Date: October 17, 2017

To: Operating Record

From: Harold D. Register, Jr., P.E.

RE: Groundwater Monitoring System Certification, §257.91(f)
   JR Whiting Power Plant, Ponds 1&2

**Introduction**

According to Title 40 Code of Federal Regulations (40 CFR) Part 257, Subpart D, §257.91(f), the owner or operator of a Coal Combustion Residual (CCR) management unit must obtain a certification from a qualified professional engineer stating that the groundwater monitoring system at the CCR management unit has been designed and constructed to meet the requirements of §257.91. Additionally, §257.91(a) details a performance standard requiring the system monitor the uppermost aquifer and include a minimum of at least one upgradient and three downgradient monitoring wells, and that if the uppermost aquifer monitoring system includes the minimum number of wells, the basis supporting use of only the minimum.

**Groundwater Monitoring System**

A groundwater monitoring system has been established for the JR Whiting Pond 1&2, which established the following locations for determining background groundwater quality and detection monitoring. In the case of JR Whiting Ponds 1&2, an intrawell statistical procedure has been selected; therefore, the groundwater monitoring system consists of only the downgradient monitoring wells. The background monitoring wells used to establish background groundwater quality will be maintained and reused to reestablish background conditions as necessary.

**Downgradient:**

- JRW MW-15001
- JRW MW-15002
- JRW MW-15003
- JRW MW-15004
- JRW MW-15005
- JRW MW-15006
Provided herein, as required by §257.91(f), is certification from a qualified professional engineer that the groundwater monitoring system at Consumers Energy JR Whiting Pond 1&2 meets the requirements of §257.91.

CERTIFICATION

Professional Engineer Certification Statement [40 CFR 257.91]

I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations §257.91 (40 CFR Part 257.91), I attest that this Groundwater Monitoring System has been designed and constructed to meet the requirements of 40 CFR 257.91. The report is accurate and has been prepared in accordance with good engineering practices, including the consideration of applicable industry standards, and with the requirements of 40 CFR Part 257.91.

Signature

October 17, 2017
Date of Certification

Harold D. Register, Jr., P.E.
Name

6201056266
Professional Engineer Certification Number

ENCLOSURES


Consumers Energy Company

SUMMARY OF MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT

J.R. Whiting Electric Generation Facility – Erie, Michigan

May 13, 2016
Summary of Monitoring Well Design, Installation, and Development

J.R. Whiting Electric Generation Facility – Erie, MI

Prepared for:
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Jackson, Michigan

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Our Ref.:
DE000722.0005.00006

Date:
May 13, 2016

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Table 3 – Estimated Hydraulic Conductivity (K) Values

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Drawing SG-22374 Whiting Plant Monitoring Wells, CCR Monitoring

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Appendix A – Soil Boring and Monitoring Well Construction Logs
Appendix B – Photographic Log
Appendix C – Hydraulic Test Results
1 INTRODUCTION

ARCADIS has prepared this Summary of Monitoring Well Design, Installation, and Development (Report) to summarize monitoring well installation activities for the J.R. Whiting electric generation facility (JRW), located in Erie, Michigan (Site). Monitoring wells were installed to achieve compliance under the recently published 40 CFR Part 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities (specifically Section 257.91(e)(1)). This Report summarizes the groundwater monitoring well installation activities, including drilling procedures, well locations, well construction details, development activities, and hydraulic testing results. The methodology used in the field activities conforms to federal and state guidance and industry standards.

2 OBJECTIVES

The objectives of this report are to document the work completed at the Site, including:

- Advancement of soil borings
- Monitoring well installation
- Monitoring well development
- Hydraulic testing

The following section describes each of these elements in more detail.

3 FIELD ACTIVITIES

3.1 Soil Borings

Six (6) soil borings were completed into bedrock using rotosonic-drilling methods operated by Stock Drilling, Inc. of Ida, Michigan with oversight provided by an ARCADIS geologist. Rotosonic drilling uses powered equipment to collect subsurface-soil samples. The rotosonic drill rig advances a length of pipe into the ground through a combination of hydraulic force and high-frequency vibration. The high-frequency vibrations allow the pipe to advance through various types of soil and bedrock producing a high-quality, continuous soil core within the pipe. Each length of pipe was extracted from the ground and emptied into a clear plastic liner for logging. This process was repeated until the total depth of the boring was reached.

