reviewed By: [signature] Date & Time: 5/11/22 1727

ESS Laboratory
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185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22E0397

Turn Time	5	Days
Regulatory State	Massachusetts	

Is this project for any of the following?: ○ CT RCP ○ MA MCP ○ RGP

Reporting Limits

Electonic Deliverables ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Address			
250 Apollo Dr			
City	**State**	**Zip Code**	**PO #**
Chelmsford	MA	01824	
Telephone Number	**FAX Number**	**Email Address**	
978-905-2419		julianne.marrion@aecom.com	

Julianne Marrion

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC
1	5.10.22	0955	Grab	Ground Water	DU-2 ~~22~~ 26	X	X	X	X
2		1020	Grab	Ground Water	DU-2-63 ML - 5/18/22				
3		1005	Grab	Ground Water	DU-2-100				
4		1285	Grab	Ground Water	DU-1-37				
5		1150	Grab	Ground Water	DU-1-68				
6		1205	Grab	Ground Water	DU-1-100				
7		1500	Grab	Ground Water	DU-3-51				
8		1337	Grab	Ground Water	DU-3-76				
9		1415	Grab	Ground Water	DU-3-100				
			Grab	Ground Water					

Container Type: AC-Air Cassette AG-Amber Glass B-BOD Bottle C-Cubitainer J-Jar O-Other P-Poly S-Sterile V-Vial

Container Volume: 1-100 mL 2-2.5 gal 3-250 mL 4-300 mL 5-500 mL 6-1L 7-VOA 8-2 oz 9-4 oz 10-8 oz 11-Other*

Preservation Code: 1-Non Preserved 2-HCl 3-H2SO4 4-HNO3 5-NaOH 6-Methanol 7-Na2S2O3 8-ZnAce, NaOH 9-NH4Cl 10-DI H2O 11-Other*

	Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC	
Container Type:	P	P	P	AG	V
Container Volume:	6	3	3	3	7
Preservation Code:	3	1	1	1	2
Number of Containers per Sample:	1	1	1	1	2

Laboratory Use Only

Cooler Present: yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 1.9 °C Ice

Sampled by : CHayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
CHayden 5/10/22	5/10/22	5/11/22	5/11/22 10:56
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
5/11/22 16:51	5.11.22 1651		

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0414

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 5:08 pm, May 23, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0414

SAMPLE RECEIPT

The following samples were received on May 11, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0414-01	DU-4-52	Ground Water	200.7, 353.2, 4500N, 5310B
22E0414-02	DU-4-76	Ground Water	200.7, 353.2, 4500N, 5310B
22E0414-03	DU-4-100	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0414

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0414

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-52
Date Sampled: 05/11/22 12:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0414
ESS Laboratory Sample ID: 22E0414-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:38	10	10	DE21338
Manganese	**0.020** (0.020)		200.7		1	KJK	05/17/22 20:38	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-52
Date Sampled: 05/11/22 12:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0414
ESS Laboratory Sample ID: 22E0414-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.896** (0.500)		5310B		1	CCP	05/12/22 18:27	mg/L	[CALC]
Nitrate as N	**1.32** (0.110)		353.2		5	JLK	05/11/22 19:04	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 17:53	mg/L	DE21127
Total Nitrogen	**1.32** (0.200)		4500N		5	JLK	05/23/22 14:15	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-76
Date Sampled: 05/11/22 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0414
ESS Laboratory Sample ID: 22E0414-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:40	10	10	DE21338
Manganese	**0.113** (0.020)		200.7		1	KJK	05/17/22 20:40	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-76
Date Sampled: 05/11/22 10:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0414
ESS Laboratory Sample ID: 22E0414-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.926** (0.500)		5310B		1	CCP	05/12/22 19:28	mg/L	[CALC]
Nitrate as N	**1.73** (0.110)		353.2		5	JLK	05/11/22 19:05	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 17:54	mg/L	DE21127
Total Nitrogen	**1.73** (0.200)		4500N		5	JLK	05/23/22 14:18	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-100
Date Sampled: 05/11/22 11:30
Percent Solids: N/A

ESS Laboratory Work Order: 22E0414
ESS Laboratory Sample ID: 22E0414-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 20:48	10	10	DE21338
Manganese	**0.166** (0.020)		200.7		1	KJK	05/17/22 20:48	10	10	DE21338

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-4-100
Date Sampled: 05/11/22 11:30
Percent Solids: N/A

ESS Laboratory Work Order: 22E0414
ESS Laboratory Sample ID: 22E0414-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.896** (0.500)		5310B		1	CCP	05/12/22 19:40	mg/L	[CALC]
Nitrate as N	**1.58** (0.110)		353.2		5	JLK	05/11/22 19:06	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/11/22 17:55	mg/L	DE21127
Total Nitrogen	**1.58** (0.200)		4500N		5	JLK	05/23/22 14:19	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0414

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE21338 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.52		mg/L	2.500		101	80-120			
Manganese	0.516		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE21127 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.249		mg/L	0.2497		100	90-110			
Nitrite as N	0.249		mg/L	0.2497		100	90-110			
Batch DE21129 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.522		mg/L	0.5000		104	90-110			
Nitrate/Nitrite as N	0.522		mg/L	0.5000		104	90-110			
Batch DE21242 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.62	0.500	mg/L	5.000		112	80-120			
Dissolved Organic Carbon (2)	5.72	0.500	mg/L	5.000		114	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.68	0.500	mg/L	5.000		114	80-120	1	20	
Dissolved Organic Carbon (2)	5.65	0.500	mg/L	5.000		113	80-120	1	20	
Batch DE21913 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	14.5	2.00	mg/L	13.20		110	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0414

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0414

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0414
Date Received: 5/11/2022
Project Due Date: 5/18/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 4.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	290700	Yes	N/A	Yes	1L Poly	H2SO4	
1	290703	Yes	N/A	Yes	250 mL Poly	NP	
1	290706	Yes	N/A	Yes	250 mL Poly	NP	
1	290709	Yes	N/A	Yes	250 mL Amber	NP	
2	290701	Yes	N/A	Yes	1L Poly	H2SO4	
2	290704	Yes	N/A	Yes	250 mL Poly	NP	
2	290707	Yes	N/A	Yes	250 mL Poly	NP	
2	290710	Yes	N/A	Yes	250 mL Amber	NP	
3	290702	Yes	N/A	Yes	1L Poly	H2SO4	
3	290705	Yes	N/A	Yes	250 mL Poly	NP	
3	290708	Yes	N/A	Yes	250 mL Poly	NP	
3	290711	Yes	N/A	Yes	250 mL Amber	NP	

2nd Review
Were all containers scanned into storage/lab? Initials
Are barcode labels on correct containers? Yes / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0414
Date Received: 5/11/2022

Are all Hex Chrome stickers attached?	Yes / No / NA
Are all QC stickers attached?	Yes / No / NA
Are VOA stickers attached if bubbles noted?	Yes / No / NA

Completed By: Taylor Davis Date & Time: 1720 5/11/22.

Reviewed By: Date & Time: 5/11/22 1734

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22604114.

