



AECOM
9 Jonathan Bourne Drive
Pocasset, MA 02559
www.aecom.com

508.833.6950 tel
508.833.6951 fax

Transmittal

To Stephen Hallem, MassDEP Boston
CC Brian Dudley, MassDEP SERO
Thomas Cambareri, Cape Cod Commission, Water Resources Department
John Kelly, Town of Orleans Town Administrator
Thomas Daley, P.E., Town of Orleans Director of Public Works & Natural Resources
George Meservey, Town of Orleans Director of Planning & Community Development
Betsy Shreve, AICP, AECOM Project Director

Subject **Town of Orleans, MA
Water Quality and Wastewater Planning
Hydrogeologic Evaluation - Wick Loading Test
Proposed Groundwater Discharge
Route 6 (Exit 12) Site**

Project Number 60476044
From Thomas Parece, P.E., AECOM Project Manager
Date August 2, 2018

Please find attached a copy of an update to the Hydrogeologic Evaluation report submitted to MassDEP for a proposed groundwater discharge at the Route 6 (Exit 12) Site in Orleans Massachusetts. The purpose of this document is to update the October 2017 Hydrogeologic Evaluation report with the results of the wick loading test performed at the site.

The discharge to the site will be from the Town of Orleans' proposed Downtown Area WWTF. The initial WWTF discharge is expected to be approximately 150,000 gpd with flows approaching 250,000 gpd at build-out. If the Town chooses to treat wastewater from the Meetinghouse Pond Area at the proposed WWTF, flows could increase to 360,000 gpd at a later date.

Based on site conditions, subsurface soils encountered, a wick loading test, and groundwater model results, a minimum of 360,000 gpd can be discharged at the site. The proposed discharge method is series of wicks. The Town expects to install three to four wicks at the site. The number of wicks installed will factor in redundancy in the WWTF discharge capacity as well as the proper operation and maintenance of the wicks. The wick design, number of wicks, and location of the wicks within the discharge area will be submitted as part of the WWTF design documentation.

If you have questions or would like to discuss the enclosed report, please contact me or Mark Owen (mark.owen@aecom.com or 508-833-6964).

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**GROUNDWATER DISCHARGE
HYDROGEOLOGIC EVALUATION
ROUTE 6 (EXIT 12) SITE
TOWN OF ORLEANS, MASSACHUSETTS**

WICK LOADING TEST

Prepared for:

Town of Orleans
19 School Road
Orleans, Massachusetts 02653

Prepared by:

AECOM Technical Services, Inc.
9 Jonathan Bourne Drive
Pocasset, Massachusetts 02559

August 2, 2018

Project No. 60476644

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1. BACKGROUND AND INTRODUCTION

The Hydrogeologic Evaluation updates the existing Hydrogeologic Evaluation titled “Hydrogeologic Evaluation Route 6 (Exit 12) Cloverleaf Site Town of Orleans, Massachusetts” and submitted to MassDEP in October 2017. On February 2, 2018, MassDEP approved the hydrogeologic evaluation for an Individual Groundwater Discharge Permit (BRPWP 79) subject to several conditions. Two of the conditions being that:

- (a) Design flow of the proposed groundwater discharge shall not exceed 145,000 gallons per day; and
- (b) Loading rate to the infiltration beds shall not be greater than the maximum allowed under present Department Guidelines. If wicks are proposed and the preferred alternative, further testing will be required prior to approval of their installation.

On April 20, 2018, a proposal to perform a wick loading test at Route 6 (Exit 12) Cloverleaf Site was submitted to MassDEP Review. Prior to submitting the proposal, Mr. Mark Owen (AECOM), Mr. Brian Dudley and Mr. Stephen Hallem visited the site on January 29, 2018 to discuss site conditions and the loading test proposal.

This letter documents the approach used to evaluate the Route 6 (Exit 12) site (Figure 1) for a wick groundwater discharge from the proposed Downtown Area wastewater treatment facility (WWTF) in Orleans Massachusetts. Copies of MassDEP’s letter approving the hydrogeologic evaluation, and the wick loading test proposal are provided in Appendix A.

This letter includes the following:

- Description of the steps taken to evaluate the site for a wick groundwater discharge;
- Summary of field investigations conducted at the Route 6 (Exit 12) site;
- Evaluation of the loading test results; and
- Preliminary wick design and discharge capacity for the Route 6 (Exit 12) site.

A wick loading test was performed to evaluate the site for the use of wicks as a groundwater discharge method for effluent from the proposed Downtown Area WWTF. The results of the wick loading test do not change the findings and conclusions of the October 2017 Hydrogeologic Evaluation and therefore this document should be considered an addendum to the original report.

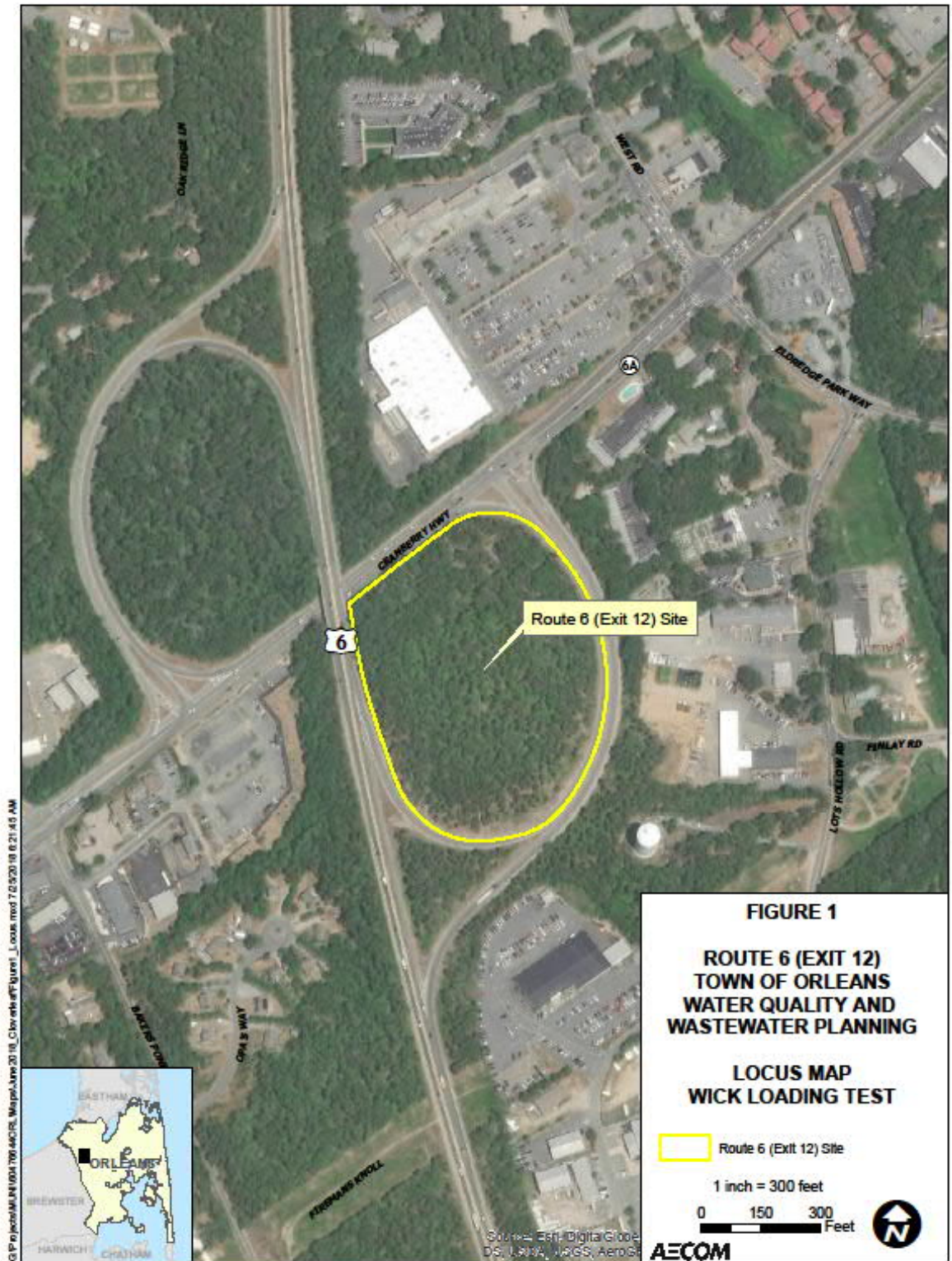
2. LOADING TEST

On April 18 2018, AECOM submitted a loading test proposal to MassDEP. The submittal included a preliminary design for the proposed test wick and a proposal to perform a 30-day loading test. A copy of the submittal is provided in Appendix A.

A wick loading test was performed to evaluate whether the site could accommodate the groundwater discharge from the Downtown Area WWTF. The loading test included the installation of four monitoring wells, the installation of test wick, performing a long-term loading test, and an analysis of the loading test data. Details of the monitoring well installation, test wick installation and loading test follow.

2.1. Monitoring Well Installation

Prior to conducting the loading test, three monitoring wells (CLS-1, CLS-2 and CLS-3) existed at the site and were installed as part of the 2017 hydrogeologic evaluation. To monitor water levels in the vicinity of the wick during the loading test, four additional monitoring wells (CLS-4, CLS-5, CLS-6 and CLS-7) were installed. The well locations are shown on Figure 2 and Figure 3. Well construction details are summarized on Table 1. Well logs are provided in Appendix B.



Monitoring wells CLS-4, CLS-5, CLS-6 and CLS-7 were installed in February and March 2018 using an AMS 9400 direct push rig. No soils samples were collected during installation. Each monitoring well consisted of ten-foot sections of schedule 40 PVC riser pipe attached to 10-foot sections of 10-slot well screen. Natural sand pack was used between the well and the formation from the base of the well to approximately 2 feet above the well screen. The sand pack was then capped by approximately 2 feet of bentonite pellets and allowed to hydrate. Natural sand pack was allowed to collapse from above the bentonite to the surface. Well construction details are summarized on Table 1. Soil boring, geologic and hydrogeologic information are included in the October 2017 hydrogeologic evaluation report.

As described in the 2017 Hydrogeologic Evaluation, soil borings at locations CLS-1, CLS-2 and CLS-3 were a tan to light brown, fine or fine-to-medium sand with low percentages of silt from a depth of 5 to approximately 60 feet. Within this interval, thin layers of silty sand, silt and silt with varying amounts of clay were encountered. These layers appeared to be discontinuous across the site.

Between 60 and 110 ft, the soils generally became finer and more variable. There were layers of clay, silt mixed sands and silt as well as medium to course sands. Most layers were no more than 2 feet thick. The variations in soil type did not appear to be continuous across the site, but discontinuous layers of highly variable soils. Overall the conductivity of the lower soils was significantly less than those of the upper soils, but did not appear to be continuous enough prevent a groundwater discharge from infiltrating into the lower soils. Details of the installation and soils encountered are provided in the 2017 report. If the site were to be developed, additional monitoring wells would be installed at various locations across the site. These fine soil layers would be logged and correlated with existing soil borings.

2.2. Test Wick Installation

A single “test” wick was installed at the Route 6 (Exit 12) site from March 20 through 27, 2018. A CME auger rig with 14-inch outside diameter (OD), 8-inch inside diameter (ID) augers was used to drill to a depth of 84 feet. A 2-inch diameter PVC well with 80 feet of screen was set inside the drilled hole and 3/4-inch diameter washed stone was placed around the 2-inch well and the one-foot diameter test wick from a depth of 84 feet to ground surface. A plastic 6-foot diameter culvert pipe was set four feet into the ground as a protective cover for the test wick. The piping has been fitted with a fire hose on the end outside the culvert pipe, and terminated inside with a 90-degree bend which directed water downward into the wick. The test wick log is attached in Appendix B.

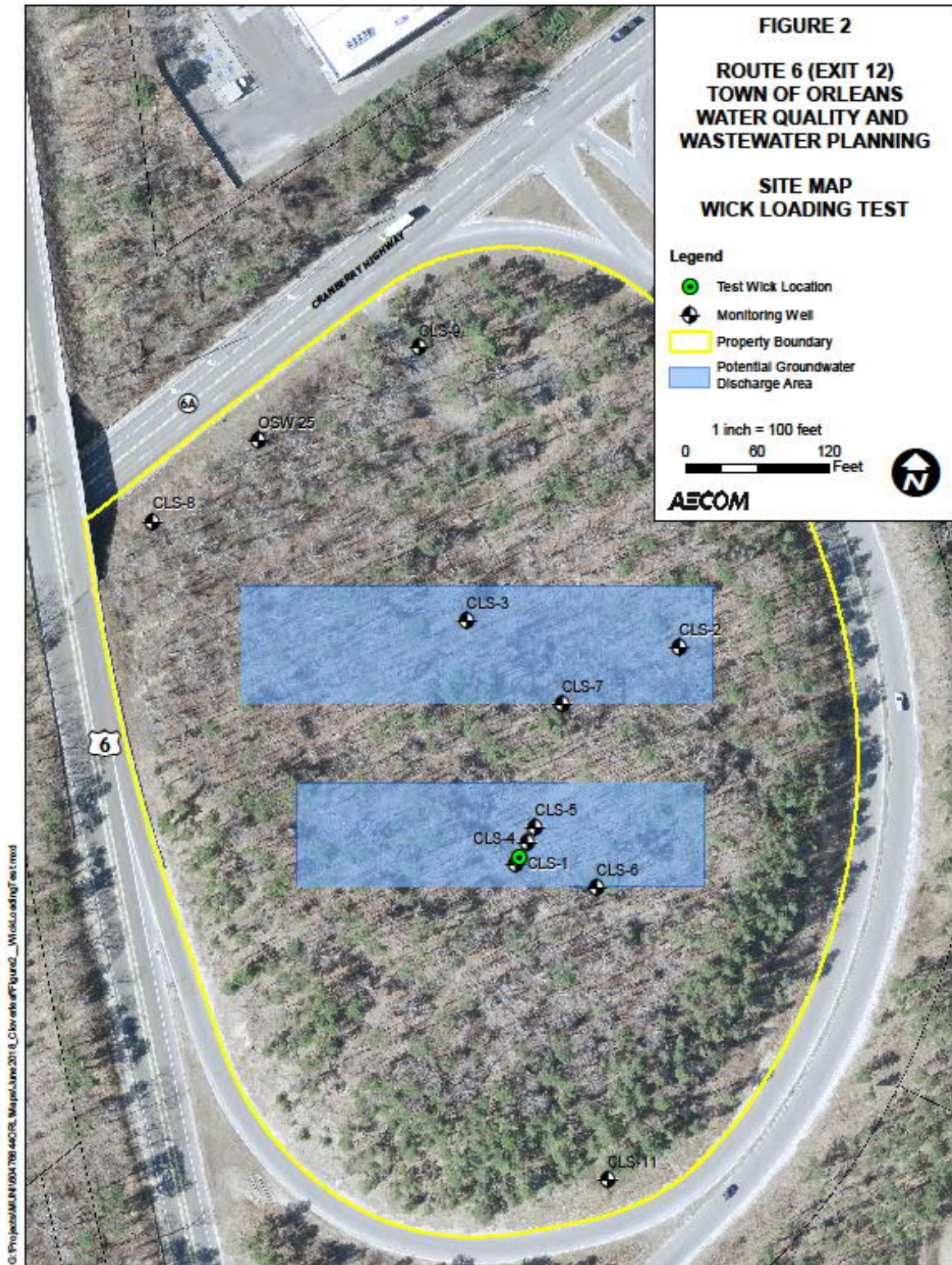
2.3. Loading Test Operation

2.3.1. Test Wick Loading

Loading of the test wick began at 9:00 am on April 2, 2018 and was completed at 10:00 on May 3, 2018. Water discharged into the wick was supplied by the Town of Orleans water system, delivered via an on-site hydrant. Water use volume was determined by taking daily readings at a passive in-line meter installed at the hydrant. Loading rate was also calculated using the meter. Over 1.43 million gallons were discharged into the wick over the course of the loading test.

2.3.2. Observation Wells

During the loading test, water levels were measured at on-site wells CLS-1 through CLS-7, and off-site wells LH-1, LH-5, MW-9, MW-14, MW-15S, MW-16S, and MW-5D. Well locations monitored are shown on Figures 2 and 3. Water levels were measured once to twice daily at on-site wells for the first five days of the loading test. Pressure transducers were installed in the test wick, monitoring wells CLS-1, CLS-4, CLS-5, CLS-6, CLS-7, and LH-1. The water levels were recorded every 10 to 15 minutes. A copy of water level data recorded during the loading test is included in Appendix C.