Continuous soil cores were collected during drilling to provide detailed lithological and stratigraphic data. An on-site geologist inspected each core, classified the contents, and recorded the observations on an ARCADIS boring log field sheet (Appendix A). A photographic log showing the general soil types observed at the Site is included as Appendix B. All soil borings were completed as monitoring wells, and details of monitoring well installation are provided in the following section.

3.2 Monitoring Well Installation

Once the total depth of the soil boring was reached, a permanent monitoring well was installed in the uppermost usable aquifer unit for completion of monitoring wells. Monitoring wells were installed through the
rotosonic drill rig piping allowing the driller to construct the monitoring well, while simultaneously removing the drill piping. Monitoring wells were constructed with 2-inch inside diameter Schedule 40, polyvinyl chloride (PVC) screens and PVC risers. The well screens have a slot size of 0.010 inch and are 10 feet in length. A medium-grained sand pack was placed around each well screen to a height 2 to 3 feet above the top of the well screen. A 3 to 4-foot thick bentonite grout seal was placed on top of the sand pack. The remainder of the annular space was sealed with a cement-bentonite grout.

The wells were finished at the surface using a 3-foot long, locking, stickup well cover set in a 24 inch by 24 inch concrete pad. Well construction logs are included in Appendix A; well construction is summarized in Table 1; well locations are shown on Drawing SG-22374. Wells were labeled according to Consumers Energy’s site-specific nomenclature provided to ARCADIS. The CE construction manager supplied keyed-alike locks for each well that match the existing well keys.

3.3 Monitoring Well Development

Newly installed monitoring wells were allowed to set for a minimum of 48 hours, after which the wells were developed. Well development was conducted by air lifting techniques using a tremie pipe to surge and evacuate. Following development with the air lifting technique, a “flow-thru cell” and a turbidity meter were utilized to monitor indicator parameters (turbidity, pH, temperature, oxidation-reduction potential (ORP), and conductivity) to determine if groundwater parameters had appropriately stabilized during the development activities at each monitoring well. The stabilization parameters are provided below in Table 2. Indicator parameters were recorded in field notes and the development process continued until development water was free of visible sediment, stabilization of the field parameters, and below 10 Nephelometric Turbidity Units (NTUs). The volume of groundwater removed during development and its appearance was recorded in the field logbook. If drilling fluids were utilized during well installation, the volume of fluids used was recorded in the field logbook. This volume was removed in addition to the volume required for standard development. Monitoring well development details are included in Table 1.

Table 2. Groundwater Parameter Stabilization Criteria

<table>
<thead>
<tr>
<th>Groundwater Parameter</th>
<th>Stabilization Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>3 readings within +/- 0.1 Standard Units</td>
</tr>
<tr>
<td>Specific Conductance (SpC)</td>
<td>3 readings within +/- 3% mS/cms</td>
</tr>
<tr>
<td>Temperature</td>
<td>3 readings within +/- 3%</td>
</tr>
<tr>
<td>Oxidation-Reduction Potential (ORP)</td>
<td>3 readings within +/- 10 mV</td>
</tr>
<tr>
<td>Turbidity</td>
<td>3 readings within +/- 10% or &lt;1 when &lt; 10 NTU</td>
</tr>
<tr>
<td>Dissolved Oxygen (DO)</td>
<td>3 readings within +/- 0.3 mg/L</td>
</tr>
</tbody>
</table>
3.4 Hydraulic Testing

On November 23 and November 24, 2015, Arcadis conducted hydraulic tests (slug tests) at six (6) monitoring wells (JRW MW-15001, JRW MW-15003, JRW MW-15005, JRW MW-15010, JRW MW-15011 and JRW MW-15012) at the Site. Well construction logs are included in Appendix A; well construction details are summarized in Table 1.