Turn Time: 5 Days
Regulatory State: Massachusetts
Is this project for any of the following?: ○ CT RCP ○ MA MCP ○ RGP
Reporting Limits
Electonic Deliverables: ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

	Address
Julianne Marrion	250 Apollo Dr

City	State	Zip Code	PO #
Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC
1	5.11.22	1210	Grab	Ground Water	DU-4-52	X	X	X	X
2		1055	Grab	Ground Water	DU-4-76	X	X	X	X
3		1130	Grab	Ground Water	DU-4-100	X	X	X	X
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					
			Grab	Ground Water					

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2
											Number of Containers per Sample:	1	1	1	1	2

Laboratory Use Only
Cooler Present: YES ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 4.1 °C IR

Sampled by : C.Hayden
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C.Hayden 5.11.22 1530	5/11/22 15:30	5/11/22 17:04	Taylor Dare 1704 5/11/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0484

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 12:17 pm, May 27, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0484

SAMPLE RECEIPT

The following samples were received on May 12, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0484-01	BR-1-55	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-02	BR-1-77	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-03	BR-1-98	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-04	BR-2-36	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-05	BR-2-66	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-06	BR-2-96	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-07	BR-3-60	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-08	BR-3-80	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-09	BR-3-100	Ground Water	200.7, 353.2, 4500N, 5310B
22E0484-10	BR-6-100	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0484

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0484

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-55
Date Sampled: 05/12/22 13:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 22:04	10	10	DE21339
Manganese	**0.034** (0.020)		200.7		1	KJK	05/17/22 22:04	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-55
Date Sampled: 05/12/22 13:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.855** (0.500)		5310B		1	CCP	05/13/22 20:47	mg/L	[CALC]
Nitrate as N	**0.758** (0.0300)		353.2		1	EAM	05/13/22 18:02	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:01	mg/L	DE21344
Total Nitrogen	**0.758** (0.200)		4500N		1	JLK	05/23/22 14:31	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-77
Date Sampled: 05/12/22 13:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 22:07	10	10	DE21339
Manganese	**0.037** (0.020)		200.7		1	KJK	05/17/22 22:07	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-77
Date Sampled: 05/12/22 13:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.24** (0.500)		5310B		1	CCP	05/13/22 21:49	mg/L	[CALC]
Nitrate as N	**1.99** (0.0500)		353.2		2	EAM	05/13/22 18:30	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:03	mg/L	DE21344
Total Nitrogen	**1.99** (0.200)		4500N		2	JLK	05/23/22 14:32	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-98
Date Sampled: 05/12/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 22:09	10	10	DE21339
Manganese	**0.055** (0.020)		200.7		1	KJK	05/17/22 22:09	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-1-98
Date Sampled: 05/12/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.32** (0.500)		5310B		1	CCP	05/13/22 22:01	mg/L	[CALC]
Nitrate as N	**0.293** (0.0300)		353.2		1	EAM	05/13/22 18:16	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:15	mg/L	DE21344
Total Nitrogen	**0.293** (0.200)		4500N		1	JLK	05/23/22 14:33	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-36
Date Sampled: 05/12/22 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 22:11	10	10	DE21339
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 22:11	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-36
Date Sampled: 05/12/22 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.24** (0.500)		5310B		1	CCP	05/13/22 22:13	mg/L	[CALC]
Nitrate as N	**1.35** (0.0500)		353.2		2	EAM	05/13/22 18:35	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:16	mg/L	DE21344
Total Nitrogen	**1.35** (0.200)		4500N		2	JLK	05/23/22 14:34	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-66
Date Sampled: 05/12/22 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 22:13	10	10	DE21339
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 22:13	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-66
Date Sampled: 05/12/22 11:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.897** (0.500)		5310B		1	CCP	05/13/22 22:50	mg/L	[CALC]
Nitrate as N	**0.827** (0.0300)		353.2		1	EAM	05/13/22 18:18	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:16	mg/L	DE21344
Total Nitrogen	**0.827** (0.200)		4500N		1	JLK	05/23/22 14:34	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-96
Date Sampled: 05/12/22 11:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**3.92** (0.100)		200.7		1	KJK	05/17/22 22:15	10	10	DE21339
Manganese	**0.225** (0.020)		200.7		1	KJK	05/17/22 22:15	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-2-96
Date Sampled: 05/12/22 11:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.49** (0.500)		5310B		1	CCP	05/13/22 23:02	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	EAM	05/13/22 18:19	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:17	mg/L	DE21344
Total Nitrogen	**1.50** (0.200)		4500N		1	JLK	05/23/22 14:35	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-60
Date Sampled: 05/12/22 09:35
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.241** (0.100)		200.7		1	KJK	05/17/22 22:18	10	10	DE21339
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 22:18	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-60
Date Sampled: 05/12/22 09:35
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**6.19** (0.500)		5310B		1	CCP	05/13/22 23:15	mg/L	[CALC]
Nitrate as N	**0.631** (0.0300)		353.2		1	EAM	05/13/22 18:20	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:18	mg/L	DE21344
Total Nitrogen	**0.947** (0.200)		4500N		1	JLK	05/23/22 14:42	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-80
Date Sampled: 05/12/22 09:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-08
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest
All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 22:28	10	10	DE21339
Manganese	**0.022** (0.020)		200.7		1	KJK	05/17/22 22:28	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-80
Date Sampled: 05/12/22 09:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-08
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.12** (0.500)		5310B		1	CCP	05/13/22 23:27	mg/L	[CALC]
Nitrate as N	**0.654** (0.0300)		353.2		1	EAM	05/13/22 18:21	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:19	mg/L	DE21344
Total Nitrogen	**0.963** (0.200)		4500N		1	JLK	05/23/22 14:42	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-100
Date Sampled: 05/12/22 08:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-09
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**6.03** (0.100)		200.7		1	KJK	05/17/22 22:31	10	10	DE21339
Manganese	**1.51** (0.020)		200.7		1	KJK	05/17/22 22:31	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-3-100
Date Sampled: 05/12/22 08:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-09
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.20** (0.500)		5310B		1	CCP	05/13/22 23:39	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	EAM	05/13/22 18:22	mg/L	[CALC]
Nitrite as N	**0.012** (0.010)		353.2		1	EAM	05/13/22 17:20	mg/L	DE21344
Total Nitrogen	**0.815** (0.200)		4500N		1	JLK	05/23/22 14:43	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-100
Date Sampled: 05/12/22 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-10
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**3.89** (0.100)		200.7		1	KJK	05/17/22 22:33	10	10	DE21339
Manganese	**0.194** (0.020)		200.7		1	KJK	05/17/22 22:33	10	10	DE21339

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-100
Date Sampled: 05/12/22 14:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0484
ESS Laboratory Sample ID: 22E0484-10
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.38** (0.500)		5310B		1	CCP	05/14/22 0:16	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	EAM	05/13/22 18:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 17:26	mg/L	DE21344
Total Nitrogen	**0.405** (0.200)		4500N		1	JLK	05/23/22 15:19	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0484

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE21339 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.52		mg/L	2.500		101	80-120			
Manganese	0.516		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE21344 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.247	0.010	mg/L	0.2497		99	90-110			
Nitrite as N	0.247	0.010	mg/L	0.2497		99	90-110			
Batch DE21345 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.488		mg/L	0.5000		98	90-110			
Batch DE21357 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.77	0.500	mg/L	5.000		95	80-120			
Dissolved Organic Carbon (2)	4.90	0.500	mg/L	5.000		98	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.12	0.500	mg/L	5.000		102	80-120	7	20	
Dissolved Organic Carbon (2)	5.10	0.500	mg/L	5.000		102	80-120	4	20	
Batch DE21913 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	14.5	2.00	mg/L	13.20		110	80-120			
Batch DE22034 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	12.8	2.00	mg/L	13.20		97	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0484