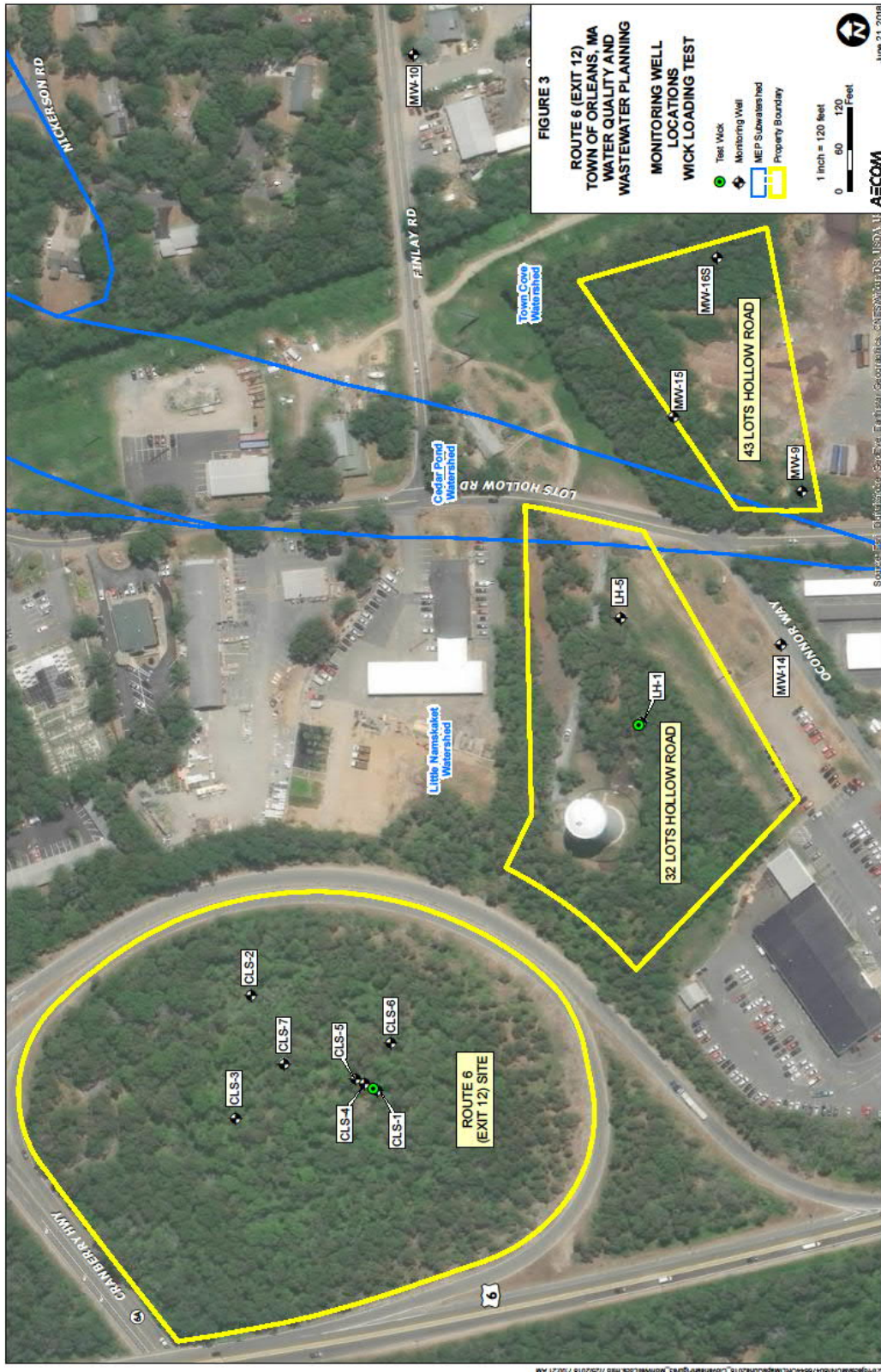


Table 1
Summary of Well Construction Details

Observation Well	Diameter (inches)	Borehole Depth	Depth of Screened Interval	Ground Elevation	Northing	Easting	Top of PVC Elevation (ft msl)	Depth to Water Table (4 8 18)	Groundwater Elevation (NAVD 88)
<u>Route 6 (Exit 12) Site</u>									
CLS-1	2.0	110	92 - 102	98.5	2747481.708	1064740.808	100.89	84.22	16.67
CLS-2	2.0	97	76 - 86	85.4	2747662.213	1064877.471	87.33	70.88	16.45
CLS-3	2.0	105	76 - 86	85.8	2747684.466	1064699.986	87.90	71.35	16.55
CLS-4	2.0	96	86 - 96	97.7	2747500.055	1064750.34	99.43	82.72	16.71
CLS-5	2.0	93	83 - 93	96.7	2747512.854	1064756.961	98.56	81.88	16.68
CLS-6	2.0	95	85 - 95	99.7	2747462.269	1064808.305	101.48	84.82	16.66
CLS-7	2.0	99	89 - 99	98.2	2747615.423	1064779.369	101.09	83.34	17.75
Test Wick	12.0	84	4 - 84	98.7	2747487.183	1064743.586	100.48	NA	NA
<u>32 Lots Hollow St.</u>									
LH-1	2.0	128	118 - 128	122.4	2747103.768	1065269.699	124.27	107.12	17.15
LH-5	2.0	124	114 - 124	118.2	2747133.158	1065419.554	119.81	102.53	17.28
<u>43 Lots Hollow St.</u>									
MW-5D	2.0	150	140 - 150	101.7	2746922.228	1066033.688	103.6	86.39	17.21
MW-9	2.0	102	92 - 102	105.5	2746873.731	1065600.504	107.32	89.99	17.33
MW-14	2.0	160	150 - 160	105.4	2746904.287	1065380.336	105.15	87.99	17.16
MW-15S	2.0	125	115 - 125	107.4	2747058.283	1065707.528	109.17	92.12	17.05
MW-16S	2.0	120	110 - 120	101.3	2746994.936	1065935.913	103.38	86.26	17.12
<u>USGS Wells</u>									
BMW-22	1.25	52	49	50.5	Lat Long (NAD 27) 41°46'30" 70°01'49"		50.4	28.00	22.08

2.3.3. Ambient Monitoring Well

USGS well BMW 22, located approximately 1.5 miles west of the Route 6 (Exit 12) site, was used to establish ambient water levels. Monitoring well BMW-22 has been monitored since 1967, and is screened in a similar formation and hydrogeologic setting as the Route 6 (Exit 12) Site. A copy of the water level data at the ambient well is provided in Appendix C.

2.3.4. Precipitation

Precipitation data was provided by the Town of Orleans Water Department and is included in Appendix D along with detailed water level readings. During the test, approximately 2.15 inches of rain was recorded. One notable rain events of more than a half-inch was recorded on April 15.

2.3.5. Loading Rate

Initial test wick loading took place at 28 gpm (40,000 gpd) for the first 14 days of the loading test. The rate was increased to 36 gpm (52,000 gpd) for the remainder of the test. Loading rates over time are summarized in Table 2.

Table 2
Loading Test Summary – Route 6 (Exit 12) Site

Loading Rate		Loading Duration		Water-Level Rise, Feet									Efficiency		
gpm	gpd	Days at Rate	Total Days	CLS-1	CLS-4	CLS-5	CLS-6	CLS-7	CLS-2	CLS-3	LH-1	LH-5	Wick	Wick	Wick
				(6)*	(15)*	(29)*	(69)*	(133)*	(220)*	(202)*	(646 ft)	(763 ft)	(0)*	Efficiency (gpm/ft)	Efficiency (gpd/ft)
28	40,320	14	14	0.41	0.43	0.53	0.32	0.53	0.40	0.48	0.09	0.11	77.14	0.36	523
36	51,840	17	31	1.29	1.39	1.54	1.06	1.80	1.11	1.26	0.48	0.48	79.44	0.45	653
														0.41	588

Note * Distance from test wick in feet

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3. LOADING TEST - RESULTS

The loading test took place during a wet winter. Approximately 2.15 inches of rain was recorded during the test. Over 10 inches of rain was recorded in the months preceding the test (January through March). Historic high water levels were recorded at BMW-22 during the loading test. In general, the loading test took place under historic high water table conditions. Daily and cumulative rainfall throughout the loading test is shown on Figure 4.

Water levels rose across the entire study area during the test. Water levels at the Route 6 (Exit 12) site (CLS-1 through CLS-7) rose between 1.0 and 1.7 feet during the loading test after adjusting for the ambient water levels recorded at BMW-22. Increases in groundwater levels across the site were relatively similar and did not necessarily correlate with the monitoring well's distance from the test wick.

Water levels at well locations LH-1, LH-5, MW-9, MW-14, MW-15S, MW-16S, and MW-5D also rose throughout the loading test (Figure 3). The groundwater level increase was fairly uniform among these wells rising between 0.3 to 0.4 feet. At the ambient well BMW-22, groundwater levels rose approximately 0.1 feet between the beginning of the test and April 16. Throughout the remainder of the test, water levels dropped approximately 0.15 feet. Figure 4 shows daily rainfall, cumulative rainfall and water level trends in wells monitored during the loading test. Table 2 summarizes high water levels recorded at each loading rate.

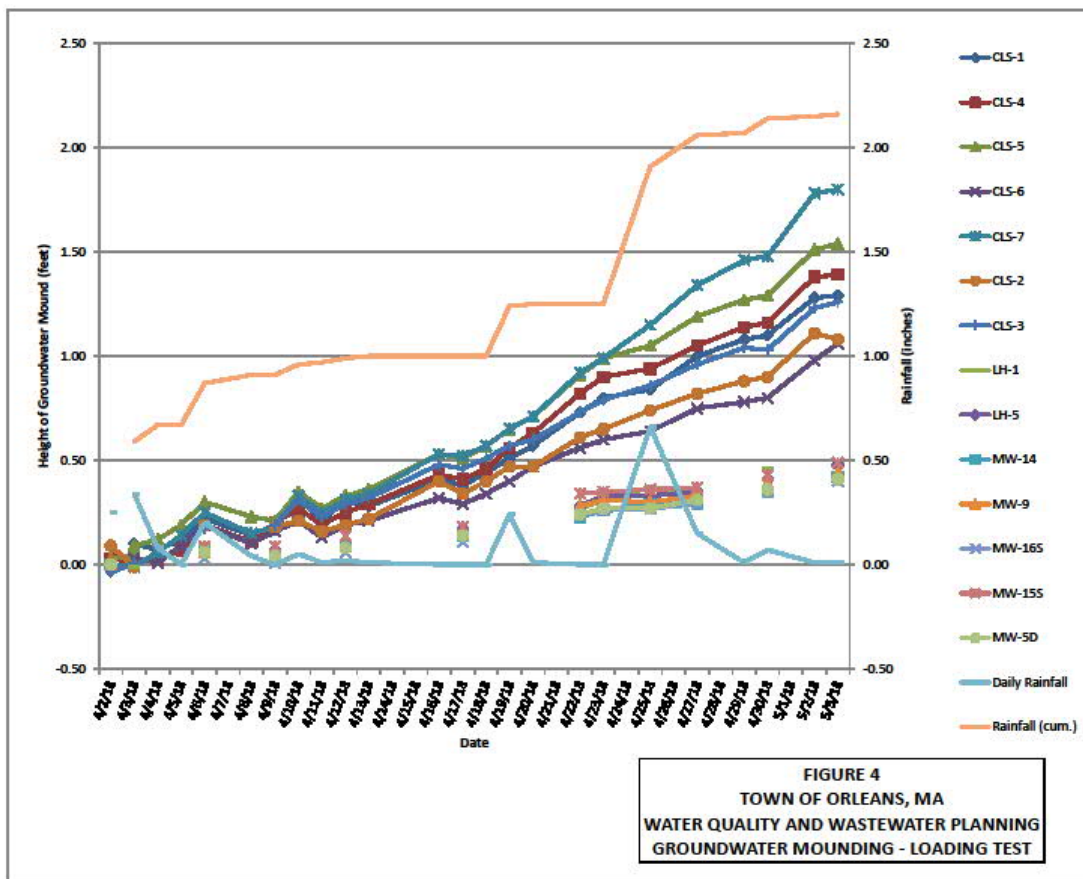


FIGURE 4
 TOWN OF ORLEANS, MA
 WATER QUALITY AND WASTEWATER PLANNING
 GROUNDWATER MOUNDING - LOADING TEST

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4. LOADING TEST - ANALYSIS

As described in Section 2.2, a 2-inch diameter PVC well was installed inside the 12-inch diameter test wick to monitor water levels during the loading test. Water levels in the test wick were digitally monitored throughout the loading test using an Onset Hobo data logger. Manual water level readings were also collected periodically. Table 2 summarizes the loading rates, high water levels (within the wick and on monitoring wells) noted during each loading rate, and the number of days of loading at each rate.

To evaluate the test wick's performance, the wick loading rate was divided by the mound height in feet. The resulting value is referred to as the wick efficiency and is expressed as gallon per day of discharge per foot of mounding within the test wick (gpd/ft).

The mound height within the wick is dependent on several factors: the loading rate, the permeability of the artificial-gravel pack within the wick, the permeability of the surrounding soils, and the surface area between the wick and the surrounding soils per foot of wick. In the full scale wick, the permeability of the artificial-gravel pack will be great enough that the packs impact to mounding is negligible. This will leave the loading rate, the permeability of the surrounding soils and the surface area of the wick as the primary factors in wick mounding. Less mounding due to higher infiltration can be expected with higher permeability soils. A larger diameter wick which creates more surface area with the formation per foot of wick, will also produce less mounding.

Using the test wick as an example, at a discharge rate of 32 gpm (46,000 gpd), a wick efficiency of 600 gpd/ft of wick mounding was calculated. Using this wick efficiency, the 1-foot diameter test wick could discharge approximately 45,000 gpd (600 gpd/ft times 75 feet).

To estimate wick mounding and the potential discharge capacity of a larger diameter wick, the efficiency of the test wick (600 gpd/ft) was multiplied by the increase in surface area per foot between the test and full scale wick. For example, if the wick diameter is increased from 1 to 3 feet, the surface area between the wick and surrounding formation would increase by a factor of 3. Assuming the same formation and infiltration rate, the wick efficiency should also increase by a factor of three.

Using the test wick location as an example, the wick efficiency of the 1-foot diameter test wick was approximately 600 gpd/ft. If a 3-foot diameter wick were installed at the same location, the wick efficiency should increase to approximately 1,800 gpd (Table 3). Therefore, a 75-foot deep 3-foot diameter wick installed at the same location as the test wick, should discharge approximately 135,000 gpd. To discharge the Downtown Area estimated build-out flow of 250,000 gpd, it would take approximately two wicks.

The anticipated discharge from the WWTF from the Downtown Area is not expected to exceed 150,000 gpd initially and 250,000 gpd at build-out. The WWTF flow could increase to 350,000 gpd if flow from the Meetinghouse Pond Area is tied into the WWTF. The estimated number of wicks required to discharge several flows are summarized in Table 3.

Table 3
Estimated Number of Wicks per Discharge Rate

Discharge Rate	Estimate of Number of Wicks			
	1-foot Diameter Test Wick Depth 75 Feet Wick Surface Area (220 sqft/ft)		3-foot Diameter Wick Depth 75 Feet Wick Surface Area (665 sqft/ft)	
	Wick Efficiency (gpd/ft)	Estimated Number of Wicks	Wick Efficiency (gpd/ft)	Estimated Number of Wicks
150,000	600	3	1,800	1
200,000	600	4	1,800	1
250,000	600	6	1,800	2
350,000	600	8	1,800	3
400,000	600	9	1,800	3
450,000	600	10	1,800	3
500,000	600	11	1,800	4

5. GROUNDWATER DISCHARGE – ROUTE 6 (EXIT 12) SITE

Based on site conditions, subsurface soils encountered, the wick loading test, and groundwater model scenario results, the Town is proposing to install a series of wicks at the Route 6 (Exit 12) Site to discharge up to 350,000 gpd of WWTF effluent. The estimated number of wicks, preliminary wick design, and proposed discharge areas are discussed in the following sections.

5.1. Preliminary Wick Design and Capacity

A wick is a column of gravel that is installed vertically from the ground surface through the unsaturated portion of the aquifer to a specified depth above the water table. Once online, effluent from the WWTF will be conveyed from the WWTF and discharged over the gravel at the surface of the wick. Once discharged, the effluent will flow downward through the gravel in the wick, discharging outward into the aquifer. This will first occur at the base, but will climb once the wick or once the discharge reaches the temporary mound created by effluent discharging into the aquifer.

Based on the site soils, depth to water table, and wick loading test results, it is expected that a full scale wick would range from three and six feet in diameter. The total depth of the wick would be between 50 and 75 feet. The final wick design including the diameter, total depth, gravel selection, etc. will be included as part of the GWDP application. Wick operations and maintenance (O&M) will also be proposed as part of the application.

As discussed in Section 4, the capacity of each wick is expected to be in excess of 150,000 gpd. It is anticipated that six to eight wicks will be installed at the site. The number of wicks installed will allow for redundancy in the discharge capacity and for proper operation and maintenance of the wicks. Once installed, each wick will be load tested using potable water to evaluate wick mounding, wick efficiency, and wick capacity. Details of the wick design and testing will be submitted with the WWTF design.