During the slug testing activities, two to three slug tests were completed at each of the monitoring wells. The slug tests were completed to estimate hydraulic conductivity (K) by introducing a water table displacement by removing a known volume of water or depressing the water level by compressed air and measuring the rate of recovery. The tests at JRW MW-15001, JRW MW-15003, and JRW MW-15005 were completed using the pneumatic slug test method where a manifold and pump was used to depress the water level. The tests at JRW MW-15010, JRW MW-15011 and JRW MW-15012 were completed using a disposable bailer to remove a known volume of water. The bailer used was 1.5-inches in diameter and 36-inches long. All wells have casing and screen diameters of 2-inches and filter pack diameter of 6-inches and are screened in the confined weathered portion of the limestone bedrock aquifer that is found 55 to 80.5 feet below ground surface (bgs). At all the monitoring wells, a pressure transducer was set to record at 0.5 second intervals to measure static head, displacement and recovery data.

Recovery data collected were analyzed using the applicable analytical solution with AQTESOLV® for Windows®. Based on diagnostic analyses, the solution utilized at three of the six wells (JR-MW-15001, JR-MW-15003 and JR-MW-15005) was the confined Hyder et al. KGS model (1994) solution that accounts for partial penetration effects. The confined Hvorslev (1951) and the confined Cooper et al. (1967) solutions were utilized for recovery data at the remaining of the wells (JRW MW-15010, JRW MW-15011 and JRW MW-15012). The results indicated an estimated hydraulic conductivity range from 1.5 to 20 feet per day (ft/d) with an average of 14 ft/d and a geometric mean of 11 ft/d. The results of this test seem to be a reasonable fit for the confined weathered limestone groundwater zone. The monitoring well locations where slug tests were conducted are shown on Drawing SG-22374 and the results of the hydraulic conductivity tests are presented in Table 3 and Appendix C.
TABLES
<table>
<thead>
<tr>
<th>MW ID</th>
<th>Former MW ID</th>
<th>Site Coordinates</th>
<th>Date Installed</th>
<th>Development Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Northing</td>
<td>Easting</td>
<td>Ground Surface Elevation (ft above msl)</td>
</tr>
<tr>
<td><strong>Downgradient MW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JRW MW-15001</td>
<td>---</td>
<td>108330.83</td>
<td>13374236.18</td>
<td>589.60</td>
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<tr>
<td>JRW MW-15002</td>
<td>---</td>
<td>108651.05</td>
<td>13374586.78</td>
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<tr>
<td>JRW MW-15003</td>
<td>---</td>
<td>108321.98</td>
<td>13374898.23</td>
<td>589.60</td>
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<tr>
<td>JRW MW-15004</td>
<td>---</td>
<td>107861.56</td>
<td>13375045.59</td>
<td>589.80</td>
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<tr>
<td>JRW MW-15005</td>
<td>---</td>
<td>107545.15</td>
<td>13374686.90</td>
<td>592.70</td>
</tr>
<tr>
<td>JRW MW-15006</td>
<td>---</td>
<td>107843.22</td>
<td>13374281.80</td>
<td>590.30</td>
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<tr>
<td><strong>Background MW</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>JRW MW-15007</td>
<td>82-MW-1</td>
<td>109293.21</td>
<td>13373656.23</td>
<td>587.10</td>
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<tr>
<td>JRW MW-15008</td>
<td>82-MW-2</td>
<td>110906.21</td>
<td>13373613.03</td>
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<td>JRW MW-15009</td>
<td>79-MW-3</td>
<td>109884.39</td>
<td>13374455.32</td>
<td>585.30</td>
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<td>JRW MW-15010</td>
<td>93-MW-4</td>
<td>110458.57</td>
<td>13373631.59</td>
<td>587.10</td>
</tr>
<tr>
<td>JRW MW-15011</td>
<td>93-MW-5</td>
<td>109790.80</td>
<td>13373648.04</td>
<td>587.50</td>
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<td>JRW MW-15012</td>
<td>93-MW-6</td>
<td>110169.45</td>
<td>13374463.62</td>
<td>585.80</td>
</tr>
</tbody>
</table>

Notes:
- ft = feet
- bgs = below ground surface
- TOC = top of casing
- NR = Not recorded
- NA = Not applicable
- msl = mean sea level
Table 3
Estimated Hydraulic Conductivity (K) Values
Consumers Energy Co.
J.R. Whiting Generating Facility
Erie, Michigan