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0484

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0484
Date Received: 5/12/2022
Project Due Date: 5/19/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.8 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? (Yes) / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	291393	Yes	N/A	Yes	250 mL Amber	NP	
1	291403	Yes	N/A	Yes	250 mL Poly	NP	
1	291404	Yes	N/A	Yes	250 mL Poly	NP	
1	291423	Yes	N/A	Yes	1L Poly	H2SO4	
2	291394	Yes	N/A	Yes	250 mL Amber	NP	
2	291405	Yes	N/A	Yes	250 mL Poly	NP	
2	291406	Yes	N/A	Yes	250 mL Poly	NP	
2	291424	Yes	N/A	Yes	1L Poly	H2SO4	
3	291395	Yes	N/A	Yes	250 mL Amber	NP	
3	291407	Yes	N/A	Yes	250 mL Poly	NP	
3	291408	Yes	N/A	Yes	250 mL Poly	NP	
3	291425	Yes	N/A	Yes	1L Poly	H2SO4	
4	291396	Yes	N/A	Yes	250 mL Amber	NP	
4	291409	Yes	N/A	Yes	250 mL Poly	NP	
4	291410	Yes	N/A	Yes	250 mL Poly	NP	
4	291426	Yes	N/A	Yes	1L Poly	H2SO4	
5	291397	Yes	N/A	Yes	250 mL Amber	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0484
Date Received: 5/12/2022

5	291411	Yes	N/A	Yes	250 mL Poly	NP
5	291412	Yes	N/A	Yes	250 mL Poly	NP
5	291427	Yes	N/A	Yes	1L Poly	H2SO4
6	291398	Yes	N/A	Yes	250 mL Amber	NP
6	291413	Yes	N/A	Yes	250 mL Poly	NP
6	291414	Yes	N/A	Yes	250 mL Poly	NP
6	291428	Yes	N/A	Yes	1L Poly	H2SO4
7	291399	Yes	N/A	Yes	250 mL Amber	NP
7	291415	Yes	N/A	Yes	250 mL Poly	NP
7	291416	Yes	N/A	Yes	250 mL Poly	NP
7	291429	Yes	N/A	Yes	1L Poly	H2SO4
8	291400	Yes	N/A	Yes	250 mL Amber	NP
8	291417	Yes	N/A	Yes	250 mL Poly	NP
8	291418	Yes	N/A	Yes	250 mL Poly	NP
8	291430	Yes	N/A	Yes	1L Poly	H2SO4
9	291401	Yes	N/A	Yes	250 mL Amber	NP
9	291419	Yes	N/A	Yes	250 mL Poly	NP
9	291420	Yes	N/A	Yes	250 mL Poly	NP
9	291431	Yes	N/A	Yes	1L Poly	H2SO4
10	291402	Yes	N/A	Yes	250 mL Amber	NP
10	291421	Yes	N/A	Yes	250 mL Poly	NP
10	291422	Yes	N/A	Yes	250 mL Poly	NP
10	291432	Yes	N/A	Yes	1L Poly	H2SO4

2nd Review

Were all containers scanned into storage/lab? Initials TD

Are barcode labels on correct containers? (Yes) / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / (NA)

Are all Hex Chrome stickers attached? Yes / No / (NA)

Are all QC stickers attached? Yes / No / (NA)

Are VOA stickers attached if bubbles noted? Yes / No / (NA)

Completed By: Yaritza Davila Date & Time: 5/12/22 1853.

Reviewed By: JH Date & Time: 5/18/22 1647

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22E0484

Turn Time: 5 Days
Regulatory State: Massachusetts
Is this project for any of the following?: ○ CT RCP ○ MA MCP ○ RGP
Reporting Limits
Electonic Deliverables: ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Address	City	State	Zip Code	PO #
250 Apollo Dr	Chelmsford	MA	01824	

Telephone Number	FAX Number	Email Address
978-905-2419		julianne.marrion@aecom.com

Julianne Marrion

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC													
1	5.12.22	1315	Grab	Ground Water	BR-1-55	X	X	X	X													
2		1345	Grab	Ground Water	BR-1-77																	
3		1355	Grab	Ground Water	BR-1-98																	
4		1200	Grab	Ground Water	BR-2-36																	
5		1100	Grab	Ground Water	BR-2-66																	
6		1105	Grab	Ground Water	BR-2-96																	
7		0735	Grab	Ground Water	BR-3-60																	
8		0845	Grab	Ground Water	BR-3-80																	
9		0850	Grab	Ground Water	BR-3-100																	
10		1455	Grab	Ground Water	BR-6-100																	

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V								
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7						
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2						
											Number of Containers per Sample:	1	1	1	1	2						

Laboratory Use Only
Cooler Present: Yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 3.8 °C / Ice

Sampled by :
Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C. Hayden 5.12.22 1645	5/12/22 16:50	5/12/22 18:32	Yaniv Davis 1832 5/12/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0534

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 12:24 pm, May 24, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0534

SAMPLE RECEIPT

The following samples were received on May 13, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0534-01	DU-5-34	Ground Water	200.7, 353.2, 4500N, 5310B
22E0534-02	DU-5-67	Ground Water	200.7, 353.2, 4500N, 5310B
22E0534-03	DU-5-100	Ground Water	200.7, 353.2, 4500N, 5310B
22E0534-04	DU-6-33	Ground Water	200.7, 353.2, 4500N, 5310B
22E0534-05	DU-6-67	Ground Water	200.7, 353.2, 4500N, 5310B
22E0534-06	DU-6-100	Ground Water	200.7, 353.2, 4500N, 5310B
22E0534-07	RI-1-105	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0534

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0534

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-34
Date Sampled: 05/13/22 10:40
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:01	10	10	DE21728
Manganese	**0.028** (0.020)		200.7		1	KJK	05/17/22 23:01	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-34
Date Sampled: 05/13/22 10:40
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.41** (0.500)		5310B		1	CCP	05/14/22 0:40	mg/L	[CALC]
Nitrate as N	**0.830** (0.0300)		353.2		1	EAM	05/13/22 20:59	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:13	mg/L	DE21346
Total Nitrogen	**1.16** (0.200)		4500N		1	JLK	05/23/22 15:21	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-67
Date Sampled: 05/13/22 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:09	10	10	DE21728
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 23:09	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-67
Date Sampled: 05/13/22 10:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.04** (0.500)		5310B		1	CCP	05/14/22 0:53	mg/L	[CALC]
Nitrate as N	**1.04** (0.0500)		353.2		2	EAM	05/13/22 21:16	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:14	mg/L	DE21346
Total Nitrogen	**1.82** (0.200)		4500N		2	JLK	05/23/22 15:22	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-100
Date Sampled: 05/13/22 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:12	10	10	DE21728
Manganese	**0.041** (0.020)		200.7		1	KJK	05/17/22 23:12	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-5-100
Date Sampled: 05/13/22 10:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.776** (0.500)		5310B		1	CCP	05/14/22 1:05	mg/L	[CALC]
Nitrate as N	**0.232** (0.0300)		353.2		1	EAM	05/13/22 21:01	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:15	mg/L	DE21346
Total Nitrogen	**0.581** (0.200)		4500N		1	JLK	05/23/22 15:22	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-33
Date Sampled: 05/13/22 12:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:14	10	10	DE21728
Manganese	**0.110** (0.020)		200.7		1	KJK	05/17/22 23:14	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-33
Date Sampled: 05/13/22 12:50
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.18** (0.500)		5310B		1	CCP	05/14/22 1:42	mg/L	[CALC]
Nitrate as N	**1.61** (0.110)		353.2		5	EAM	05/13/22 21:17	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:15	mg/L	DE21346
Total Nitrogen	**1.61** (0.200)		4500N		5	JLK	05/23/22 15:29	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-67
Date Sampled: 05/13/22 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:16	10	10	DE21728
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 23:16	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-67
Date Sampled: 05/13/22 12:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.17** (0.500)		5310B		1	CCP	05/14/22 1:54	mg/L	[CALC]
Nitrate as N	**3.66** (0.110)		353.2		5	EAM	05/13/22 21:18	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:16	mg/L	DE21346
Total Nitrogen	**3.66** (0.200)		4500N		5	JLK	05/23/22 15:30	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-100
Date Sampled: 05/13/22 11:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-06
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:18	10	10	DE21728
Manganese	**0.050** (0.020)		200.7		1	KJK	05/17/22 23:18	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: DU-6-100
Date Sampled: 05/13/22 11:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-06
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.14** (0.500)		5310B		1	CCP	05/14/22 2:06	mg/L	[CALC]
Nitrate as N	**1.45** (0.110)		353.2		5	EAM	05/13/22 21:19	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:22	mg/L	DE21346
Total Nitrogen	**1.45** (0.200)		4500N		5	JLK	05/23/22 15:30	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-1-105
Date Sampled: 05/13/22 13:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-07
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/17/22 23:27	10	10	DE21728
Manganese	ND (0.020)		200.7		1	KJK	05/17/22 23:27	10	10	DE21728