5.2. Preliminary Wick Locations

At this time, the wicks are proposed to be installed in the southern discharge area (Figure 2). This is primarily due to the slightly higher ground elevation and greater depth to the water table. The final wick locations will be based on discussion with and approval of MassDOT, the Town, and site conditions. The final locations will be submitted with the final wick design as part of the GWDP application.

5.3. Groundwater Monitoring Plan

A groundwater monitoring plan will be implemented to assess both baseline and compliance groundwater quality in the vicinity of the proposed discharge. The number and location of the compliance monitoring wells will be based on the final wick locations. Preliminary monitoring locations (CLS-8, CLS-9, CLS-10 and CLS-11) are shown on Figure 5. A detailed compliance monitoring plan will be submitted with the GWDP application.

Prior to discharging, two rounds of groundwater samples will be collected at the compliance monitoring wells and sent to a laboratory for analysis. As required by MassDEP, water samples will be analyzed in the field for temperature, pH and specific conductance. Groundwater samples collected from each of the monitoring wells will also be sent to a MassDEP certified laboratory for analysis. At a minimum, laboratory analysis will include nitrate-nitrogen, total nitrogen, total phosphorus, sodium, and volatile organic compounds (VOCs). Groundwater sampling will be conducted in accordance with MassDEP guidance. A round of water levels will also be collected during each round of sampling. The water level data and water quality results will be submitted to the MassDEP for review.



6. PRIMARY AND RESERVE DISCHARGE LOCATIONS

A summary of the proposed primary and reserve discharge locations follows.

6.1. Primary Discharge Location

The Town of Orleans has selected 32 Lots Hollow as the primary discharge location and is seeking MassDEP approval to discharge 500,000 gpd at the site. The request to discharge WWTF effluent at the site will be included as part of the Groundwater Discharge Permit application. 32 Lots Hollow Road is shown on Figure 6.

Based on site conditions, subsurface soils encountered, the wick loading test, and groundwater model scenario results, the Town is proposing to install a series of wicks at the 32 Lots Hollow Road Site is to discharge 500,000 gpd of WWTF effluent. Groundwater modeling indicates that a minimum of 500,000 gpd can be discharged at the site. The Town has submitted a Hydrogeologic Evaluation for up to 500,000 gpd discharge at 32 Lots Hollow Road.

6.2. Reserve Discharge Locations

Three reserve discharge locations have been identified. The locations are 43 Lots Hollow Road, Route 6 (Exit 12), and 223 Beach Road. The reserve discharge locations are shown on Figure 6.

6.2.1. Route 6 (Exit 12)

MassDEP has approved a discharge of 140,000 gpd at the Route 6, Exit 12 site. As discussed above, the Town is requesting a groundwater discharge of 350,000 gpd through a series of wicks from MassDEP. The site is controlled by MassDOT. The Town of Orleans and MassDOT are working on an agreement to allow the Town to use the site for a groundwater discharge.

6.2.2. 43 Lots Hollow Road

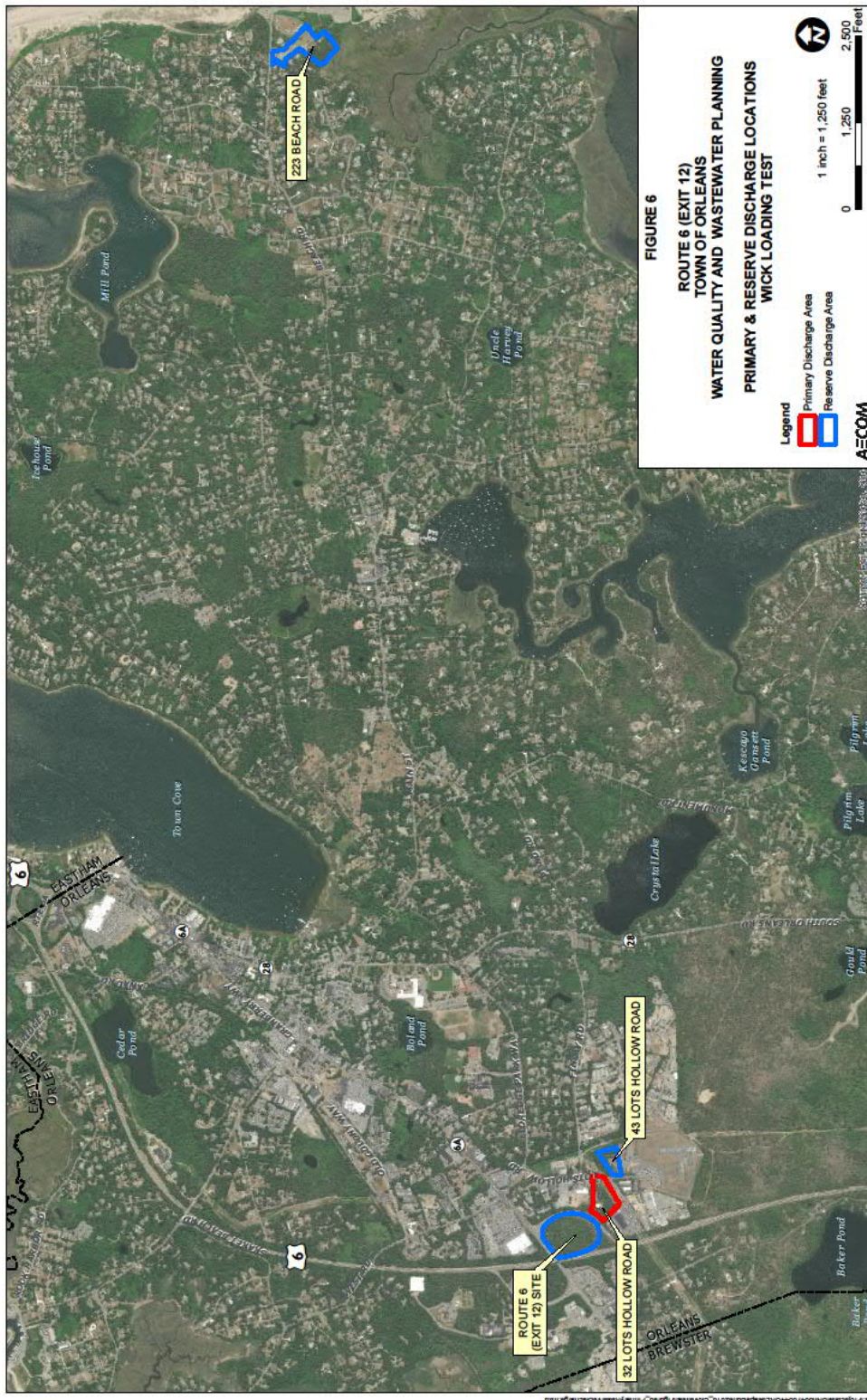
The Hydrogeologic Evaluation for 43 Lots Hollow Road has been submitted to MassDEP for approval of a 500,000 gpd discharge at the site (Figure 6). As with 32 Lots Hollow Road, the groundwater discharge would take place through a series of wicks.

6.2.3. 223 Beach Road

MassDEP has approved 223 Beach Road for a 200,000 gpd discharge using subsurface leaching trenches. A copy of the MassDEP approval letter is provided in Appendix A.

Model scenarios performed as part of the site Hydrogeologic Evaluation (AECOM, 2017), indicated that at the discharge rate of 200,000 gpd, all of the WWTF discharge and nitrate load would reach the Atlantic Ocean. At discharges greater than 200,000 gpd, a portion of the effluent and nitrate load discharged to a subwatershed (Pochet River) of the nitrate impacted Pleasant Bay Watershed.

The soils at 223 Beach Road will allow a discharge greater than 200,000 gpd. If the Town planned to discharge at a rate greater than the approved 200,000 gpd, additional nitrate reduction measures at the WWTF or within the Pochet River subwatershed, may be required by MassDEP. The purpose of the nitrate reduction measures would be to offset the additional nitrate load from the WWTF discharge to the Pochet River subwatershed. Prior to increasing the discharge over 200,000 gpd, the Town would be required by MassDEP to submit a request to MassDEP for the proposed discharge rate. At a minimum, the request would need to include the anticipated discharge rate at the site, an estimate of the nitrate load from the WWTF discharge to the Pochet River subwatershed, and supporting documentation.



Appendix A
Correspondence

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Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Southeast Regional Office • 20 Riverside Drive, Lakeville MA 02347 • 508-946-2700

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

February 2, 2018

Mr. John Kelly
Town Administrator
Orleans Town Hall
19 School Road
Orleans, MA 02653

RE: ORLEANS: Route 6 Cloverleaf,
BRP WP 83, Approval of Hydrogeologic
Evaluation Report,
Transmittal No.: X277248

Dear Mr. Kelly:

The Massachusetts Department of Environmental Protection (MassDEP) has completed its review of the hydrogeologic evaluation report titled "HYDROGEOLOGIC EVALUATION ROUTE 6 (EXIT 12) CLOVERLEAF SITE TOWN OF ORLEANS, MASSACHUSETTS", dated October, 2017 and submitted on your behalf by AECOM. The report summarizes the results of a hydrogeologic evaluation conducted by AECOM to support a future Groundwater Discharge Permit Application for a proposed effluent discharge at Route 6 Cloverleaf (Exit 12) in Orleans, Massachusetts. The evaluation was conducted in accordance with the scope-of-work submitted by AECOM on November 30, 2015 and approved by MassDEP on May 16, 2017. Notice of the availability of the scope-of-work was published in the Environmental Monitor on December 23, 2015.

The evaluated discharge area is approximately 75,000 sq. ft. in west Orleans at the interchange of Route 6 and Route 6A, owned by the Commonwealth of Massachusetts, MassDOT. This site was chosen because of its relatively close proximity to the proposed WWTF at Overland Way and because it is outside the impaired Town Cove Watershed. The site is not located within any Zone II wellhead protection areas.

Soil tests and borings performed within the footprint of the proposed infiltration beds encountered mostly medium to fine sands at depths between 11 to 15 feet. The soils became finer at lower depths between 60 to 110 feet with observed layers of silt mixed with sands, silt and clay. None of these finer layers were observed to be greater than 2 feet thick. There were a total of seven test holes and four soil borings drilled. Three monitoring wells were also installed. Two percolation tests was carried out on DOH-1 and DOH-2 in the C layer characterized as sand, and

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it was assumed to be representative of similar layers found in some, but not all, of the holes excavated on the site. The result showed a percolation rate of less than 2 minutes per inch.

The proposed infiltration beds were evaluated at design flows of 25,000, 50,000, 100,000, 150,000, 200,000, 300,000, 400,000 and 500,000 gallons per day. If wicks are proposed as the infiltration structure of choice, further testing and evaluation by MassDEP is required. The area required for the discharge is yet to be finalized with MassDOT.

Groundwater was encountered in the monitoring wells at an average depth of 65 to 75 feet below ground surface. The hydraulic conductivity based on grain size analysis ranged from 0.05 ft/day to 255 ft/day depending on the soil texture. The average hydraulic conductivity was determined to be 45 ft/day. The seasonal high groundwater level was estimated by comparing water level information from USGS reference wells and water level collected at the site. The long-term USGS reference well, although over 8700 feet from the Route 6 site, shares similar formation and hydrogeologic setting. Groundwater contours were plotted by measuring water level from the monitoring wells and converting them to elevations in mean sea level. This was used to determine the direction of groundwater flow across the site which was to the north-northwest at a hydraulic gradient of 0.0016 ft/ft.

AECOM modified a regional groundwater flow model of the Monomoy Lens developed by USGS and coupled it with a particle tracking model to show potential groundwater movement over a given period. In order to demonstrate that the updated model was similar to the original USGS model and would give adequate prediction of the different effluent scenarios that were explored, both models were run to check for groundwater elevation at different points on the site. Similar results were obtained for both runs. The results of the simulation showed that there would be no impacts with respect to groundwater mounding. At the highest proposed flow volume of 500,000 gpd, the simulation showed that the maximum mound height below the discharge area is 7.4 feet which provides a water table elevation of 45 feet below the ground surface. The estimated high water level elevation was 1.80 feet. These elevations provide more than the required four feet of unsaturated separation between the top of the mounded seasonal high water table and the base of the proposed disposal beds.

The results of the groundwater mounding were verified by The Department using AQETSOLV groundwater mounding calculator by inputting the highest proposed loading rate of 500,000 gpd, the area (sq. ft.) of discharge area mentioned in the report and all other necessary parameters like the varying hydraulic conductivities at different areas used on the model from the results in the hydrogeologic report. Similar mounding heights to that achieved by the model were realized. Based on the results shown and verification using the calculator, mounding is not expected to be a concern at the site even at high discharge volumes of up to 500,000 gpd. The results of the simulation carried out by AECOM showed the possibility of particles traveling into the outer reaches of the Namskaket and Little Namskaket marshes at loading rates of 150,000 gpd or more. Also at loading rates of 200,000 or more, there is potential for the discharge reaching Rock Harbor.

On November 7, 2017, AECOM submitted a revised Groundwater Monitoring Plan to MassDEP that outlines procedures for the long-term monitoring of groundwater quality in the

vicinity of the proposed soil absorption system. The plan proposes a monitoring well network that consists of monitoring wells; CLS-1, CLS-2 and CLS-3.

Pursuant to 314 CMR 5.09 (1) (f), MassDEP hereby approves the hydrogeologic report submitted by AECOM and authorizes the applicant to apply for an Individual Groundwater Discharge Permit (BRPWP 79) subject to the following conditions:

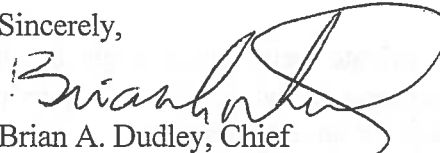
1. The design flow of the proposed groundwater discharge shall not exceed 145,000 gallons per day.
2. The loading rate to the infiltration beds shall not be greater than the maximum allowed under present Department guidelines. If wicks are proposed as the preferred alternative, further testing will be required prior to approval of their installation.
3. The proposed infiltration beds shall not be constructed until a Groundwater Discharge Permit has been obtained from MassDEP.
4. The proposed infiltration beds shall be constructed within the footprint indicated on Figure 4, "SITE PLAN" found in the hydrogeologic report. .
5. There are private wells which might be affected by the discharge at the site and will need to connect to the Town of Orleans public water supply or be monitored on an annual basis for adverse impacts.
6. There is possible impact of mounding on the marshes; therefore, monitoring of the species present is recommended prior to discharge to document any potential changes during discharge commencement.
7. MassDEP approves the monitoring well locations proposed in the Groundwater Monitoring Plan. Upgradient and downgradient wells must be specified. The proposed well locations and approved monitoring plan will be referenced in the Groundwater Discharge Permit when issued. MassDEP recognizes that proposed locations are somewhat dependent upon final site development (e.g. building and road placement) and may require modification; however, changes must be submitted to this office for approval prior to well installation. Final monitoring wells must be installed and sampled for all groundwater quality parameters listed in the issued permit no later than 90 days prior to startup of the wastewater treatment plant and discharge to the infiltration beds.
8. An Initial Groundwater Monitoring Well and Groundwater Quality Report must be submitted to this office prior to any discharge of wastewater. This report must include:
 - a. a final surveyed site plan with location of the infiltration beds, all monitoring wells and all appropriate elevation data,
 - b. boring logs and well construction details for all monitoring wells, and

- c. the analytical results of the groundwater samples collected from the final groundwater monitoring wells. These results will establish the baseline groundwater quality for the site.

Please be advised that this approval **is not** a Groundwater Discharge Permit. It does, however, authorize the project proponent to submit an Individual Groundwater Discharge Permit application for the discharge described at the evaluated location. MassDEP requires that the Individual Groundwater Discharge Permit application (BRPWP 79) be accompanied by a MassDEP Transmittal form and include all required supporting documentation. Included in the supporting documentation shall be a certification from a Massachusetts Registered Professional Engineer that the approved Hydrogeologic Evaluation Report has been reviewed and accurately reflects site conditions as of the date of permit application. Information on any changes noted during the review shall be included in the Engineering Report that accompanies the application. Please be advised, the submittal of plans and specifications may be required at any time during the review of the permit application.

If you have questions regarding the comments and conditions of this approval, please contact Kermit Studley of this office at (508) 946-2803.