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Test</th>
<th>H (ft)</th>
<th>H* (ft)</th>
<th>K (ft/d)</th>
<th>K (cm/sec)</th>
<th>Slug Test Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>JRW MW-15001</td>
<td>1</td>
<td>1.27</td>
<td>1.114</td>
<td>18</td>
<td>6.2E-03</td>
<td>Cooper et al. (1967)</td>
</tr>
<tr>
<td>JRW MW-15001</td>
<td>2</td>
<td>1.18</td>
<td>0.981</td>
<td>15</td>
<td>5.3E-03</td>
<td>Hvorslev (1951)</td>
</tr>
<tr>
<td>JRW MW-15003</td>
<td>1</td>
<td>1.27</td>
<td>1.114</td>
<td>20</td>
<td>7.1E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>JRW MW-15003</td>
<td>2</td>
<td>2.28</td>
<td>2.138</td>
<td>20</td>
<td>7.1E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>JRW MW-15005</td>
<td>1</td>
<td>1.18</td>
<td>0.981</td>
<td>18</td>
<td>6.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>JRW MW-15005</td>
<td>2</td>
<td>2.28</td>
<td>2.138</td>
<td>20</td>
<td>7.1E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>JRW MW-15010</td>
<td>2</td>
<td>1.69</td>
<td>1.69</td>
<td>15</td>
<td>5.3E-03</td>
<td>Hvorslev (1951)</td>
</tr>
<tr>
<td>JRW MW-15010</td>
<td>3</td>
<td>1.05</td>
<td>1.05</td>
<td>15</td>
<td>5.3E-03</td>
<td>Hvorslev (1951)</td>
</tr>
<tr>
<td>JRW MW-15012</td>
<td>1</td>
<td>0.844</td>
<td>0.831</td>
<td>16</td>
<td>5.5E-03</td>
<td>Cooper et al. (1967)</td>
</tr>
<tr>
<td>JRW MW-15012</td>
<td>3</td>
<td>1.69</td>
<td>1.625</td>
<td>16</td>
<td>5.5E-03</td>
<td>Cooper et al. (1967)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>1.25</td>
<td>1.177</td>
<td>7.7</td>
<td>2.7E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<td>Average</td>
<td>3</td>
<td>2.31</td>
<td>2.02</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<td>Average</td>
<td>3</td>
<td>2.31</td>
<td>2.138</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>1.20</td>
<td>1.311</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>2.31</td>
<td>2.138</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>1.20</td>
<td>1.311</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>1.20</td>
<td>1.311</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>1.20</td>
<td>1.311</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
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<td>Average</td>
<td>3</td>
<td>1.20</td>
<td>1.311</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
<tr>
<td>Average</td>
<td>3</td>
<td>1.20</td>
<td>1.311</td>
<td>12</td>
<td>4.2E-03</td>
<td>KGS Model (Hyder et. al, 1994)</td>
</tr>
</tbody>
</table>

Note:
K = Conductivity
H0 = initial displacement
H* = expected (calculated) displacement
cm/sec = centimeters per second
ft = feet
ft/d = feet per day

References
Elevations were verified from benchmarks CP #3081 and CP #7 (not shown). Approximately 1/2 mile east of Northeast Corner, Section 15. On 11-19-2015, a level loop was performed between BM and Control Point (CP) #3081. A second loop was done from CP to Traverse Point (TP) #1918 and to TP #2168. On 11-20-15, a loop was performed utilizing TP #3081 to determine elevations on Monitoring Wells at Top of Pipe on Pond 1 & 2 and TP #1 (not shown). Another loop was performed from TP #3081, determining elevations for TP #1918 & TP #2168. Ground elevations at base of MW pipe were obtained on 11-10-15 by GPS observation.
APPENDIX A