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: RI-1-105
Date Sampled: 05/13/22 13:55
Percent Solids: N/A

ESS Laboratory Work Order: 22E0534
ESS Laboratory Sample ID: 22E0534-07
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.965** (0.500)		5310B		1	CCP	05/14/22 2:18	mg/L	[CALC]
Nitrate as N	**0.431** (0.0300)		353.2		1	EAM	05/13/22 21:14	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/13/22 20:23	mg/L	DE21346
Total Nitrogen	**0.431** (0.200)		4500N		1	JLK	05/23/22 15:31	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0534

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE21728 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.52		mg/L	2.500		101	80-120			
Manganese	0.516		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE21346 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.244	0.010	mg/L	0.2497		98	90-110			
Nitrite as N	0.244	0.010	mg/L	0.2497		98	90-110			
Batch DE21347 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.489		mg/L	0.5000		98	90-110			
Nitrate/Nitrite as N	0.489		mg/L	0.5000		98	90-110			
Batch DE21357 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	4.77	0.500	mg/L	5.000		95	80-120			
Dissolved Organic Carbon (2)	4.90	0.500	mg/L	5.000		98	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.12	0.500	mg/L	5.000		102	80-120	7	20	
Dissolved Organic Carbon (2)	5.10	0.500	mg/L	5.000		102	80-120	4	20	
Batch DE22034 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	12.8	2.00	mg/L	13.20		97	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0534

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0534

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0534
Date Received: 5/13/2022
Project Due Date: 5/20/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 2.1 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	291780	Yes	N/A	Yes	1L Poly	H2SO4	
1	291787	Yes	N/A	Yes	250 mL Amber	NP	
1	291794	Yes	N/A	Yes	250 mL Poly	NP	
1	291795	Yes	N/A	Yes	250 mL Poly	NP	
2	291781	Yes	N/A	Yes	1L Poly	H2SO4	
2	291788	Yes	N/A	Yes	250 mL Amber	NP	
2	291796	Yes	N/A	Yes	250 mL Poly	NP	
2	291797	Yes	N/A	Yes	250 mL Poly	NP	
3	291782	Yes	N/A	Yes	1L Poly	H2SO4	
3	291789	Yes	N/A	Yes	250 mL Amber	NP	
3	291798	Yes	N/A	Yes	250 mL Poly	NP	
3	291799	Yes	N/A	Yes	250 mL Poly	NP	
4	291783	Yes	N/A	Yes	1L Poly	H2SO4	
4	291790	Yes	N/A	Yes	250 mL Amber	NP	
4	291800	Yes	N/A	Yes	250 mL Poly	NP	
4	291801	Yes	N/A	Yes	250 mL Poly	NP	
5	291784	Yes	N/A	Yes	1L Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0534
Date Received: 5/13/2022

5	291791	Yes	N/A	Yes	250 mL Amber	NP
5	291802	Yes	N/A	Yes	250 mL Poly	NP
5	291803	Yes	N/A	Yes	250 mL Poly	NP
6	291785	Yes	N/A	Yes	1L Poly	H2SO4
6	291792	Yes	N/A	Yes	250 mL Amber	NP
6	291804	Yes	N/A	Yes	250 mL Poly	NP
6	291805	Yes	N/A	Yes	250 mL Poly	NP
7	291786	Yes	N/A	Yes	1L Poly	H2SO4
7	291793	Yes	N/A	Yes	250 mL Amber	NP
7	291806	Yes	N/A	Yes	250 mL Poly	NP
7	291807	Yes	N/A	Yes	250 mL Poly	NP

2nd Review

Were all containers scanned into storage/lab? Initials TD

Are barcode labels on correct containers? (Yes) / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: Taylor Davis Date & Time: 5/13/22 1846

Reviewed By: [signature] Date & Time: 5.13.22 1648

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 220534.

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○ CT RCP ○ MA MCP ○ RGP	

Reporting Limits

Electonic Deliverables ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

	Address		
Julianne Marrion	250 Apollo Dr		
City	**State**	**Zip Code**	**PO #**
Chelmsford	MA	01824	
Telephone Number	**FAX Number**	**Email Address**	
978-905-2419		julianne.marrion@aecom.com	

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC											
1	5.13.22	1040	Grab	Ground Water	DU-5-34	X	X	X	X											
2	↓	1010	Grab	Ground Water	DU-5-67	X	X	X	X											
3		1000	Grab	Ground Water	DU-5-100	X	X	X	X											
4		1250	Grab	Ground Water	DU-6-33	X	X	X	X											
5		1200	Grab	Ground Water	DU-6-67	X	X	X	X											
6		1155	Grab	Ground Water	DU-6-100	X	X	X	X											
7	↓	1355	Grab	Ground Water	PZ-1-105	X	X	X	X											
			Grab	Ground Water																
			Grab	Ground Water																
			Grab	Ground Water																

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V						
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7				
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2				
											Number of Containers per Sample:	1	1	1	1	2				

Laboratory Use Only

Cooler Present: Yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 2-1 °C IR

Sampled by : C. Hayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C. Hayden 5.13.22 1630	5/13/22 16:24	5/13/22 18:06	Taylor Davis 1806 5/13/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0680

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 1:19 pm, May 26, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