Sincerely,



Brian A. Dudley, Chief
Wastewater Management – Cape and Islands

cc: Mr. Mark Owen, PG
AECOM,
9 Jonathan Bourne Drive,
Pocasset, MA 02559

Memorandum

To Brian Dudley, MassDEP SERO
CC George Meservey, Town of Orleans, Director of Planning & Community Development;
Steve Hallem, MassDEP Boston
Henry Barbaro: MassDOT Boston
Thomas Cambareri: Cape Cod Commission
Betsy Shreve-Gibb, AICP, AECOM Project Director
Mark Owen, PG, AECOM
Subject **Town of Orleans, MA**
Water Quality and Wastewater Planning
Proposed Wick Loading Test
Route 6 Cloverleaf Proposed Discharge Area
Project Number 60476644
From Thomas Parece, P.E., AECOM Project Manager
Date April 18, 2018

On behalf of the Town of Orleans, AECOM is submitting an updated proposed Hydrogeologic Evaluation Scope of work for the proposed groundwater discharge at the Route 6 (Exit 12) Cloverleaf site (Figure 1). The updated scope proposes to install a test wick and conduct a 30-day wick loading test in addition to the Hydrogeologic Evaluation completed in 2017 and summarized in the final report submitted October, 2017. AECOM proposes to update the final report to include details on the wick installation, wick loading test, groundwater model results, conclusions, and recommendation.

1. Background

The proposed hydrogeologic site evaluation is being conducted as part of the evaluation of proposed treatment and disposal of sanitary sewage generated in the Downtown Area of Orleans, MA. Proposed treatment would take place at a new facility on Overland Way in Orleans, MA.

On December 15, 2015, a proposed scope of work to conduct a Hydrogeologic Site Evaluation was submitted to MassDEP for review and comment. The notification of the proposed scope of work was published in Volume 85, Issue 4 on December 23, 2015 of the Environmental Monitor and was open to public comment. The Proposed Hydrogeologic Site Evaluation was approved by MassDEP on May 16, 2017.

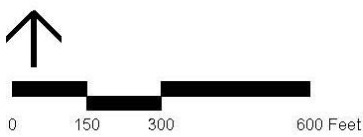
The Hydrogeologic Evaluation was completed in the fall of 2017. The final report was submitted to MassDEP in October 2017. On February 2, 2018, the MassDEP approved the Hydrogeologic Evaluation report pursuant to 314 CMR. 5.09 (1) (f) and authorizes the Town of Orleans to apply for an Individual Groundwater Discharge Permit (BRPWP 79). The conditional approval was for a groundwater discharge not to exceed 145,000 gallons per day (gpd).

Since the completion of the hydrogeologic evaluation and submittal of the of the final report, the Town has received a Site Access Permit granting permission to install four additional monitoring wells, a test wick, and perform a 30-day loading test at the site. A copy of the access permit is provided in Appendix A.



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Figure 1
Locus Map
Water Quality and Wastewater Planning
Route 6 (Interchange 12) Cloverleaf
Downtown Area - Groundwater Discharge



At present, the Town is also seeking an agreement with MassDOT to allow a groundwater discharge at the site. The form of the agreement and timing are to be determined.

The project history and background, previous proposed scope, and results of the Hydrogeologic Evaluation are contained in the Hydrogeologic Evaluation report submitted October 2017.

In the following section, AECOM has updated the Proposed Hydrogeologic Evaluation to reflect the installation of a test wick, perform a 30-day loading test, evaluate the loading test results, and update the Hydrogeologic Evaluation report. All proposed tasks, as well as those included in December 23, 2015 Proposed Hydrogeologic Evaluation are included below. Tasks that have been completed have been identified. The results of those tasks are included in the report submitted in October 2017.

2. Updated Hydrogeologic Evaluation Scope

- A. Test Pit Investigation – Completed 2017
- B. Soils Testing and Data Analysis - Completed 2017
- C. Baseline Water Quality Analysis - Completed 2017
- D. Estimate of High Water Table - Completed 2017
- E. Test Wick Design and Installation - Proposed

As part of the Hydrogeologic Evaluation, a test wick will be installed and load tested to assist in evaluating the capacity of a full-sized wick. The approximate location of the test wick is shown on Figure 2. Also shown on Figure 2 are the existing and proposed monitoring well locations for observing groundwater levels during the loading test. The monitoring wells are to be located approximately 5, 15, 30, 60, 120, 200 and 220 feet from the proposed test wick.

The test wick will be installed using a drilling rig with 14-inch outside diameter, 8.78-inch inside diameter augers. The borehole will be drilled to approximately 2 feet above the water table or 83 feet below land surface (bls). Once drilled, an internal observation well consisting of 2-inch diameter PVC well screen and casing will be installed and centralized in the borehole to the total depth of the borehole. The internal observation well will be installed with approximately 80 feet of continuous slot (20-slot) PVC well screen and 5 feet of PVC casing at the top. As the augers are removed, a washed ¾-inch stone will be installed between the formation and well screen. The test wick will be completed with protective casing and secured with a concrete pad and locking cover.

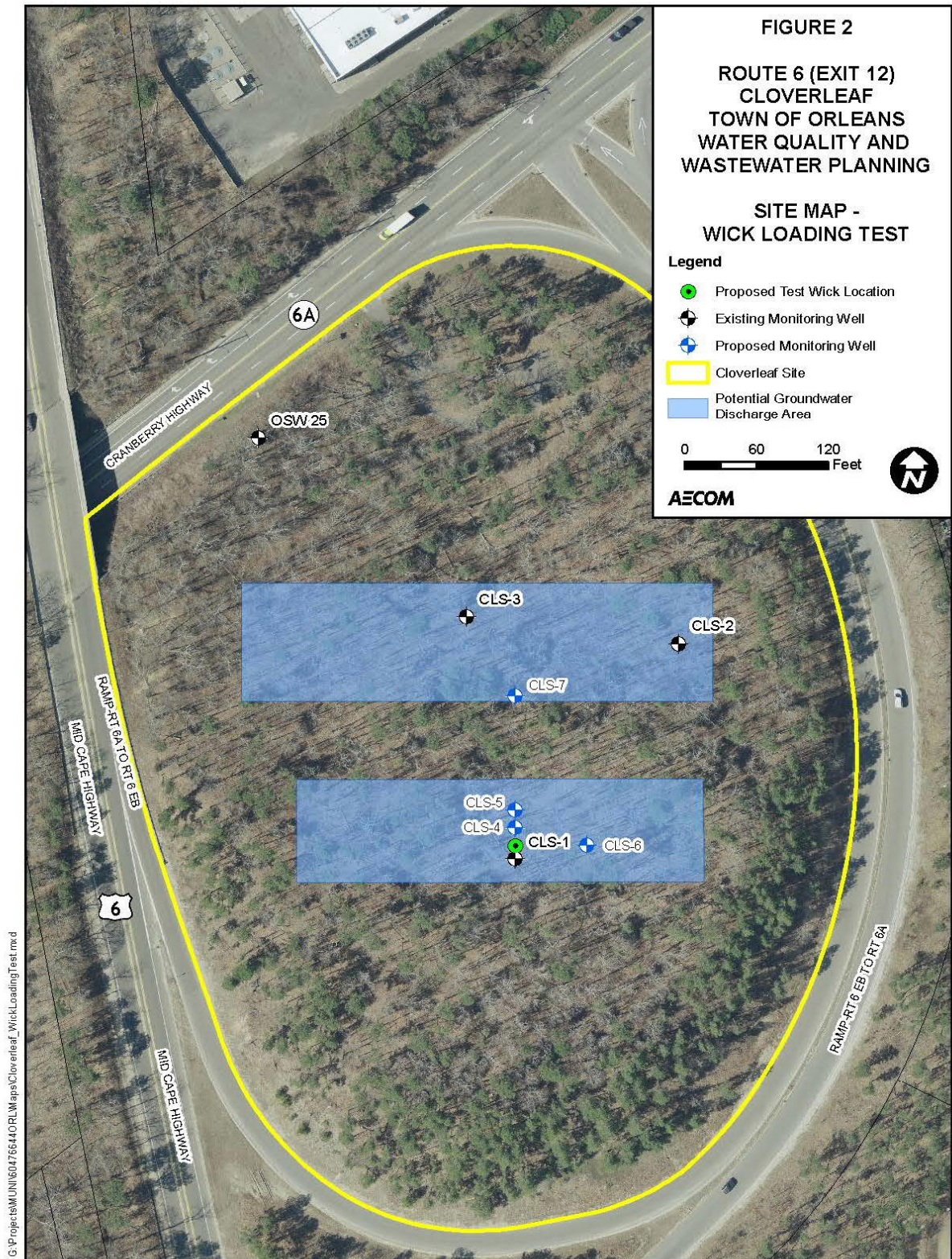
1) 30-Day Loading Test - Proposed

Once installed, the 30-day loading test will be performed by discharging potable over the gravel at the top of the test wick. The source of potable water will be from the Orleans Water Department.

The loading test will consist of successively higher loading rates, beginning at approximately 20 to 25 gallons per minute (gpm). Each step of the loading test will be increased incrementally based on the previous loading rate and water levels observed in the internal monitoring well. We anticipate that each step of the test will last several days, although the goal is to allow water levels within the test wick and monitoring well CLS-1 (located approximately 5 feet from the wick) to level off before beginning the subsequent step.

Background water level readings will be collected daily for a minimum of 5 days prior to the start of the prolonged loading test. Background water level readings will be collected from the test wick and monitoring wells CLS-1, CLS-5, CLS-6, and LH-1,

Data loggers will be installed in the test wick and monitoring wells CLS-1, CLS-4, CLS-5, CLS-6, and CLS-7 to monitor water levels throughout the loading test. Monitoring wells CLS-2, CLS-3, LH-1, LH-5, MW-9, and MW-14, will also be monitored periodically throughout the test.



Manual water level readings will be collected at all of the well locations periodically throughout the loading test. Precipitation data will be collected and recorded daily at the Orleans Water Department located approximately 5,200 feet southeast of the 32 Lots Hollow Road. Water level data from USGS monitoring well BMW-22 will be used to provide ambient water levels.

At the conclusion of the test, water level data will be summarized and analyzed to evaluate groundwater mounding and the loading efficiency of the soils underlying the site. The water level data will also be used to design and estimate the capacity of a full sized wick as well as estimate the capacity of the site for a groundwater discharge.

2) Estimated Groundwater Mounding - Proposed

Data obtained from the site investigations will be analyzed and used to update a numerical groundwater flow model to simulate groundwater flow in the vicinity of the proposed discharge. The groundwater flow model will use MODFLOW, developed in 1988 by McDonald and Harbaugh of the USGS, to compute groundwater flow in an aquifer under different stressors. Once calibrated, groundwater mounding resulting from the discharge of wastewater will be simulated. The model will also be used to design the proposed groundwater discharge method, and assess potential impacts to sensitive receptors.

3) Final Report - Proposed

The Hydrogeological Evaluation Report previously submitted will be updated to include the test wick installation and loading test methods. The updated report will also summarize and update the results of the field investigations, data analysis, groundwater mounding analysis, numerical model documentation, and potential impacts to sensitive receptors. Included will be pertinent USGS geologic and hydrogeologic data, estimated depth to bedrock, the location of existing and potential water supply wells, water supply protection areas, and pertinent subsurface investigations conducted at nearby sites.

The updated report will also identify watershed recharge areas and boundaries, assess potential impacts of nitrogen to receiving waterbodies, and estimate the additional nutrient load to the receiving watershed(s). The groundwater model results will include the lateral extent of the groundwater discharge, separation between the ground surface and the mounded water table under high water table conditions, groundwater travel times, and potential impacts on watershed(s), infrastructure, and potential sensitive receptors.

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Appendix A

MassDOT Access Permit No. 5-2017-0056 (Amendment)

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Charles D. Baker, Governor
Karyn E. Polito, Lieutenant Governor
Stephanie Pollack, Secretary & CEO
Jonathan L. Gulliver, Highway Administrator



**Permit #: 5-2017-0056
AMENDMENT**

PERMIT - ORLEANS

Subject to all terms, conditions, and restrictions printed, attached or written below, and on the reverse side hereof, permission is hereby granted to **AECOM**, Mark R. Owen, 9 Jonathan Bourne Drive, Pocasset, MA 02559 to enter upon the State Highway in the Town of **ORLEANS** on Auto Route 6, locally known as Mid-Cape Highway and on Auto Route 6A, locally known as Cranberry Highway.

AMENDMENT TO PERMIT 5-2017-0056

This permit is being amended to install three to four additional monitoring wells, one test pit, perform a 30-day wick loading test, and perform periodic water level data collection from the proposed test pit and monitoring wells, within the State Highway Layout (S.H.L.O.). The monitoring wells and the test pit will be installed inside the southeastern cloverleaf of Exit 12 on Route 6, and adjacent to Route 6A (Cranberry Highway). The monitoring wells will have a 2" diameter with an approximate depth of 100 feet and the test pit will have a 14" diameter with an approximate depth of 85 feet.

The Grantee(s) must adhere to all the terms and conditions stated herein and as outlined in the original Permit #5-2017-0056.

All work is to be done as described herein and as shown on the attached aerial pictures.

Upon completion of the work within the shoulder area, all disturbed areas must be filled and brought up to grade, compacted and loamed and seeded. Unless allowed herein, monitoring wells are not permitted within the hardened surface of the roadway. However, if permission is granted to allow the wells to be placed within the roadway or sidewalk areas must be backfilled, compacted and patched with hot mix asphalt/cement concrete as per existing conditions and in accordance with MassDOT, Highway Division, standard specifications.

The Grantee(s) will be responsible for the work performed under this Permit against cracks, settling or heaves until work is performed on said areas by MassDOT, Highway Division.

The Grantee(s) will be responsible to replace/reset any covers that may be damaged.

THE BACKFILLING METHOD FOR WORK WITHIN THE HARDENED SURFACE FOR SOIL BORINGS, TEST PITS, OR SMALL TRENCH OPENINGS WILL BE AS FOLLOWS:

"FOLLOWING CONDITIONS APPLY TO PERMITS"

Conditions Relating Particularly to Permits for the Laying of Pipes, Conduits, etc.

After any pipes, conduits, drains or other underground structures are laid, or any excavation is made in the roadway, the trenches or openings shall be properly backfilled with suitable material, the back-filling shall be thoroughly tamped, and the surface of the road over said structures shall be left even with the adjoining ground. If the work is done in cold weather no frozen material shall be used for back-filling.

Wherever the hardened surface of the roadway, gutters, or any part of the surface of the highway is disturbed it shall be replaced in as good condition as before it was disturbed, and if new materials are required they shall correspond with those already in place on the road.

Where service pipes are to cross the highway the connections shall be made without disturbing the hardened surface of the roadway, by driving the pipes under the roadway, or the service pipes shall be carried under and across the road in a larger pipe, unless otherwise ordered by the Director.

The Grantee shall maintain the surface of the roadway over said structures as long as MassDOT may deem necessary, until all signs of the trenches shall have been eliminated.

Conditions Relating Particularly to Permits for the Erection of Poles, Wires, and Overhead Structures, and the Cutting and Trimming of Trees

In the erection of pole lines, unless otherwise herein provided, no trees located within the limits of the State Highway shall be cut or trimmed. No guy wires shall be attached to trees without a special permit from MassDOT, and in no event shall they be so attached as to girdle the trees or in any way interfere with their growth. The wires shall be so protected at all time and places that they shall not interfere with or injure the trees either inside or outside the location of the highway.

Where the cutting or trimming of trees is authorized by this permit, only such cutting and trimming shall be done as may be designated by the Director.

In the construction or reconstruction of pole lines no guy wires shall be erected nearer to the surface of the ground than six feet; provided, however, that the owners of such lines may maintain such guy wires at a lower elevation than six feet from the ground until such time as MassDOT shall notify them to remove said wires or to the elevation first stated.

In order to protect the trees through which any wires may pass, said wires shall be insulated and such other tree guards used as may be directed by the Director.

Where high tension wires are erected under this permit, they shall be so located that, under conditions of maximum severity as regards a coating of ice or snow, there shall be a space of at least eight feet between such high tension wires and other wires.

The Grantee shall, within sixty days from the date of completion of the work, file in the office of MassDOT a plan showing the location of each pole erected in accordance with the permit, said plan to be of such size and in such form as MassDOT may direct.

General and Additional Conditions

Whenever the word "MassDOT" is used herein it shall mean the Massachusetts Department of Transportation of the Commonwealth of Massachusetts.

Whenever the word "Director" is used herein it shall mean the District Highway Director or other authorized representative of MassDOT.

Whenever the word "Grantee" is used herein it shall mean the person or persons, corporation or municipality to whom this permit is granted, or their legal representatives.

During the progress of the work all structures under ground and above ground shall be properly protected from damage or injury; such barriers shall be erected and maintained as may be necessary for the protection of the traveling public; the same shall be properly lighted at night; and the Grantee shall be responsible for the damages to persons or property due to or resulting from any work done under this permit.

Except as herein authorized, no excavation shall be made or obstacle placed within the limits of the State highways in such a manner as to interfere unnecessarily with the travel over said road.

If any grading of sidewalk work done under this permit interferes with the drainage of the State highway in any way, such catch basins and outlets shall be constructed as may be necessary, in the opinion of the Director, to take proper care of such drainage.

Wherever the hardened surface of the roadway is disturbed and the Director may consider it necessary or advisable to do so, said surface will be restored by the employees of MassDOT, at such time as MassDOT may direct, and the expense thereof shall be borne by the Grantee, who shall purchase and deliver on the road the materials necessary for said work if and when directed by the Director. All payments to the supplier and to laborers, inspectors, etc., employed by MassDOT for or on account of the work herein contemplated shall be made by said Grantee forthwith on receipt of written orders, pay rolls, or vouchers approved by MassDOT.