SAMPLE RECEIPT

The following samples were received on May 18, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0680-01	BR-5-37	Ground Water	200.7, 353.2, 4500N, 5310B
22E0680-02	BR-5-64	Ground Water	200.7, 353.2, 4500N, 5310B
22E0680-03	BR-5-90	Ground Water	200.7, 353.2, 4500N, 5310B
22E0680-04	BR-6-56	Ground Water	200.7, 353.2, 4500N, 5310B
22E0680-05	BR-6-78	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-37
Date Sampled: 05/18/22 13:30
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/19/22 14:20	10	10	DE21831
Manganese	**0.075** (0.020)		200.7		1	KJK	05/19/22 14:20	10	10	DE21831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-37
Date Sampled: 05/18/22 13:30
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**3.47** (0.500)		5310B		1	CCP	05/23/22 22:08	mg/L	[CALC]
Nitrate as N	**0.731** (0.0300)		353.2		1	JLK	05/19/22 19:24	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/19/22 17:03	mg/L	DE21933
Total Nitrogen	**1.08** (0.200)		4500N		1	JLK	05/23/22 15:36	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-64
Date Sampled: 05/18/22 13:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/19/22 14:23	10	10	DE21831
Manganese	ND (0.020)		200.7		1	KJK	05/19/22 14:23	10	10	DE21831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-64
Date Sampled: 05/18/22 13:00
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.938** (0.500)		5310B		1	CCP	05/23/22 22:45	mg/L	[CALC]
Nitrate as N	**1.10** (0.0500)		353.2		2	JLK	05/19/22 19:25	mg/L	[CALC]
Nitrite as N	**0.011** (0.010)		353.2		1	JLK	05/19/22 17:04	mg/L	DE21933
Total Nitrogen	**1.11** (0.200)		4500N		2	JLK	05/23/22 15:36	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-90
Date Sampled: 05/18/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**3.28** (0.100)		200.7		1	KJK	05/19/22 14:32	10	10	DE21831
Manganese	**0.490** (0.020)		200.7		1	KJK	05/19/22 14:32	10	10	DE21831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-5-90
Date Sampled: 05/18/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.05** (0.500)		5310B		1	CCP	05/23/22 22:57	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	JLK	05/19/22 19:26	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/19/22 17:05	mg/L	DE21933
Total Nitrogen	ND (0.200)		4500N		1	JLK	05/25/22 14:57	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-56
Date Sampled: 05/18/22 15:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.119** (0.100)		200.7		1	KJK	05/19/22 14:34	10	10	DE21831
Manganese	ND (0.020)		200.7		1	KJK	05/19/22 14:34	10	10	DE21831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-56
Date Sampled: 05/18/22 15:10
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.03** (0.500)		5310B		1	CCP	05/23/22 23:09	mg/L	[CALC]
Nitrate as N	**1.34** (0.110)		353.2		5	JLK	05/19/22 19:26	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/19/22 17:06	mg/L	DE21933
Total Nitrogen	**1.34** (0.200)		4500N		5	JLK	05/25/22 15:00	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-78
Date Sampled: 05/18/22 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-05
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/19/22 14:40	10	10	DE21831
Manganese	**0.027** (0.020)		200.7		1	KJK	05/19/22 14:40	10	10	DE21831

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-6-78
Date Sampled: 05/18/22 15:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0680
ESS Laboratory Sample ID: 22E0680-05
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.889** (0.500)		5310B		1	CCP	05/23/22 23:21	mg/L	[CALC]
Nitrate as N	**2.21** (0.110)		353.2		5	JLK	05/19/22 19:27	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	JLK	05/19/22 17:06	mg/L	DE21933
Total Nitrogen	**2.21** (0.200)		4500N		5	JLK	05/25/22 15:01	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE21831 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.53		mg/L	2.500		101	80-120			
Manganese	0.514		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE21933 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.250		mg/L	0.2497		100	90-110			
Nitrite as N	0.250		mg/L	0.2497		100	90-110			
Batch DE21934 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.509		mg/L	0.5000		102	90-110			
Nitrate/Nitrite as N	0.509		mg/L	0.5000		102	90-110			
Batch DE22034 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	12.8	2.00	mg/L	13.20		97	80-120			
Batch DE22051 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.11	0.500	mg/L	5.000		102	80-120			
Dissolved Organic Carbon (2)	5.23	0.500	mg/L	5.000		105	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.05	0.500	mg/L	5.000		101	80-120	1	20	
Dissolved Organic Carbon (2)	5.09	0.500	mg/L	5.000		102	80-120	3	20	
Batch DE22335 - TKN Prep										

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Classical Chemistry										
Batch DE22335 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	13.9	2.00	mg/L	13.20		105	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0680

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0680
Date Received: 5/18/2022
Project Due Date: 5/25/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.7 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** Yes / No / NA
10. Were any analyses received outside of hold time? Yes / No

11. Any Subcontracting needed? Yes / No
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / No
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA
13. Are the samples properly preserved? Yes / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / No
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	293636	Yes	N/A	Yes	1L Poly	H2SO4	
1	293641	Yes	N/A	Yes	250 mL Poly	NP	
1	293642	Yes	N/A	Yes	250 mL Poly	NP	
1	293651	Yes	N/A	Yes	250 mL Amber	NP	
2	293637	Yes	N/A	Yes	1L Poly	H2SO4	
2	293643	Yes	N/A	Yes	250 mL Poly	NP	
2	293644	Yes	N/A	Yes	250 mL Poly	NP	
2	293652	Yes	N/A	Yes	250 mL Amber	NP	
3	293638	Yes	N/A	Yes	1L Poly	H2SO4	
3	293645	Yes	N/A	Yes	250 mL Poly	NP	
3	293646	Yes	N/A	Yes	250 mL Poly	NP	
3	293653	Yes	N/A	Yes	250 mL Amber	NP	
4	293639	Yes	N/A	Yes	1L Poly	H2SO4	
4	293647	Yes	N/A	Yes	250 mL Poly	NP	
4	293648	Yes	N/A	Yes	250 mL Poly	NP	
4	293654	Yes	N/A	Yes	250 mL Amber	NP	
5	293640	Yes	N/A	Yes	1L Poly	H2SO4	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0680
Date Received: 5/18/2022

5	293649	Yes	N/A	Yes	250 mL Poly	NP
5	293650	Yes	N/A	Yes	250 mL Poly	NP
5	293655	Yes	N/A	Yes	250 mL Amber	NP

2nd Review

Were all containers scanned into storage/lab? Initials TD

Are barcode labels on correct containers? Yes / No

Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA

Are all Hex Chrome stickers attached? Yes / No / NA

Are all QC stickers attached? Yes / No / NA

Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: [signature] Date & Time: 5.18.22 1818

Reviewed By: [signature] Date & Time: 5.18.22 1900

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22E0680

Turn Time	5	Days
Regulatory State	Massachusetts	
Is this project for any of the following?:	○ CT RCP ○ MA MCP ○ RGP	

Reporting Limits

Electonic Deliverables: ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Address			
Julianne Marrion	250 Apollo Dr		
City	**State**	**Zip Code**	**PO #**
Chelmsford	MA	01824	
Telephone Number	**FAX Number**	**Email Address**	
978-905-2419		julianne.marrion@aecom.com	

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC													
1	5.18.22	1330	Grab	Ground Water	BL-5-37	X	X	X	X													
2	↓	1300	Grab	Ground Water	BL-5-64	↓	↓	↓	↓													
3		1305	Grab	Ground Water	BL-5-90																	
4		1510	Grab	Ground Water	BL-6-56																	
5	↓	1515	Grab	Ground Water	BL-6-78	↓	↓	↓	↓													
			Grab	Ground Water																		
			Grab	Ground Water																		
			Grab	Ground Water																		
			Grab	Ground Water																		
			Grab	Ground Water																		

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial		P	P	P	AG	V							
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*		6	3	3	3	7					
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*		3	1	1	1	2					
												Number of Containers per Sample:	1	1	1	1	2					

Laboratory Use Only

Cooler Present: Yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 3.7 °C / Ice

Sampled by : C. Toomey

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Courtney Toomey 5-18-22 1640	5/18/22 16:40	5/18/22 18:01	1801 5/18/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0752

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 3:03 pm, May 26, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0752

SAMPLE RECEIPT

The following samples were received on May 19, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0752-01	BR-4-100	Ground Water	200.7, 353.2, 4500N, 5310B
22E0752-02	BR-4-68	Ground Water	200.7, 353.2, 4500N, 5310B
22E0752-03	BR-4-84	Ground Water	200.7, 353.2, 4500N, 5310B
22E0752-04	NA-2-88	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0752

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0752

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-100
Date Sampled: 05/19/22 12:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/20/22 15:23	10	10	DE22028
Manganese	**0.210** (0.020)		200.7		1	KJK	05/20/22 15:23	10	10	DE22028

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-100
Date Sampled: 05/19/22 12:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.06** (0.500)		5310B		1	CCP	05/23/22 23:34	mg/L	[CALC]
Nitrate as N	**1.79** (0.110)		353.2		5	EAM	05/20/22 18:52	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/20/22 17:32	mg/L	DE22040
Total Nitrogen	**1.79** (0.200)		4500N		5	JLK	05/25/22 16:03	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-68
Date Sampled: 05/19/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	ND (0.100)		200.7		1	KJK	05/20/22 15:26	10	10	DE22028
Manganese	**0.118** (0.020)		200.7		1	KJK	05/20/22 15:26	10	10	DE22028

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-68
Date Sampled: 05/19/22 13:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**1.90** (0.500)		5310B		1	CCP	05/24/22 0:11	mg/L	[CALC]
Nitrate as N	**0.440** (0.0300)		353.2		1	EAM	05/20/22 18:36	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/20/22 17:33	mg/L	DE22040
Total Nitrogen	**0.643** (0.200)		4500N		1	JLK	05/25/22 16:06	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-84
Date Sampled: 05/19/22 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-03
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.141** (0.100)		200.7		1	KJK	05/20/22 15:28	10	10	DE22028
Manganese	**0.084** (0.020)		200.7		1	KJK	05/20/22 15:28	10	10	DE22028

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: BR-4-84
Date Sampled: 05/19/22 14:15
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-03
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.928** (0.500)		5310B		1	CCP	05/24/22 0:23	mg/L	[CALC]
Nitrate as N	**2.18** (0.110)		353.2		5	EAM	05/20/22 18:53	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/20/22 17:34	mg/L	DE22040
Total Nitrogen	**2.18** (0.200)		4500N		5	JLK	05/25/22 16:07	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-88
Date Sampled: 05/19/22 15:25
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-04
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.927** (0.100)		200.7		1	KJK	05/20/22 15:30	10	10	DE22028
Manganese	**0.523** (0.020)		200.7		1	KJK	05/20/22 15:30	10	10	DE22028

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-88
Date Sampled: 05/19/22 15:25
Percent Solids: N/A

ESS Laboratory Work Order: 22E0752
ESS Laboratory Sample ID: 22E0752-04
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.910** (0.500)		5310B		1	CCP	05/24/22 0:35	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	EAM	05/20/22 18:37	mg/L	[CALC]
Nitrite as N	**0.011** (0.010)		353.2		1	EAM	05/20/22 17:35	mg/L	DE22040
Total Nitrogen	ND (0.200)		4500N		1	JLK	05/25/22 16:07	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0752

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE22028 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.53		mg/L	2.500		101	80-120			
Manganese	0.514		mg/L	0.5000		103	80-120			
Classical Chemistry										
Batch DE22040 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.261		mg/L	0.2497		105	90-110			
Nitrite as N	0.261		mg/L	0.2497		105	90-110			
Batch DE22041 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.503		mg/L	0.5000		101	90-110			
Nitrate/Nitrite as N	0.503		mg/L	0.5000		101	90-110			
Batch DE22051 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.11	0.500	mg/L	5.000		102	80-120			
Dissolved Organic Carbon (2)	5.23	0.500	mg/L	5.000		105	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.05	0.500	mg/L	5.000		101	80-120	1	20	
Dissolved Organic Carbon (2)	5.09	0.500	mg/L	5.000		102	80-120	3	20	
Batch DE22435 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	13.1	2.00	mg/L	13.20		99	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0752

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0752

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0752
Date Received: 5/19/2022
Project Due Date: 5/26/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 4.6 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / (No)
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	294406	Yes	N/A	Yes	1L Poly	H2SO4	
1	294410	Yes	N/A	Yes	250 mL Amber	NP	
1	294414	Yes	N/A	Yes	250 mL Poly	NP	
1	294415	Yes	N/A	Yes	250 mL Poly	NP	
2	294407	Yes	N/A	Yes	1L Poly	H2SO4	
2	294411	Yes	N/A	Yes	250 mL Amber	NP	
2	294416	Yes	N/A	Yes	250 mL Poly	NP	
2	294417	Yes	N/A	Yes	250 mL Poly	NP	
3	294408	Yes	N/A	Yes	1L Poly	H2SO4	
3	294412	Yes	N/A	Yes	250 mL Amber	NP	
3	294418	Yes	N/A	Yes	250 mL Poly	NP	
3	294419	Yes	N/A	Yes	250 mL Poly	NP	
4	294409	Yes	N/A	Yes	1L Poly	H2SO4	
4	294413	Yes	N/A	Yes	250 mL Amber	NP	
4	294420	Yes	N/A	Yes	250 mL Poly	NP	
4	294421	Yes	N/A	Yes	250 mL Poly	NP	

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0752
Date Received: 5/19/2022

2nd Review
Were all containers scanned into storage/lab? Initials TD
Are barcode labels on correct containers? Yes / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA
Are all Hex Chrome stickers attached? Yes / No / NA
Are all QC stickers attached? Yes / No / NA
Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed By: [signature] Date & Time: 5/19/22 1828.
Reviewed By: [signature] Date & Time: 5.19.22 1916

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22E0752

Turn Time: 5 Days
Regulatory State: Massachusetts
Is this project for any of the following?: ○ CT RCP ○ MA MCP ○ RGP
Reporting Limits
Electonic Deliverables: ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Julianne Marrion	Address: 250 Apollo Dr	
City: Chelmsford	State: MA	Zip Code: 01824 / PO #:
Telephone Number: 978-905-2419	FAX Number:	Email Address: julianne.marrion@aecom.com

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC														
1	5-19-22	1245	Grab	Ground Water	BR-4-100	x	x	x	x														
2	5-19-22	1305	Grab	Ground Water	BR-4-68																		
3	5-19-22	1415	Grab	Ground Water	BR-4-84																		
4	5-19-22	1525	Grab	Ground Water	NA-2-88																		
			Grab	Ground Water																			
			Grab	Ground Water																			
			Grab	Ground Water																			
			Grab	Ground Water																			
			Grab	Ground Water																			
			Grab	Ground Water																			

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V									
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7							
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2							
											Number of Containers per Sample:	1	1	1	1	2							

Laboratory Use Only

Cooler Present: yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 4.6 °C / Ice

Sampled by : C. Tormey

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
Courtney Tormey 5/19/22 1630	5/19/22 16:54	5/19/22 17:56	Taylor Davis 1756 5/19/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)

CERTIFICATE OF ANALYSIS

Julianne Marrion
AECOM Environment - ENSR
9 Jonathan Bourne Dr
Pocasset, MA 02559

RE: Orleans MA (60476644)
ESS Laboratory Work Order Number: 22E0823

This signed Certificate of Analysis is our approved release of your analytical results. These results are only representative of sample aliquots received at the laboratory. ESS Laboratory expects its clients to follow all regulatory sampling guidelines. Beginning with this page, the entire report has been paginated. This report should not be copied except in full without the approval of the laboratory. Samples will be disposed of thirty days after the final report has been delivered. If you have any questions or concerns, please feel free to call our Customer Service Department.

Laurel Stoddard
Laboratory Director

REVIEWED
By ESS Laboratory at 4:42 pm, May 27, 2022

Analytical Summary
The project as described above has been analyzed in accordance with the ESS Quality Assurance Plan. This plan utilizes the following methodologies: US EPA SW-846, US EPA Methods for Chemical Analysis of Water and Wastes per 40 CFR Part 136, APHA Standard Methods for the Examination of Water and Wastewater, American Society for Testing and Materials (ASTM), and other recognized methodologies. The analyses with these noted observations are in conformance to the Quality Assurance Plan. In chromatographic analysis, manual integration is frequently used instead of automated integration because it produces more accurate results.