IF THE GRANTEE DOES ANY WORK CONTRARY TO THE ORDERS OF THE DIRECTOR, AND, AFTER DUE NOTICE, FAILS TO CORRECT SUCH WORK OR TO REMOVE STRUCTURES OR MATERIALS ORDERED TO BE REMOVED, OR FAILS TO COMPLETE WITHIN THE SPECIFIED TIME THE WORK AUTHORIZED BY THIS PERMIT, MASSDOT MAY, WITH OR WITHOUT NOTICE, CORRECT OR COMPLETE SUCH WORK IN WHOLE OR IN PART, OR REMOVE SUCH STRUCTURES OR MATERIALS, AND THE GRANTEE SHALL REIMBURSE MASSDOT FOR ANY EXPENSE INCURRED IN CORRECTING AND/OR COMPLETING THE WORK OR REMOVING THE STRUCTURES OR MATERIALS.

ALL OF THE WORK HEREIN CONTEMPLATED SHALL BE DONE UNDER THE SUPERVISION AND TO THE SATISFACTION OF THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION, AND THE ENTIRE EXPENSE THEREOF SHALL BE BORNE BY THE GRANTEE.

On the completion of the work herein contemplated all rubbish and debris shall be removed and the roadway and roadsides shall be left neat and presentable and satisfactory to the Director.

MassDOT hereby reserves the right to order the change of location or the removal of any structure or structures authorized by this permit at any time, said change or removal to be made by and at the expense of the Grantee or its / their successors or assigns.

This permit may be modified or revoked at any time by MassDOT without rendering said MassDOT or the Commonwealth of Massachusetts liable in any way.

The Grantee shall pay the salary, subsistence and travel expenses of any inspector appointed by MassDOT to supervise the work herein contemplated.

All of the above conditions shall be applicable to the work herein authorized, unless the same are inconsistent with the conditions on the face of the permit, in which case the conditions written or printed on the face of the permit shall apply.

The acceptance of this permit or the doing of any work thereunder shall constitute an agreement by the Grantee to comply with all of the conditions and restrictions printed or written herein.

Soil borings, test pits or small trench openings (less than 4 feet deep) must be backfilled with Gravel or Dense Graded Crushed Stone properly compacted in accordance with AASHTO Standard Specifications of Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth) (Designation T238-86 Method B - Direct Transmission shall be used to determine in-place density) and Moisture Content of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth) (Designation T239-91). If the depth is larger than 4 feet, then Controlled Density Fill (CDF - M4.08.0, Type 2E Flowable, and Excavatable) should be used. Additionally, the repair must match the existing pavement thickness or a minimum of seven (7) inches of Hot Mix Asphalt consisting of 3" of Hot Mix Asphalt Base Course, 2" of Hot Mix Asphalt Binder Course and 2" of Hot Mix Asphalt Modified Top Course.

The infra-red method must be performed in conjunction with the permanent patch to create a smooth driving surface consistent with the existing roadway. The District Office must be notified two business days prior to starting this work, so that an inspector may be assigned. This mix must be machine laid.

All traffic safety lines if disturbed shall be replaced in kind.

The Grantee(s) shall be responsible for the maintenance and repair of this portion of the roadway and shall perform routine inspections for deficiencies such as settling, heaving, cracks etc. This responsibility shall remain in effect until the resurfacing of this particular portion of highway is performed by MassDOT, Highway Division.

All disturbed areas within the hardened surface of the roadway must be backfilled, compacted and patched with hot mix asphalt/cement concrete as per existing conditions and in accordance with MassDOT, Highway Division, standard specifications. Soil borings in the soft shoulder must be filled and brought up to grade compacted and loamed and seeded.

CLOSING CONDITIONS

ALL OF SAID WORK SHALL COMPLY WITH THE TERMS AND CONDITIONS HEREIN, AND MUST BE DONE AS DIRECTED BY AND TO THE SATISFACTION OF THE ENGINEER.

All work done under this contract shall be in conformance with the Massachusetts Highway Department "Standard Specifications for Highways and Bridges" dated 1988, as amended and the "Supplemental Specifications to the Standard Specifications for Highways and Bridges" dated July 1, 2015. All construction shall conform to the October 2017 edition of the Massachusetts Department of Transportation, Highway Division "Construction Standard Details (English Edition)"; the latest Manual on Uniform Traffic Control Devices with Massachusetts Amendments; the latest edition to the following: the 1996 Construction and Traffic Standard Details (as related to Traffic Standard details only); the 1990 Standard Drawings for Traffic Signs and Supports; the 1968 Standard Drawings for Traffic Signals and Highway Lighting; the latest edition of American Standard for Nursery Stock; the Plans and these Special Provisions.

The Grantee(s) shall indemnify and save harmless the Commonwealth and MassDOT, Highway Division, against all suits, claims or liability of every name and nature arising at the time out of or in consequence of the acts of the Grantee(s) in the performance of the work covered by this Permit and/or failure to comply with the terms and conditions of this Permit whether by themselves or their employees or subcontractors.

It is noted that the Grantee(s) will be responsible for future corrective actions resulting from defective work under the subject permit. Any damage to roadway and/or shoulder as a result of the permitted work is the Grantee's responsibility and shall be repaired at his/her expense.

THE GRANTEE(S) SHALL CONTACT THE PERMITS SECTION AT (508) 884-4306 WHEN THE WORK REQUIRED UNDER THIS PERMIT HAS BEEN COMPLETED IN ORDER FOR A FINAL INSPECTION TO BE PERFORMED BY MASSDOT, HIGHWAY DIVISION. IF THE COMPLETION OF WORK FORM IS NOT RETURNED, THE LIABILITY ASSUMED UNDER THIS PERMIT WILL CONTINUE.

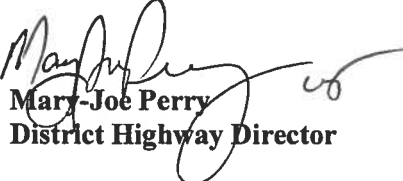
A COPY OF THIS PERMIT MUST BE ON THE JOB SITE AT ALL TIMES FOR INSPECTION. FAILURE TO HAVE THIS PERMIT AVAILABLE AT THE SITE WILL RESULT IN SUSPENSION OF THE RIGHTS GRANTED BY THE PERMIT.

No work shall be done under this Permit until the Grantee has communicated with and received instructions from MassDOT, Highway Division's District Highway Director at 1000 County Street, Taunton, MA 02780.

The Permit shall be void unless the work herein contemplated shall have been completed before FEBRUARY 22, 2019.

Dated at TAUNTON this 6TH day of MARCH, 2018.

MassDOT-Highway Division,
By



Mary-Joe Perry
District Highway Director

FSJ: fsj ^{dmw}
cc: Foreman

From: Parece, Tom [<mailto:Tom.Parece@aecom.com>]
Sent: Wednesday, February 14, 2018 11:35 AM
To: Berthiaume, Nicole M. (DOT)
Cc: jkelly@town.orleans.ma.us; George Meservey (gmeservey@town.orleans.ma.us); Shreve, Betsy; Owen, Mark
Subject: Orleans, MA - Route 6 Exit 12 - Site Access Permit # 5-2017-0056 Extension

Nicole.

Thank you for your assistance on Site Access Permit # 5-2017-0056.

As discussed, the Town of Orleans wishes to continue with the proposed Hydrogeologic Evaluation within the southeast cloverleaf of Exit 12 on Route 6 in Orleans, Massachusetts (Figure 1). The proposed scope included in Permit # 5-2017-0056 has been substantially completed however additional investigations are required to meet MassDEP criteria for completing a Hydrogeologic Evaluation.

On behalf of the Town, **AECOM requests an extension** to Site Access Permit # 5-2017-0056 to allow for the completion of the following tasks.

1. The installation of three to four 2-inch diameter monitoring wells to a depth of approximately 100 feet (Figure 2).
2. The installation of one test wick (approximately 14-inches in diameter) to a depth of approximately 85 feet.
3. The performance of a 30-day wick loading test.
4. The collection of periodic water level data from the test wick and monitoring wells.

At this time, we do not anticipate the removal of any trees to perform the described work. AECOM will make every attempt to install the test wick and monitoring wells in areas where the removal of trees will not be necessary. If any trees in excess of 6-inches need to be removed, AECOM will tag the tree(s) and contact MassDOT prior to proceeding with the work. We also do not anticipate any work to occur within 30-feet of any road right-of-ways adjacent to the cloverleaf shown on Figure 2.

Approximately two weeks prior to mobilizing to the site, AECOM will review the US Fish and Wildlife Service's (USFWS) mapping for the northern long-eared bat (NLEB). If the proposed work is located within 0.25 miles of a known NLEB hibernacula or with 150 feet from a known NLEB maternity roost tree, MassDOT will be notified.

Dig Safe will be notified one to two weeks prior to any subsurface excavation (test wick and monitoring well installation). A copy of the Dig Safe Ticket will be forwarded to MassDOT prior to beginning work.

I have also attached a figure showing what the monitoring wells and test wicks will look like at the surface once installed.

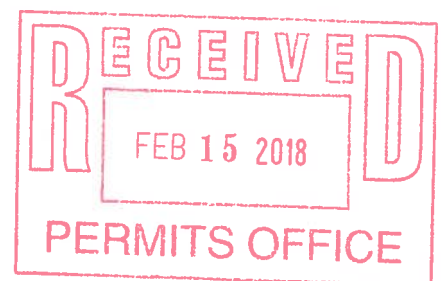
AECOM anticipates that the proposed work will be completed prior to June 1, 2018.

If you have any questions, please contact this office.

Thanks,
Tom

Thomas E. Parece, P.E.
Associate Vice President - Water
D 1.978.905.2354 C 1.978.764.9027
tom.parece@aecom.com

AECOM
9 Jonathan Bourne Drive, Pocasset, MA 02559
T 1.508.833.6950 F 1.508.833.6951



**Notice to MassDOT, Highway Division
of
Completion of Work**

Grantee Name: _____

City/Town Project Location: _____

Permit No.: _____ **Date Issued:** _____

Subject to all of the terms, conditions and restrictions as described on the attached Permit, permission is hereby granted to proceed with the work described within the Permit which has been issued to perform work within the State Highway Layout by the MassDOT, Highway Division, District Five, 1000 County Street, Taunton, MA 02780, (508) 824-6633.

Please notify the Permits Section at (508) 884-4306, at least two (2) business days prior to starting the proposed work.

Your attention is called to the time frame allowed for completion of said work which is found on the last page of the Permit. If the proposed work can not be completed prior to the expiration date or alterations to any of the Permit conditions become necessary, you must contact the Permits Engineer in writing to extend/amend the Permit as soon as possible for review and approval of such request.

Upon completion of the work described within the Permit, you must complete the bottom portion (do not detach) of this letter and forwarded it to MassDOT, Highway Division. A final inspection will then be scheduled to be performed. If the work performed was found in compliance with the terms and conditions as outlined in the Permit, the Permit will then be signed off as complete and to the satisfaction of the Engineer.

IF THIS NOTICE IS NOT RETURNED, THE GRANTEE'S LIABILITY ASSUMED UNDER THIS PERMIT WILL CONTINUE UNTIL THE PERMIT IS SIGNED OFF AS COMPLETE

By Authority of the Massachusetts District Five Highway Director, Ms. Mary-Joe Perry

To MassDOT, Highway Division
Attention Permits Office:

I, the Grantee of the above mentioned Permit, hereby notify you that the work outlined and authorized under the terms and conditions of said Permit, has been completed in accordance with all requirements of the MassDOT, Highway Division and request a final inspection to be performed.

Work Completed on: _____ Date: _____

Permit Grantee's name: _____ Print: _____

Signed: _____ Date: _____
Grantee(s) signature

A notice of "sign-off" will only be sent at the request of the Grantee

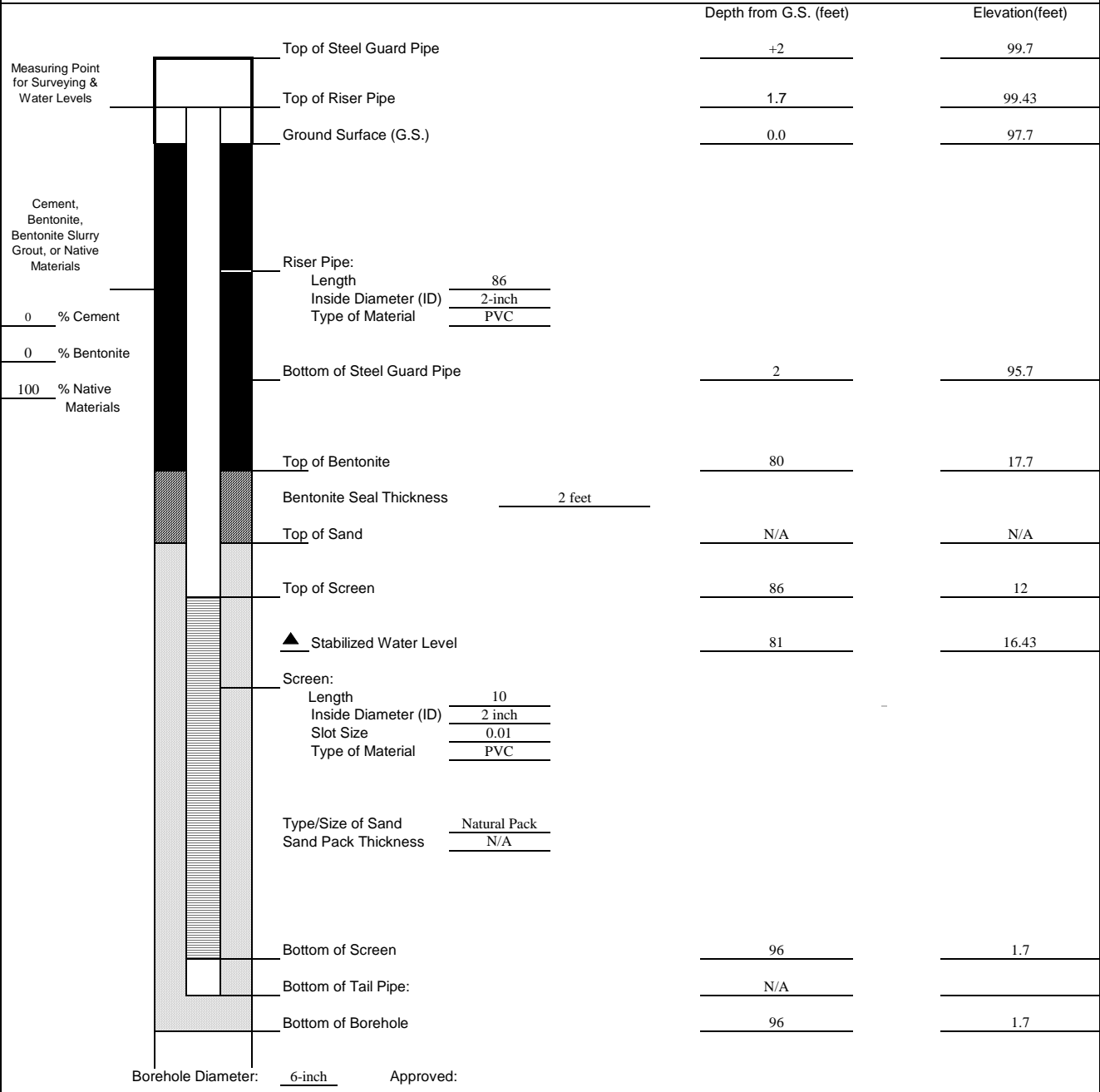
Appendix B
Monitoring Well and Wick Logs

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<i>Client: Town of Orleans</i>	WELL ID: CLS-4
<i>Project Number: 60476644</i>	
<i>Site Location: Orleans, MA</i>	<i>Date Installed: 03/19/2018</i>
<i>Well Location: Exit 12 Cloverleaf Coords:</i>	<i>Inspector: Erika Amir-Lin</i>
<i>Method: CME truck mounted hollow-stem auger</i>	<i>Contractor: Desmond Drilling</i>