The test results present in this report are in compliance with TNI and relative state standards, and/or client Quality Assurance Project Plans (QAPP). The laboratory has reviewed the following: Sample Preservations, Hold Times, Initial Calibrations, Continuing Calibrations, Method Blanks, Blank Spikes, Blank Spike Duplicates, Duplicates, Matrix Spikes, Matrix Spike Duplicates, Surrogates and Internal Standards. Any results which were found to be outside of the recommended ranges stated in our SOPs will be noted in the Project Narrative.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0823

SAMPLE RECEIPT

The following samples were received on May 20, 2022 for the analyses specified on the enclosed Chain of Custody Record.

The samples and analyses listed below were analyzed in accordance with the Guidelines Establishing Test Procedures for the Analysis of Pollutants, 40 CFR Part 136, as amended.

Lab Number	Sample Name	Matrix	Analysis
22E0823-01	NA-2-55	Ground Water	200.7, 353.2, 4500N, 5310B
22E0823-02	NA-2-22	Ground Water	200.7, 353.2, 4500N, 5310B

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0823

PROJECT NARRATIVE

No unusual observations noted.

End of Project Narrative.

DATA USABILITY LINKS

To ensure you are viewing the most current version of the documents below, please clear your internet cookies for www.ESSLaboratory.com. Consult your IT Support personnel for information on how to clear your internet cookies.

Definitions of Quality Control Parameters

Semivolatile Organics Internal Standard Information

Semivolatile Organics Surrogate Information

Volatile Organics Internal Standard Information

Volatile Organics Surrogate Information

EPH and VPH Alkane Lists

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0823

CURRENT SW-846 METHODOLOGY VERSIONS

Analytical Methods

1010A - Flashpoint
6010C - ICP
6020A - ICP MS
7010 - Graphite Furnace
7196A - Hexavalent Chromium
7470A - Aqueous Mercury
7471B - Solid Mercury
8011 - EDB/DBCP/TCP
8015C - GRO/DRO
8081B - Pesticides
8082A - PCB
8100M - TPH
8151A - Herbicides
8260B - VOA
8270D - SVOA
8270D SIM - SVOA Low Level
9014 - Cyanide
9038 - Sulfate
9040C - Aqueous pH
9045D - Solid pH (Corrosivity)
9050A - Specific Conductance
9056A - Anions (IC)
9060A - TOC
9095B - Paint Filter
MADEP 04-1.1 - EPH
MADEP 18-2.1 - VPH

Prep Methods

3005A - Aqueous ICP Digestion
3020A - Aqueous Graphite Furnace / ICP MS Digestion
3050B - Solid ICP / Graphite Furnace / ICP MS Digestion
3060A - Solid Hexavalent Chromium Digestion
3510C - Separatory Funnel Extraction
3520C - Liquid / Liquid Extraction
3540C - Manual Soxhlet Extraction
3541 - Automated Soxhlet Extraction
3546 - Microwave Extraction
3580A - Waste Dilution
5030B - Aqueous Purge and Trap
5030C - Aqueous Purge and Trap
5035A - Solid Purge and Trap

SW846 Reactivity Methods 7.3.3.2 (Reactive Cyanide) and 7.3.4.1 (Reactive Sulfide) have been withdrawn by EPA. These methods are reported per client request and are not NELAP accredited.

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-55
Date Sampled: 05/20/22 11:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0823
ESS Laboratory Sample ID: 22E0823-01
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**0.837** (0.100)		200.7		1	KJK	05/25/22 22:11	10	10	DE22443
Manganese	**1.56** (0.020)		200.7		1	KJK	05/25/22 22:11	10	10	DE22443

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-55
Date Sampled: 05/20/22 11:05
Percent Solids: N/A

ESS Laboratory Work Order: 22E0823
ESS Laboratory Sample ID: 22E0823-01
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**0.523** (0.500)		5310B		1	CCP	05/24/22 14:58	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	EAM	05/20/22 20:04	mg/L	[CALC]
Nitrite as N	ND (0.010)		353.2		1	EAM	05/20/22 19:34	mg/L	DE22047
Total Nitrogen	**0.203** (0.200)		4500N		1	JLK	05/25/22 16:18	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-22
Date Sampled: 05/20/22 11:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0823
ESS Laboratory Sample ID: 22E0823-02
Sample Matrix: Ground Water
Units: mg/L

Extraction Method: 200.7/6010BNoDigest

All methods used are in accordance with 40 CFR 136.

Dissolved Metals

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	I/V	F/V	Batch
Iron	**4.01** (0.100)		200.7		1	KJK	05/25/22 22:13	10	10	DE22443
Manganese	**0.117** (0.020)		200.7		1	KJK	05/25/22 22:13	10	10	DE22443

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA
Client Sample ID: NA-2-22
Date Sampled: 05/20/22 11:45
Percent Solids: N/A

ESS Laboratory Work Order: 22E0823
ESS Laboratory Sample ID: 22E0823-02
Sample Matrix: Ground Water

All methods used are in accordance with 40 CFR 136.

Classical Chemistry

Analyte	Results (MRL)	MDL	Method	Limit	DF	Analyst	Analyzed	Units	Batch
Dissolved Organic Carbon (Average)	**11.0** (1.00)		5310B		2	CCP	05/24/22 1:00	mg/L	[CALC]
Nitrate as N	ND (0.0300)		353.2		1	EAM	05/20/22 20:10	mg/L	[CALC]
Nitrite as N	**0.011** (0.010)		353.2		1	EAM	05/20/22 19:40	mg/L	DE22047
Total Nitrogen	**0.597** (0.200)		4500N		1	JLK	05/25/22 16:19	mg/L	[CALC]

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0823

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
Dissolved Metals										
Batch DE22443 - 200.7/6010BNoDigest										
Blank										
Iron	ND	0.100	mg/L							
Manganese	ND	0.020	mg/L							
LCS										
Iron	2.50		mg/L	2.500		100	80-120			
Manganese	0.503		mg/L	0.5000		101	80-120			
Classical Chemistry										
Batch DE22047 - General Preparation										
Blank										
Nitrite as N	ND	0.010	mg/L							
Nitrite as N	ND	0.010	mg/L							
LCS										
Nitrite as N	0.262	0.010	mg/L	0.2497		105	90-110			
Nitrite as N	0.262	0.010	mg/L	0.2497		105	90-110			
Batch DE22048 - General Preparation										
Blank										
Nitrate/Nitrite as N	ND	0.020	mg/L							
Nitrate/Nitrite as N	ND	0.020	mg/L							
LCS										
Nitrate/Nitrite as N	0.508	0.020	mg/L	0.5000		102	90-110			
Nitrate/Nitrite as N	0.508	0.020	mg/L	0.5000		102	90-110			
Batch DE22051 - General Preparation										
Blank										
Dissolved Organic Carbon (1)	ND	0.500	mg/L							
Dissolved Organic Carbon (2)	ND	0.500	mg/L							
LCS										
Dissolved Organic Carbon (1)	5.11	0.500	mg/L	5.000		102	80-120			
Dissolved Organic Carbon (2)	5.23	0.500	mg/L	5.000		105	80-120			
LCS Dup										
Dissolved Organic Carbon (1)	5.05	0.500	mg/L	5.000		101	80-120	1	20	
Dissolved Organic Carbon (2)	5.09	0.500	mg/L	5.000		102	80-120	3	20	
Batch DE22435 - TKN Prep										
Blank										
Total Kjeldahl Nitrogen as N	ND	0.20	mg/L							
LCS										
Total Kjeldahl Nitrogen as N	13.1	2.00	mg/L	13.20		99	80-120			