MONITORING WELL CONSTRUCTION DETAIL

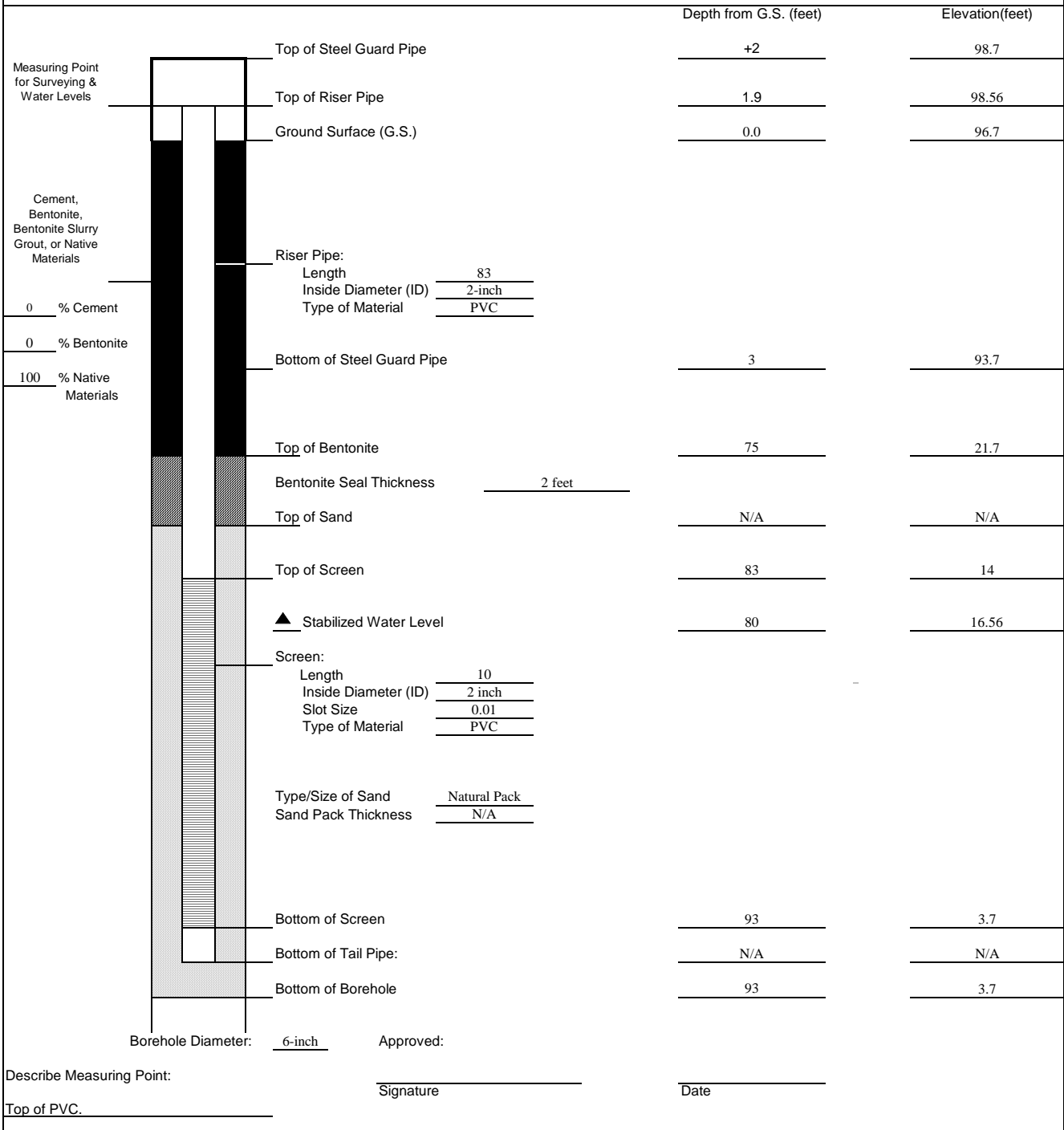


Describe Measuring Point: _____
 Top of PVC: _____

Approved: _____
 Signature _____ Date _____

AECOM	Client: <i>Town of Orleans</i>	WELL ID: CLS-5	
	Project Number: <i>60476644</i>		
	Site Location: <i>Orleans, MA</i>		Date Installed: <i>03/20/2018</i>
	Well Location: <i>Exit 12 Cloverlead</i> Coords:		Inspector: <i>Erika Amir-Lin</i>
	Method: <i>CME truck mounted hollow-stem auger</i>		Contractor: <i>Desmond Drilling</i>

MONITORING WELL CONSTRUCTION DETAIL





Client: Town of Orleans

Project Number: 60476644

Site Location: Orleans, MA

Well Location: 32 Lots Hollow Coords:

Method: CME truck mounted hollow-stem auger

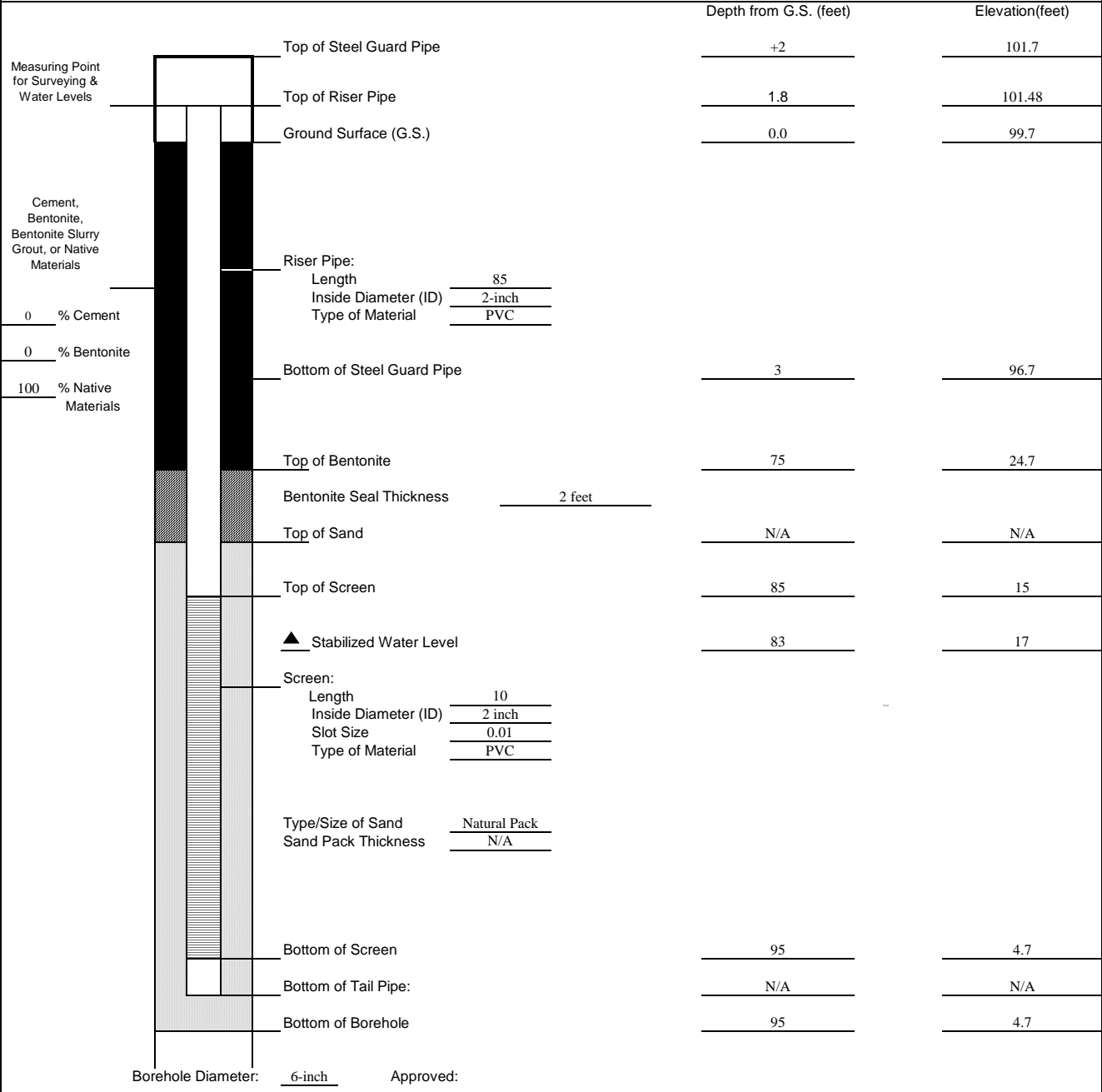
WELL ID: CLS-6

Date Installed: 03/22/2018

Inspector: Erika Amir-Lin

Contractor: Desmond Drilling

MONITORING WELL CONSTRUCTION DETAIL



Describe Measuring Point:

Top of PVC.

Approved:

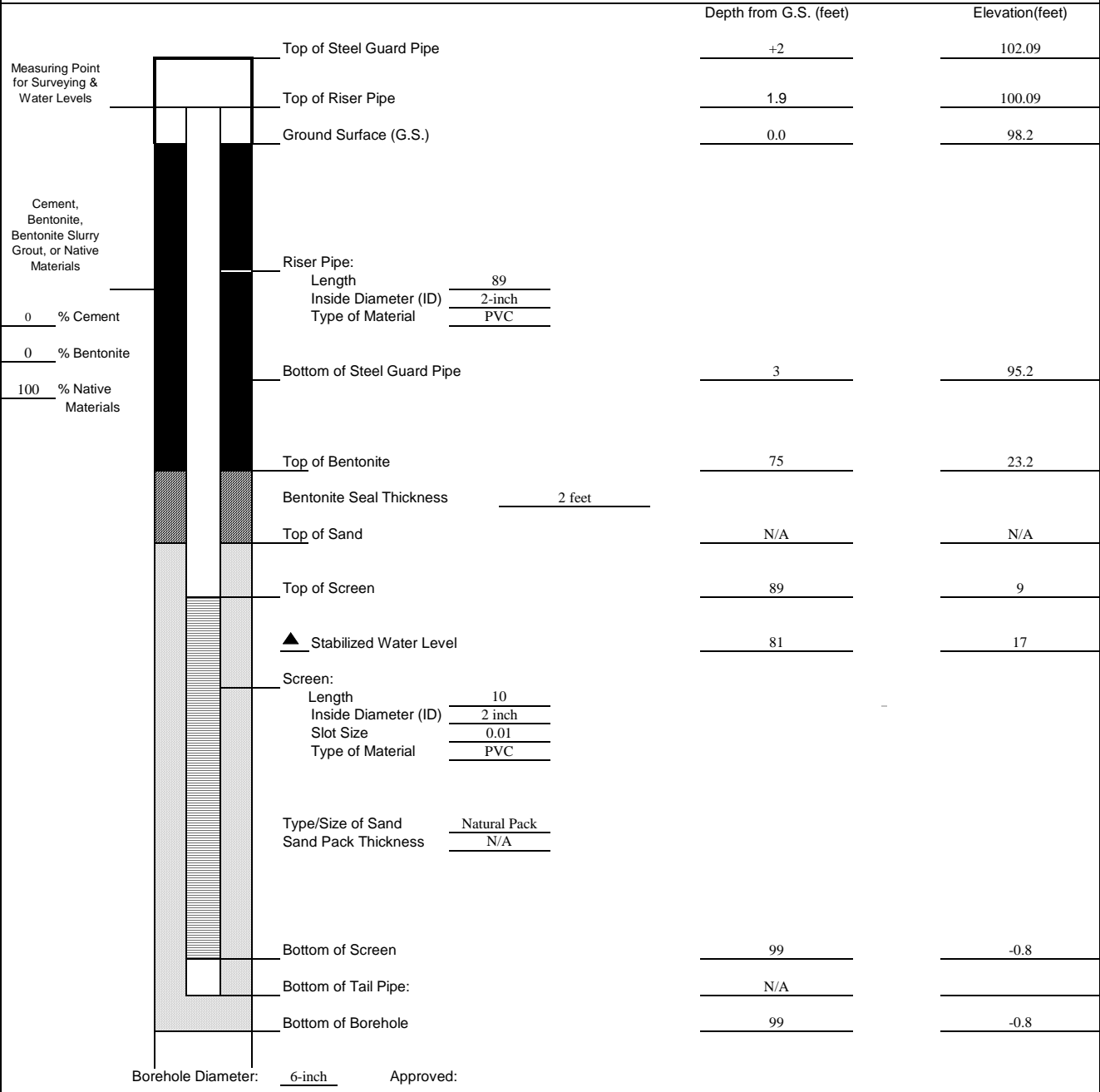
Signature

Date



<i>Client: Town of Orleans</i>	WELL ID: CLS-7
<i>Project Number: 60476644</i>	
<i>Site Location: Orleans, MA</i>	<i>Date Installed: 03/23/2018</i>
<i>Well Location: 32 Lots Hollow Coords:</i>	<i>Inspector: Erika Amir-Lin</i>
<i>Method: CME truck mounted hollow-stem auger</i>	<i>Contractor: Desmond Drilling</i>

MONITORING WELL CONSTRUCTION DETAIL





Describe Measuring Point: _____ Signature _____ Date _____

Top of PVC. _____

Project Number: 60476644 Client: Town of Orleans	 250 Apollo Drive (Chelsea, Massachusetts) (978) 905-2100	Boring: CLS-1	Well Data Boring Number: _____ Sheet: 1 of 4 Surface Elevation (ft-asl): _____ Equipment: Geoprobe 6620, CME Inside Diameter: 2"
Site Location: Clover Leaf site Orleans, MA	Project Manager: Mark Owen Field Tech: C. Hayden, E. Amir, B. Morris Started: 3/6/2017 Drill Contractor: NE Geotech Driller: Hayes, T. Desmond Date Completed: 4/11/2017		Boring Depth: 98 ft Screen Depth: 91.5-101.5 Screen length: 10ft

Depth	Sample Identification	Rec (ft)	Sorting	Moisture	PID (ppm)	Field Identification	Description	Fill Mat.	Tube	Fill Mat.	Depth
1	0 ft to 5 ft					Pre-Cleared to 5 ft					1
2											2
3											3
4											4
5											5
6	5 ft to 10 ft	2.5 ft		dry		5 to 7.5 ft: Brown-Tan fine sand					6
7											7
8											8
9											9
10											10
11	10 ft to 15 ft	1.5 ft		Dry		10 to 11.5 ft: Brown-Tan fine sand	SAND				11
12											12
13											13
14											14
15											15
16	15 ft to 20 ft	5 ft		dry		15 to 16.5 ft: Brown-Tan fine sand					16
17						16.5 to 20 ft: Tan fine sand, (Fe-stain @ 12.5-13)					17
18						18					
19						19					
20						20					
21	20 ft to 25 ft	4.25 ft		dry		20 to 24.25 ft: Tan fine sand,	SAND				21
22						22					
23						23					
24						24					
25						25					
26	25 ft to 30 ft	3 ft		dry		25 to 27 ft: Tan - Brown fine to medium sand (little coarse sand @26-26.5)					26
27						27 to 28 ft: Tan / Brown fine sand					27
28											28
29											29
30											30

Project Number 60476644 Client Town of Orleans		 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100				Boring: CLS-1		Well Data		
Site Location Clover Leaf site Orleans, MA						Boring Number Sheet 3 of 4		Surface Elevation (ft-asl)		
Project Manager Mark Owen		Field Tech C Hayden, E Amir, B Mc		Date Started: 3/6/2017		Equipment Geoprobe 6620 CME		Screen length 10ft		
Drill Contractor NE Geotech		Driller Hayes, T Desmon		Date Completed: 4/11/2017		Inside Diameter 2"				
Depth	Sample Identification	Rec (ft)	Soiling	Moisture	PH (ppm)	Field Identification		Description		
60 ft to 65 ft		2 ft		moist		60 to 62 ft: Tan fine sand dense grey silty fine sand - 60 3-60 6				
65 ft to 70 ft		2.3 ft		moist		65 to 68 ft: Tan fine sand				
70 ft to 75 ft		2.3 ft		moist		70 to 73 ft: Tan fine sand				
						End of Boring				
						Start of well install by Desmond Drilling, 2 ft split spoons				
70 ft to 72 ft		1.6 ft		dry		70 to 71.6 ft: Tan medium sand, clean		Blow count: 4, 7, 11, 15		
72 ft to 74 ft		1.75 ft		dry		72 to 73.7 ft: Tan fine sand, Fe-staining at 2", 3", 8", 16", trace grey silt 73.7 to 73.75 ft: Grey silt, Fe mottling		Blow count: 6, 11, 13, 15		
74 ft to 76 ft		1.7 ft		moist		74 to 74.75 ft: Light brown sand, fine silty sand, Fe- mottling 74.75 to 75.1 ft: Grey silt, stiff 75.1 to 75.6 ft: Tan sand, Fe-mottling, trace silt 75.6 to 75.7 ft: Grey silt, stiff		Blow count: 7, 14, 19, 19		
76 ft to 78 ft		1.6		moist		76 to 76.7 ft: Tan fine sand, clean 76.7 to 77.6 ft: Light brown fine sand, becoming silty fine sand at bottom		Blow count: 8, 12, 17, 23		
78 ft to 80 ft		1.8		moist		78 to 78.2 ft: Light brown fine sand, clean 78.2 to 78.7 ft: Brown grey mottled silt, stiff 78.7 to 79.3 ft: Brown clayey silt, very stiff, low plasticity 79.3 to 79.8 ft: Tan fine sand, clean		Blow count: 12, 13, 15, 21		
80 ft to 82 ft		1.7		moist		80 to 81.4 ft: Light brown sand with Fe-mottling, fine sand, trace silt 81.4 to 81.6 ft: Brown grey mottled silt, stiff 81.6 to 81.7 ft: Light brown medium sand, clean		Blow count: 7, 14, 10, 8		
82 ft to 84 ft		1.6 ft		moist		82 to 83 ft: Tan fine sand, clean 83 to 83.6 ft: Light brown, silty sand, Fe-staining mottling, stiff		Blow count: 5, 10, 13, 19		
84 ft to 86 ft		1.7 ft		wet		84 to 85.7 ft: Brown medium sand, little fine sand, trace silt		Blow count: 7, 11, 10, 11		
86 ft to 88 ft		1.3 ft		wet		86 to 87.3 ft: Brown fine sand, little medium sand, trace silt		Blow count: 5, 6, 10, 11		
88 ft to 90 ft		1.5 ft		wet		88 to 89 ft: Brown medium sand, some fine sand, trace silt 89 to 89.5 ft: Brown fine sand, trace silt		Blow count: 25		
90 ft to 92 ft		1.7 ft		wet		90 to 90.25 ft: Brown medium sand, some fine sand 90.25 to 90.3 ft: Brown/grey mottled clayey silt, stiff, low-med plastic 90.3 to 90.6 ft: Brown fine silty sand 90.6 to 91 ft: Brown fine sandy silt 91 to 91.7 ft: Brown fine sand, some med sand, trace silt		Blow count: 25		
92 ft to 94 ft		1.3 ft		wet		92 to 92.4 ft: Brown fine sand, trace silt 92.4 to 93.3 ft: Brown fine sand, little silt, stiff silt traces		Blow count: 50		
94 ft to 96 ft		2 ft		wet		94 to 95.5 ft: Brown fine sand 95.5 to 96 ft: silt sand layering, grey-brown mottling				
96 ft to 98 ft		2 ft				96 to 97 ft: fine tan sand, clean 97 to 98 ft: silt layers with some fine sand, grey-brown mottling, clayish				