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0823

Notes and Definitions

U	Analyte included in the analysis, but not detected
D	Diluted.
ND	Analyte NOT DETECTED at or above the MRL (LOQ), LOD for DoD Reports, MDL for J-Flagged Analytes
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference
MDL	Method Detection Limit
MRL	Method Reporting Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
DL	Detection Limit
I/V	Initial Volume
F/V	Final Volume
§	Subcontracted analysis; see attached report
1	Range result excludes concentrations of surrogates and/or internal standards eluting in that range.
2	Range result excludes concentrations of target analytes eluting in that range.
3	Range result excludes the concentration of the C9-C10 aromatic range.
Avg	Results reported as a mathematical average.
NR	No Recovery
[CALC]	Calculated Analyte
SUB	Subcontracted analysis; see attached report
RL	Reporting Limit
EDL	Estimated Detection Limit
MF	Membrane Filtration
MPN	Most Probable Number
TNTC	Too numerous to Count
CFU	Colony Forming Units

CERTIFICATE OF ANALYSIS

Client Name: AECOM Environment - ENSR
Client Project ID: Orleans MA

ESS Laboratory Work Order: 22E0823

ESS LABORATORY CERTIFICATIONS AND ACCREDITATIONS

ENVIRONMENTAL

Rhode Island Potable and Non Potable Water: LAI00179
http://www.health.ri.gov/find/labs/analytical/ESS.pdf

Connecticut Potable and Non Potable Water, Solid and Hazardous Waste: PH-0750
http://www.ct.gov/dph/lib/dph/environmental_health/environmental_laboratories/pdf/OutofStateCommercialLaboratories.pdf

Maine Potable and Non Potable Water, and Solid and Hazardous Waste: RI00002
http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/partners/labCert.shtml

Massachusetts Potable and Non Potable Water: M-RI002
http://public.dep.state.ma.us/Labcert/Labcert.aspx

New Hampshire (NELAP accredited) Potable and Non Potable Water, Solid and Hazardous Waste: 2424
http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm

New York (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: 11313
http://www.wadsworth.org/labcert/elap/comm.html

New Jersey (NELAP accredited) Non Potable Water, Solid and Hazardous Waste: RI006
http://datamine2.state.nj.us/DEP_OPRA/OpraMain/pi_main?mode=pi_by_site&sort_order=PI_NAMEA&Select+a+Site:=58715

Pennsylvania: 68-01752
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

Shipped/Delivered Via: ESS Courier

ESS Project ID: 22E0823
Date Received: 5/20/2022
Project Due Date: 5/27/2022
Days for Project: 5 Day

1. Air bill manifest present? No
   Air No.: NA
2. Were custody seals present? No
3. Is radiation count <100 CPM? Yes
4. Is a Cooler Present? Yes
   Temp: 3.3 Iced with: Ice
5. Was COC signed and dated by client? Yes
6. Does COC match bottles? Yes
7. Is COC complete and correct? Yes
8. Were samples received intact? Yes
9. **Were labs informed about short holds & rushes?** (Yes) / No / NA
10. Were any analyses received outside of hold time? Yes / (No)

11. Any Subcontracting needed? Yes / (No)
    ESS Sample IDs:
    Analysis:
    TAT:
12. Were VOAs received? Yes / (No)
    a. Air bubbles in aqueous VOAs? Yes / No
    b. Does methanol cover soil completely? Yes / No / NA

13. Are the samples properly preserved? (Yes) / No
    a. If metals preserved upon receipt: Date: Time: By/Acid Lot#:
    b. Low Level VOA vials frozen: Date: Time: By:

Sample Receiving Notes:

14. Was there a need to contact Project Manager? Yes / (No)
    a. Was there a need to contact the client? Yes / No
    Who was contacted? Date: Time: By:

Resolution:

Sample Number	Container ID	Proper Container	Air Bubbles Present	Sufficient Volume	Container Type	Preservative	Record pH (Cyanide and 608 Pesticides)
1	295295	Yes	N/A	Yes	1L Poly	H2SO4	
1	295297	Yes	N/A	Yes	250 mL Amber	NP	
1	295299	Yes	N/A	Yes	250 mL Poly	NP	
1	295300	Yes	N/A	Yes	250 mL Poly	NP	
2	295296	Yes	N/A	Yes	1L Poly	H2SO4	
2	295298	Yes	N/A	Yes	250 mL Amber	NP	
2	295301	Yes	N/A	Yes	250 mL Poly	NP	
2	295302	Yes	N/A	Yes	250 mL Poly	NP	

2nd Review
Were all containers scanned into storage/lab? Initials: [illegible]
Are barcode labels on correct containers? (Yes) / No
Are all Flashpoint stickers attached/container ID # circled? Yes / No / NA
Are all Hex Chrome stickers attached? Yes / No / NA
Are all QC stickers attached? Yes / No / NA
Are VOA stickers attached if bubbles noted? Yes / No / NA

Completed

ESS Laboratory Sample and Cooler Receipt Checklist

Client: AECOM Environment - ENSR - KPB

ESS Project ID: 22E0823

Date Received: 5/20/2022

By: [signature] Date & Time: 5/20/22 1840

Reviewed By: [signature] Date & Time: 5/2022 1854

ESS Laboratory

Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston RI 02910
Tel. (401) 461-7181 Fax (401) 461-4486
www.esslaboratory.com

CHAIN OF CUSTODY

ESS Lab # 22E0823

Turn Time	5	Days
Regulatory State	Massachusetts	

Is this project for any of the following?: ○ CT RCP ○ MA MCP ○ RGP

Reporting Limits

Electonic Deliverables ☐ Data Checker ☐ Excel ☐ Other (Please Specify →)

Company Name	Project #	Project Name
AECOM	60476644	Orleans PRB

Address			
Julianne Marrion	250 Apollo Dr		
City	State	Zip Code	PO #
Chelmsford	MA	01824	
Telephone Number	FAX Number	Email Address	
978-905-2419		julianne.marrion@aecom.com	

ESS Lab ID	Collection Date	Collection Time	Sample Type	Sample Matrix	Sample ID	Analysis: Total Nitrogen	Nitrate, Nitrite	Lab Filter Dissolved Fe, Mn	DOC												
1	5.10.22	1105	Grab	Ground Water	NA-2-55	X	X	X	X												
2	5.10.22	1145	Grab	Ground Water	NA-2-22	X	X	X	X												
			Grab	Ground Water																	
			Grab	Ground Water																	
			Grab	Ground Water																	
			Grab	Ground Water																	
			Grab	Ground Water																	
			Grab	Ground Water																	
			Grab	Ground Water																	
			Grab	Ground Water																	

Container Type:	AC-Air Cassette	AG-Amber Glass	B-BOD Bottle	C-Cubitainer	J-Jar	O-Other	P-Poly	S-Sterile	V-Vial	P	P	P	AG	V							
Container Volume:	1-100 mL	2-2.5 gal	3-250 mL	4-300 mL	5-500 mL	6-1L	7-VOA	8-2 oz	9-4 oz	10-8 oz	11-Other*	6	3	3	3	7					
Preservation Code:	1-Non Preserved	2-HCl	3-H2SO4	4-HNO3	5-NaOH	6-Methanol	7-Na2S2O3	8-ZnAce, NaOH	9-NH4Cl	10-DI H2O	11-Other*	3	1	1	1	2					
											Number of Containers per Sample:	1	1	1	1	2					

Laboratory Use Only

Cooler Present: Yes ○ Drop Off
Seals Intact: ○ Pickup
Cooler Temperature: 3.3 °C / Ca

Sampled by : C Hayden

Comments: Please specify "Other" preservative and containers types in this space

Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)
C Hayden 5.10.22 1630	5/20/22 16:44	5/20/22 18:32	1832 5/20/22
Relinquished by: (Signature, Date & Time)	Received By: (Signature, Date & Time)	Relinquished By: (Signature, Date & Time)	Received By: (Signature, Date & Time)