Project Number: 60476644 Client: Town of Orleans			 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100			Boring: CLS-2							
Site Location: Overland Way, Tr-Town Orleans, MA						Boring Number: Sheet: 1 of 2 Surface Elevation (ft-asl) Equipment: Geoprobe 6620			Well Data				
Project Manager: Mark Owen			Field Tech: C. Hayden			Date Started: 3/8/2017			Boring Depth:				
Drill Contractor: NE Geotech			Driller: Hayes			Date Completed: 3/8/2017			Screen Depth:				
Project Manager: Mark Owen			Field Tech: C. Hayden			Date Started: 3/8/2017			Boring Depth:				
Drill Contractor: NE Geotech			Driller: Hayes			Date Completed: 3/8/2017			Screen Depth:				
Project Manager: Mark Owen			Field Tech: C. Hayden			Date Started: 3/8/2017			Boring Depth:				
Drill Contractor: NE Geotech			Driller: Hayes			Date Completed: 3/8/2017			Screen Depth:				
Depth	Sample Identification	Rec (ft)	Sorting	Moist	PID (ppm)	Field Identification			Description	Full Mat.	Tube	Full Mat.	Depth
1	0 ft to 5 ft	5 ft				Pre-Cleared to 5 ft							1
2													2
3													3
4													4
5													5
6	5 ft to 10 ft	4.4 ft		dry		5 - 7.5 ft: Brown / grey fine sand, little medium sand, trace coarse sands							6
7						7.5 to 8.5 ft: Grey fine sand, trace medium sand							7
8						8.5 to 9.4 ft: Red-brown fine sand							8
9													9
10													10
11	10 ft to 15 ft	4.5 ft		Dry		10 to 14.5 ft: Fine sand							11
12						- 10-11 : Red brown							12
13						-11-14.45: light brown							13
14						-tree root fibers throughout							14
15													15
16	15 ft to 20 ft	4.3 ft		dry		15 to 15.8 ft: Light brown fine sand							16
17						15.8 to 16.6 ft: Light brown fine sand, trace medium sand and gravel							17
18						16.6 to 19.3 ft : Light brown fine/medium sand, mottled from 18.4-19 and color transition to tan at 18.8							18
19													19
20													20
21	20 ft to 25 ft	4.3 ft		wet		20 to 20.6 ft: Tan fine sand							21
22						20.6 to 21 ft: Mottled black and brown - red/brown - red - orange silt							22
23						21 to 22.6 ft: Brown silt							23
24						22.6 to 24.3 ft: Brown silty clay with fine sand lenses at 23-23.5, slightly plastic							24
25													25
26	25 ft to 30 ft	3.1 ft		wet		25 to 27.3 ft: Brown clay, slightly plastic							26
27						27.3 to 27.6 ft: Tan fine sand							27
28						27.6 to 27.8 ft: Brown clay, plastic							28
29						27.8 to 28.1 ft: Brown/red silt with little clay varves							29
30													30

Project Number: 60476644 Client: Town of Orleans		AECOM				Boring: CLS-2						
Site Location: Overland Way, Tri-Town Orleans, MA		250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100				Boring Number: Sheet: 1 of 2 Surface Elevation (ft-asl): Equipment: Geoprobe 6620		Well Data				
Project Manager: Mark Owen		Field Tech: C Hayden		Date Started: 3/8/2017		Inside Diameter: 2"		Boring Depth: Screen Depth:				
Drill Contractor: NE Geotech		Driller: Hayes		Date Completed: 3/8/2017				Screen length:				
Depth	Sample Identification	Rec (ft)	Sorting	Moist	PID (ppm)	Field Identification		Description	Fill Mat	Tube	Fill Me	Depth
31	30 ft to 35 ft	3 ft		dry		30 to 33ft: Tan brown mottled fine sand						31
32												32
33												33
34												34
35												35
36	35 ft to 40 ft	2.9 ft		wet		35 to 37 ft: Tan red mottled fine sand 37 to 37.1 ft: clay varve 37.1 to 37.4 ft: Yellow-tan fine sand 37.4 to 37.9 ft: Brown-grey clay, plastic, red-org fine sand pocket at 37.8-37.9						36
37												37
38												38
39												39
40												40
41	40 ft to 45 ft	2.7 ft		wet		40 to 40.5 ft: Brown clay, plastic 40.5 to 41 ft: Iron mottled brown-greey silty clay, plastic 41 to 41.9 ft: Tan, fine sand 41.9 to 42.7 ft: FE-stained mottled brown grey silt clay						41
42												42
43												43
44												44
45												45
46	46											
47	47											
48	48											
49	49											
50	50											
51	51											
52	52											
53	53											
54	54											
55	55											
56	56											
57	57											
58	58											
59	59											
60	60											

Project Number: 60476644 Client: Town of Orleans		AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100				Boring: CLS-3					
Site Location: Overland Way, Tr-Town Orleans, MA						Boring Number: Sheet: 2 of 4 Surface Elevation (ft-asl) Equipment: Geoprobe 6620, CME		Well Data Boring Depth: 105ft Screen Depth: 76-86 ft Screen length: 10ft			
Project Manager: Mark Owen		Field Tech: C. Hayden			Date Started: 3/8/2017		Inside Diameter: 2"				
Drill Contractor: NE Geotech		Driller: Hayes, Desmond			Date Completed: 3/31/2017						
Depth	Sample Identification	Rec (ft)	Sorting	Moist	PID (ppm)	Field Identification		Description	Fill	ME	Depth
31	30 ft to 35 ft	5 ft		wet		30 to 33.2 ft: Tan fine/very fine sand, mottled -30.4 ft: silt varve -32.5 ft: clay varve bordered by iron staining					31
32											32
33											33
34											34
35											35
36	35 ft to 40 ft	3 ft		wet		35 to 38 ft: Tan fine/very fine sand, mottled					36
37											37
38											38
39											39
40											40
41	40 ft to 45 ft	3.7 ft		wet		40 to 43.7 ft: Tan, mottled fine/very fine sand					41
42											42
43											43
44											44
45											45
46	45 ft to 50 ft	3 ft		wet		45 to 48 ft: Tan, mottled fine/very fine sand					46
47											47
48											48
49											49
50											50
51	50 ft to 55 ft	2.6 ft		wet		50 to 52.6 ft: Tan, mottled fine/very fine sand, grey silt layer at 50.5 ft (dry)					51
52											52
53											53
54											54
55											55
56	55 ft to 60 ft	1.5 ft		wet		55 to 56 ft: Tan mottled fine sand 56 to 56.5 ft: Tan mottled fine sand, with brown clay pocket					56
57											57
58											58
59											59
60											60

Project Number: 60476644 Client: Town of Orleans			AECOM 250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100			Boring: CLS-3			Well Data								
Site Location: Clover Leaf site Orleans, MA						Boring Number: Sheet: 3 of 4 Surface Elevation (ft-asl): Equipment: Geoprobe 6620, CME						Boring Depth: 105ft Screen Depth: 76-86 ft					
Project Manager: Mark Owen			Field Tech: C Hayden			Date Started: 3/8/2017			Inside Diameter: 2"			Screen length: 10ft					
Drill Contractor: NE Geotech/Des			Driller: Hayes, Desmond			Date Completed: 3/31/2017											
Depth	Sample Identification	Rec (ft)	Sorting	Moist	PID (ppm)	Field Identification			Description			Fill	Max	Tube	Fill	ME	Depth
60	60 ft to 65 ft	2 ft		wet		60 to 62 ft: Tan mottled fine sand pronounced silt varves from 60-60.5 ft (grey) ----- End of Boring ----- ----- Start of well install by Desmond Drilling, 2ft split spoons -----											
66	65 ft to 67 ft	1.7 ft				65 to 66.3 ft: Fe mottled tan fine sand, clay varves at 66-66.2 66.3 to 66.5 ft: Grey, clay plastic 66.5 to 66.7 ft: Fe mottled tan fine sand			Blow count: 7, 10, 9, 9								
68	67 ft to 69 ft	1.7 ft				67 to 68.7 ft: Grey, clay plastic			Blow count: 6, 7, 9, 9								
69	69 ft to 71 ft	1.5 ft		moist wet		69 to 70 ft: Tan - grey fine sand, grey clay lens at 69.3 70 to 70.4 ft: Grey/Red-brown fine sand-silt - clay matrix 70.4 to 70.5 ft: Light brown, Fe-mottled fine sand			Blow count: 5, 8, 8, 10								
71	71 ft to 73 ft	1.6 ft		wet wet wet wet		71 to 71.2 ft: Light brown, Fe-mottled fine sand 71.2 to 71.6 ft: Grey/brown silt, trace fine sand 71.6 to 71.9 ft: Grey/brown silt, grey clay 71.9 to 72.1 ft: Grey clay, tan/brown fine sand 72.1 to 72.6 ft: Tan/brown fine sand			Blow count: 5, 6, 10, 11								
74	73 ft to 75 ft	2.0 ft		wet		73 to 75 ft: Brown fine sand, grey silt varve at 74.8			Blow count: 4, 5, 8, 12								
76	75 ft to 77 ft	1.4 ft				75 to 77 ft: Brown fine sand, grey silt varve at 75.7			Blow count: 13								
77	77 ft to 79 ft	1.7 ft				77 to 78.7 ft: Brown fine sand, grey clay varve at 78.1			Blow count: 25								
79	79 ft to 81 ft	1.8 ft				79 to 80.8 ft: Brown fine sand, interm clay pockets from 80-80.3			Blow count: 40								
81	81 ft to 83 ft	0.8 ft				81 to 81.8 ft: Tight brown fine sand, trace medium sand			Blow count: 35								
83	83 ft to 85 ft	1.6 ft				83 to 83.6 ft: Tight brown fine sand, trace medium sand 83.6 to 84.2 ft: Brown fine sand and silt 84.2 to 84.6 ft: Grey tan clayey silt, mottled by fine sand			Blow count: 35								
	85 ft to 87 ft	1.8 ft				85 to 85.4 ft: Brown fine sand little medium sand 85.4 to 86.5 ft: Heavily mottled sandy silt, multiple layers of clay and silt 86.5 to 86.8 ft: Grey silty sand			Blow count: 35								
	87 ft to 89 ft	1.9 ft				87 to 88 ft: Brown fine sand, little silt 88 to 88.9 ft: Brown fine sand, little medium sand			Blow count: 40								
	89 ft to 91 ft	1.2 ft				89 to 90.2 ft: Brown fine sand, little medium sand			Blow count: 45								
	91 ft to 93 ft	1.2 ft				91 to 92.2 ft: Brown fine sand, little medium sand			Blow count: 50								
	93 ft to 95 ft	1.7 ft				93 to 93.8 ft: Brown fine sand, some silt, little medium sand 93.8 to 94.7 ft: Mottled brown/grey fine sand and silt			Blow count: 50								

Project Number: 60476644 Client: Town of Orleans		AECOM				Boring: TTS-1								
Site Location: Overland Way, Tri-Town Orleans, MA		250 Apollo Drive Chelmsford, Massachusetts (978) 905-2100				Boring Number: Sheet: 1 of 3 Surface Elevation (ft-asl)			Well Data					
Project Manager: Mark Owen		Field Tech: C Hayden		Started: 3/13/2017		Equipment: Geoprobe 6620 p			Boring Depth: 45 ft					
Drill Contractor: NE Geotech		Driller: Hayes		Date Completed: 3/13/2017		Inside Diameter: 2"			Screen Depth: 35 - 45 ft					
Screen length: 10 ft														
Depth	Sample Identification	Rec (ft)	Soring	Moisture	PID (ppm)	Field Identification				Description	Fill Mat.	Tube	Fill Mat.	Depth
1	0 ft to 5 ft					Pre-Cleared to 5 ft on 03/07/2017 0-8" roots and organic material, 8-60" fine to medium sand with some gravel								1
2														2
3														3
4														4
5														5
6	5 ft to 10 ft	4.5 ft		dry		5 to 9.5 ft: Brown / light brown fine sand								6
7														7
8														8
9														9
10														10
11	10 ft to 15 ft	3.7 ft		Dry		10 to 13.7 ft: Brown to light brown fine sand (12.3-12.7 coarsens to mix with some medium sand)								11
12														12
13														13
14														14
15														15
16	15 ft to 20 ft	3.7 ft		dry		15 to 18.7 ft: Brown / light brown find sand molted throughout								16
17														17
18														18
19														19
20														20
21	20 ft to 25 ft	3.7 ft		dry		20 to 22 ft: Tan / light brown poorly sorted layers of fine sand, medium sand, fine-medium sand, silty sand, and silt 22ft: Rock fragment, Lg gravel								21
22														22
23						22.1 to 22.8 ft: light brown medium to coarse sand and gravel to fine sand and silt, clay at 22.8								23
24						22.8 to 23.7 ft: Tan fine to medium sand								24
25														25
26	25 ft to 30 ft	3.7		dry		25 to 26.1 ft: Tan / orange-tan fine to medium sand - fine sand I								26
27						26.1 to 27.6 ft: Brown, tight fine sand, some medium sand, silt "varves"								27
28						27.6 to 28.7 ft: Tan fine to medium sand, grey silt / clay varve at 28.2								28
29														29
30														30



Client: Town of Orleans

Project Number: 60476644

Site Location: Orleans, MA

Well Location: Exit 12 Cloverleaf Coords:

Method: CME truck mounted hollow-stem auger

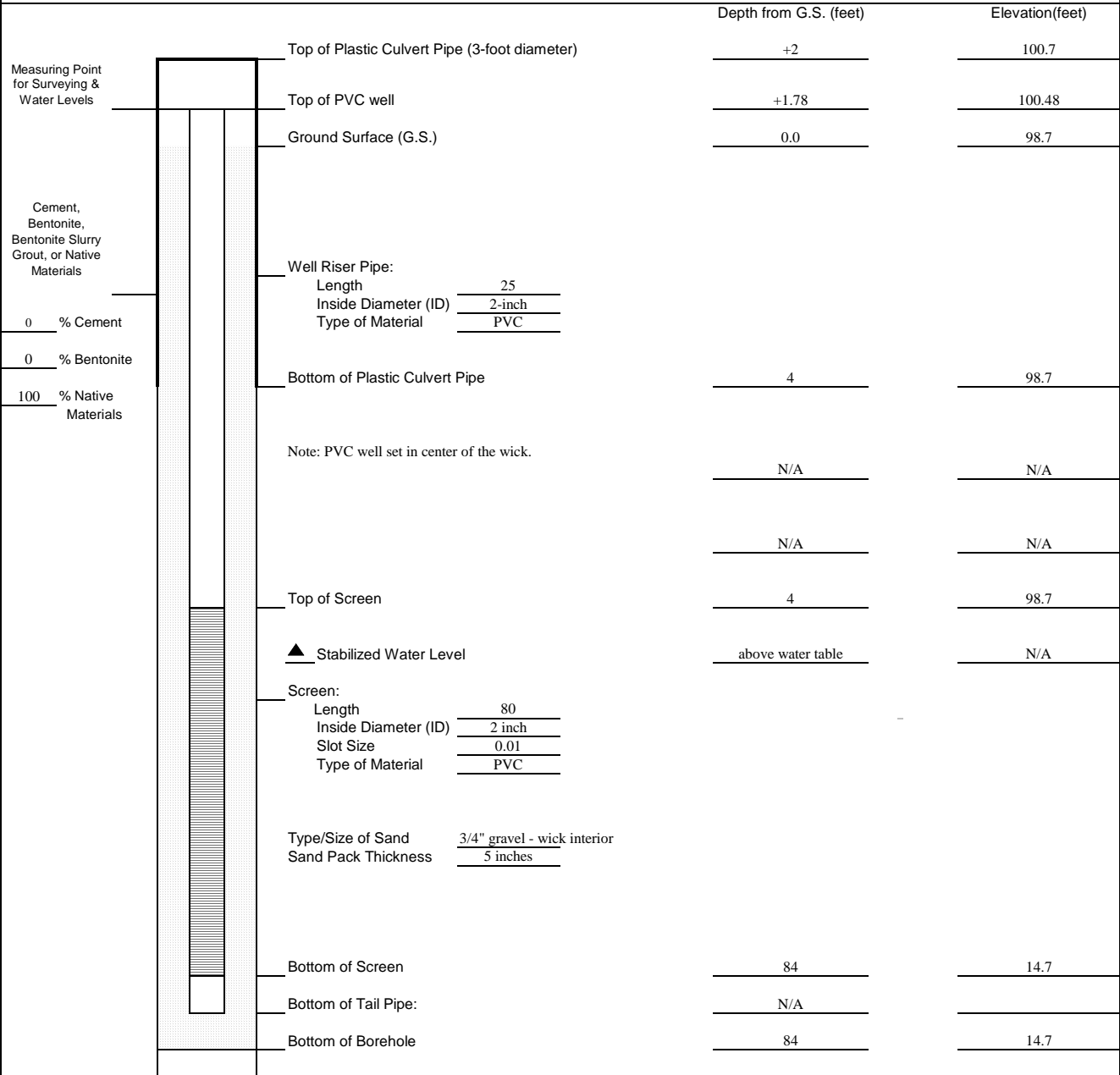
Test Wick - Cloverleaf Site

Date Installed: 03/20/2018 - 03/27/2018

Inspector: Mark Owen

Contractor: Desmond Drilling

WICK DISCHARGE CONSTRUCTION DETAIL



Measuring Point for Surveying & Water Levels

Cement, Bentonite, Bentonite Slurry Grout, or Native Materials
0 % Cement
0 % Bentonite
100 % Native Materials

Borehole Diameter: 12-inch

Approved:

Describe Measuring Point:

Signature

Date

Top of 2" PVC well inside wick well.

Appendix C
Loading Test Water Level Data

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Water Levels and Groundwater Mounding, April-May 2018
Cloverleaf Site
Exit 12, Orleans, MA

Well ID	Day	Distance from Wick (ft)	Static Water Level (ft. b.s)	Monday 4/22/2018 8:30		Tuesday 4/23/2018 8:00		Tuesday 4/23/2018 1:00		Wednesday 4/24/2018 7:30		Thursday 4/25/2018		Friday 4/26/2018 15:00		Saturday 4/27/2018		Mound Height	Water Level Increase	Mound Height	Water Level Increase
				Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height				
Day Meter Loading Rate Wick Well			Start Load Test	0	0	1	1	1	2	3	4	4	6	6	2,798,500	2,798,500	2,798,500				
CLS-1		0	84.09	84.09	84.20	84.10	84.09	84.09	84.09	84.05	83.93	83.93	83.99	83.99	83.93	83.93	83.99	0.22	0.23	0.14	0.14
CLS-2		6	84.22	84.22	84.20	84.10	84.20	84.20	84.20	84.20	84.20	84.20	84.20	84.20	84.20	84.20	84.20	0.22	0.23	0.14	0.14
CLS-3		1	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	84.18	0.22	0.23	0.14	0.14
CLS-4		29	81.88	81.88	81.82	81.77	81.77	81.70	81.70	81.68	81.56	81.56	81.56	81.56	81.56	81.56	81.56	0.37	0.32	0.23	0.23
CLS-5		69	84.82	84.82	84.81	84.77	84.77	84.75	84.75	84.68	84.56	84.56	84.56	84.56	84.56	84.56	84.56	0.26	0.19	0.10	0.10
CLS-6		133	83.34	83.34	83.33	83.33	83.33	83.22	83.22	83.15	83.02	83.02	83.02	83.02	83.02	83.02	83.02	0.26	0.24	0.15	0.15
CLS-7		202	70.88	70.88	70.87	70.87	70.87	70.87	70.87	70.87	70.87	70.87	70.87	70.87	70.87	70.87	70.87	0.24	0.24	0.15	0.15
CLS-8		221	71.35	71.35	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	0.24	0.24	0.15	0.15
CLS-9		221	71.35	71.35	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	71.32	0.24	0.24	0.15	0.15
LH-1		646	107.12	107.12	107.11	107.11	107.11	107.11	107.11	107.11	107.11	107.11	107.11	107.11	107.11	107.11	107.11	0.17	0.17	0.10	0.10
LH-2		783	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	102.76	0.17	0.17	0.10	0.10
LH-5		862	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	0.13	0.13	0.06	0.06
MW-14		1,052	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	0.13	0.13	0.06	0.06
MW-9		1,052	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	89.99	0.13	0.13	0.06	0.06
MW-16S		1,052	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	86.26	0.10	0.10	0.03	0.03
MW-15S		1,360	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	92.12	0.16	0.16	0.09	0.09
MW-5D		1,460	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	86.39	0.13	0.13	0.06	0.06
(Local Ave*)																					
Rainfall (in)																					
Rainfall (cum.)																					
BHW 22 (Ambient)		7,825	28.00	28.00	28.00	27.98	27.98	27.98	27.94	27.95	27.93	27.95	27.93	27.93	27.93	27.93	27.91	0.07	0.09	0.01	0.01
Notes:				Notes: Start Loading Test																	
* MSL = Mean Sea Level																					
** Average of closest, most distant wells. Likely outside of influence of loading.																					
*** http://forecast.weather.gov/MapClick.php?lat=41.7821&lon=-83.9776&WolKutTKY1																					

http://waterdata.usgs.gov/nwis/dv/?_lang=en&_format=module&site_no=4146310000014601
<http://forecast.weather.gov/MapClick.php?lat=41.7821&lon=-83.9776&WolKutTKY1>

Water Levels and Groundwater Mounding, April-May 2018
Cloverleaf Site
Exit 12, Orleans, MA

30-Day Loading Test

Monday 4/9/2018 10:00		Tuesday 4/10/2018 16:00		Wednesday 4/11/2018 8:30		Thursday 4/12/2018 0:00		Friday 4/13/2018 12:15		Monday 4/16/2018 12:00		Tuesday 4/17/2018 9:15		Wednesday 4/18/2018 10:00		Thursday 4/19/2018 9:00	
Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height	Water Level Increase	Mound Height
7 2,841,100 7:10		8 83.82 81.46 81.46		9 2,914,500 7:54		10 2,956,000 7:50		11 6.95		14 3,118,700 6:54		15 6.95		18 3,296,700 3:36		18 3,296,700 3:36	
0.24	0.17	0.40	0.33	0.29	0.21	0.32	0.28	0.37	0.28	0.49	0.41	0.46	0.38	0.52	0.44	0.58	0.51
0.28	0.21	0.42	0.35	0.35	0.27	0.42	0.38	0.45	0.38	0.51	0.53	0.61	0.51	0.65	0.57	0.72	0.65
0.23	0.16	0.28	0.21	0.21	0.13	0.28	0.21	0.30	0.21	0.40	0.32	0.39	0.29	0.42	0.34	0.47	0.40
0.25	0.18	0.34	0.23	0.33	0.25	0.34	0.24	0.43	0.34	0.61	0.53	0.62	0.52	0.65	0.57	0.72	0.65
0.25	0.18	0.34	0.23	0.33	0.25	0.34	0.24	0.43	0.34	0.48	0.40	0.44	0.34	0.48	0.40	0.54	0.47
0.26	0.19	0.38	0.21	0.24	0.16	0.38	0.29	0.31	0.22	0.48	0.40	0.44	0.34	0.48	0.40	0.54	0.47
0.26	0.19	0.38	0.21	0.24	0.16	0.38	0.29	0.31	0.22	0.48	0.40	0.44	0.34	0.48	0.40	0.54	0.47
0.11	0.04	0.38	0.31	0.31	0.23	0.38	0.29	0.41	0.32	0.56	0.48	0.56	0.46	0.59	0.51	0.64	0.57
0.14	0.07	0.38	0.31	0.31	0.23	0.38	0.29	0.41	0.32	0.56	0.48	0.56	0.46	0.59	0.51	0.64	0.57
0.09	0.06	0.18	0.14	0.15	0.06	0.18	0.09	0.11	0.06	0.09	0.09	0.24	0.14	0.14	0.14	0.14	0.14
0.08	0.01	0.15	0.11	0.15	0.06	0.18	0.09	0.11	0.06	0.09	0.09	0.24	0.14	0.14	0.14	0.14	0.14
0.11	0.04	0.17	0.08	0.22	0.17	0.08	0.08	0.08	0.08	0.08	0.08	0.26	0.26	0.08	0.08	0.07	0.07
0.14	0.04	0.20	0.00	0.08	0.00	0.20	0.00	0.09	0.09	0.08	0.08	0.09	0.10	0.08	0.08	0.07	0.07
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.09	0.08	0.08	0.09	0.10	0.08	0.08	0.07	0.07
3.67	3.67	3.67	3.67	3.67	3.67	3.67	3.67	4.43	4.43	5.05	5.05	5.05	5.05	5.05	5.05	5.05	5.05
27.93	27.93	27.91	27.91	27.91	27.91	27.91	27.91	27.91	27.91	27.92	27.92	27.90	27.90	27.92	27.92	27.93	27.93
Notes: Download Loggers Remove sand from wick rehab well		Notes:		Notes:		Notes:		Notes:		Notes:		Notes:		Notes:		Notes:	

Water Levels and Groundwater Mounding, April-May 2018
 Cloverleaf Site
 Exit 12, Orleans, MA

Friday		Saturday		Sunday		Monday		Tuesday		Wednesday		Thursday	
5/4/2018	Water Level Increase	5/5/2018	Water Level Increase	5/6/2018	Water Level Increase	5/7/2018	Water Level Increase	5/8/2018	Water Level Increase	5/9/2018	Water Level Increase	5/10/2018	Water Level Increase
9:00		15:00		15:00		9:00		9:30		15:00		15:00	
Mound Height		Mound Height		Mound Height		Mound Height		Mound Height		Mound Height		Mound Height	
1		3		3		4		5		7		7	
3,996.300		0		0		0		0		0		0	
Dry						Dry		Dry					
83.08	1.14	83.12	1.10	83.09	1.13	83.09	1.13	83.10	1.12	83.13	1.09	83.13	1.09
81.78	1.40	81.78	1.44	81.78	1.44	81.78	1.40	81.78	1.38	81.78	1.43	81.78	1.43
80.48	1.40	80.44	1.44	80.48	1.56	80.48	1.40	80.49	1.38	80.45	1.43	80.45	1.43
83.82	1.00	83.81	1.01	83.80	1.02	83.80	1.02	83.80	1.02	83.83	0.99	83.83	0.99
81.59	1.75	81.43	1.91	81.43	1.91	81.43	1.91	81.43	1.91	81.36	1.98	81.36	1.98
68.85	1.03	68.75	1.13	68.75	1.13	68.75	1.09	68.78	1.10	68.70	1.18	68.70	1.18
70.14	1.21	70.05	1.30	70.05	1.30	70.05	1.30	70.04	1.31	69.96	1.39	69.96	1.39
106.77	0.35	NM		106.75	0.37	106.75	0.37	106.74	0.38	106.66	0.46	106.66	0.46
107.51	0.31	NM		107.53	0.37	107.53	0.37	107.53	0.37	107.53	0.46	107.53	0.46
87.68	0.31	NM		87.71	0.28	87.71	0.28	87.72	0.27	87.68	0.31	87.68	0.31
89.65	0.34	NM		89.67	0.32	89.67	0.32	89.69	0.30	89.65	0.34	89.65	0.34
85.95	0.31	NM		86.00	0.26	86.00	0.26	86.01	0.25	85.95	0.31	85.95	0.31
91.73	0.39	NM		91.76	0.36	91.76	0.36	91.76	0.36	91.72	0.40	91.72	0.40
86.07	0.32	NM		86.12	0.27	86.12	0.27	86.13	0.26	86.09	0.30	86.09	0.30
88.90	0.36			88.94	0.31	88.94	0.31	88.95	0.31	88.91	0.35	88.91	0.35
0.08		0.20		0.20		0.04		0.00		0.05		0.05	
6.53		6.73		6.73		6.77		6.77		6.82		6.82	
28.09	-0.09	28.12	-0.12	28.14	-0.14	28.14	-0.14	28.16	-0.16	28.15	-0.15	28.15	-0.15
Notes:		Notes:		Notes:		Notes:		Notes:		Notes:		Notes:	

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# ----- WARNING -----
# Some of the data that you have obtained from this U.S. Geological Survey database
# may not have received Director's approval. Any such data values are qualified
# as provisional and are subject to revision. Provisional data are released on the
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# for any damages resulting from its use.
#
# Additional info: https://help.waterdata.usgs.gov/policies/provisional-data-statement
#
# File-format description: https://help.waterdata.usgs.gov/faq/about-tab-delimited-output
# Automated-retrieval info: https://help.waterdata.usgs.gov/faq/automated-retrievals
#
# Contact: gs-w_support_nwisweb@usgs.gov
# retrieved: 2018-06-06 06:22:08 EDT (caww01)
#
# Data for the following 1 site(s) are contained in this file
# USGS 414630070014901 MA-BMW 22 BREWSTER, MA
# -----
#
# Data provided for site 414630070014901
# TS parameter statistic Description
# 65166 72019 00003 Depth to water level, feet below land surface (Mean)
# 00 72019 00011 Depth to water level, feet below land surface (Instantaneous)
#
# Data-value qualification codes included in this output:
#
# A Approved for publication -- Processing and review completed.
# P Provisional data subject to revision.
#
# Discrete groundwater status codes included in this output:
# '00_72019_00011_cd'
#
# "" The reported water-level measurement represents a static level
#
# A Approved for publication -- Processing and review completed.
# P Provisional data subject to revision.
#
agency_cd site_no datetime tz_cd 65166_72019_00003 65166_72019_00003_cd 00_72019_00011 00_72019_00011_cd
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Appendix D
Precipitation Data

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DAY	WEATHER	TEMP. F	WIND		BAROMETER inches	RAINFALL inches	SNOW inches	RELATIVE HUMIDITY	REMARKS
			speed	direction					
1	PC	45	4	15 NW	29.97	0.01	87	MAY 2018 H-57	
2	Clear	64	<1	SW	29.97		51	H-80	
3	PC	63	<1	SW	29.91	.01	52	H-74	
4	PC	61	<1	SSW	29.89	.01	89	H-73	
5	Clody	59	<1	W	29.87		58	H-71	
6	Clody	52	<1	SW	30.06	.44	72	H-61	
7	MC	51	<1	NW	29.97		97	H-63	
8	Fog	44	<1	N	30.25	.01	98	H-66	
9	Fog	51	<1	ESE	30.18		98	H-24	
10	Clody	51	<1	NE	29.95	.03	92	H-62	
11	Clear	65	2	W	29.86		65	H-61	
12	Clody	49	<1	SE	30.18	.23	95	H-56	
13	Clody	49	<1	NE	30.16		98	H-57	
14	Clody	49	<1	SE	30.00		97	H-61	
15	Clody	54	<1	SSW	29.86	.06	97	H-62	
16	Clody	54	2	N	30.14		79	H-61	
17	LT Rain	53	<1	ESE	29.97	.25	98	H-62	
18	Clody	52	2	NNE	30.25		83	H-59	
19	Clody	50	<1	E	30.38	.11	86	H-56	
20	Clody	61.3	4	SW	29.94	.16	98	H-65	
21	Clear	62.3	<1	NNE	30.10		70	H-71	
22	PC	60.2	<1	SW	30.13	.12	83	H-70	
23	Clody	57.0	<1	W	29.83	.06	97	H-70	
24	Clear	53.6	<1	SE	30.06		87	H-61	
25	Clear	59.9	<1	SW	29.94		84	H-76	
26	Clear	66.6	<1	SSW	29.73		84	H-79	
27	Clody	53.3	6	ESE	30.09	.16	89	H-64	
28	Clody	52.3	<1	NW	30.03	.02	98	H-56	
29	Clear	56.9	<1	SW	29.92		77	H-81	
30	Clear	58.4	<1	WNW	30.23		91	H-73	
31	Fog	55.9	<1	SSE	30.10		98	H-67	

Σ = 1.6811 Σ = 52

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