Soil Boring and Monitoring Well Construction Logs
<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 6.0'</td>
<td>0.0</td>
<td>0.0</td>
<td>NA</td>
<td>0.0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>(0.0 - 6.0') Hydrovac; no lithology recorded.</td>
</tr>
<tr>
<td>6.0 - 9.0'</td>
<td>3.1</td>
<td>NA</td>
<td>NA</td>
<td>3.1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>(6.0 - 11.0') Bottom ASH; trace small cobbles, subrounded to subangular; black (10YR 2/1).</td>
</tr>
<tr>
<td>9.0 - 19.0'</td>
<td>6.6</td>
<td>NA</td>
<td>NA</td>
<td>6.6</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>(11.0 - 17.5') Fly ASH; wet; black (10YR 2/1).</td>
</tr>
<tr>
<td>19.0 - 21.0'</td>
<td>0.0</td>
<td>NA</td>
<td>NA</td>
<td>0.0</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>(17.5 - 29.0') CLAY, high plasticity; dry; medium stiff; olive gray (5Y 4/2) with dark yellowish brown mottling (10YR 4/6).</td>
</tr>
<tr>
<td>21.0 - 31.0'</td>
<td>4.6</td>
<td>NA</td>
<td>NA</td>
<td>4.6</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:** bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 11.0' bgs.
No odor or staining observed.
Date Start: 10/23/15  Date Finish: 10/26/15
Drilling Company: Stock Drilling  Driller's Name: Austin G.
Drilling Method: Hydrovac/Sonic  Sampling Method: Continuous
Rig Type: Sonic  Water Level Start (ft. bgs.): 11.0
Water Level Finish (ft. btoc.): NA

Samples/Int/Type

ELEVATION

Sample Run Number  Sample/Int/Type  Recovery (feet)  PID Headspace (ppm)  Analytical Sample  Geologic Column

30 -30

35 -35
6  31.0-41.0'  12.0  NA  

(29.0 - 34.0') CLAY, low plasticity; trace silt; trace granule to small pebbles, subrounded to subangular; very stiff; brown (10YR 5/3).

(34.0 - 70.0') CLAY, high plasticity; trace silt; trace very fine to fine sand; trace granule to small pebbles, subrounded to subangular; dry; medium stiff; dark gray (10YR 4/1).

NOTE: Trace medium pebbles to large cobbles, subrounded to subangular starting at 43.0' bgs.

40 -40
7  41.0-51.0'  8.6  NA

(34.0 - 70.0') CLAY, high plasticity; trace silt; trace very fine to fine sand; trace granule to small pebbles, subrounded to subangular; dry; medium stiff; dark gray (10YR 4/1).

NOTE: Trace medium pebbles to large cobbles, subrounded to subangular starting at 43.0' bgs.

50 -50
8  51.0-61.0'  6.4  NA

(34.0 - 70.0') CLAY, high plasticity; trace silt; trace very fine to fine sand; trace granule to small pebbles, subrounded to subangular; dry; medium stiff; dark gray (10YR 4/1).

NOTE: Clay is very stiff to hard at 59.0' bgs.

55 -55

60 -60

Remarks: bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 11.0' bgs.
No odor or staining observed.
**Well/Boring ID:** JRW MW-15001  
**Client:** Consumers Energy  
**Location:** JR Whiting Facility  
4525 East Erie Road  
Erie, MI 48133  
**Weather Conditions:** 50 F Sunny

<table>
<thead>
<tr>
<th>Sample Run Number</th>
<th>Elevation</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>61.0-71.0'</td>
<td>6.2</td>
<td>NA</td>
<td></td>
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<tr>
<td>10</td>
<td>71.0-81.0'</td>
<td>6.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>81.0-86.0'</td>
<td>3.7</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>86.0-88.0'</td>
<td>0.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:** bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 11.0' bgs.
No odor or staining observed.
Stratigraphic Description

Well/Boring ID: JRW MW-15002
Client: Consumers Energy
Location: JR Whiting Facility
        4525 East Erie Road
        Erie, MI 48133
Weather Conditions: 55 F Cloudy

Date Start: 10/27/15
Date Finish: 10/28/15
Drilling Company: Stock Drilling
Driller's Name: Austin G.
Drilling Method: Hydrovac/Sonic
Sampling Method: Continuous
Rig Type: Sonic
Water Level Start (ft. bgs.): 6.0
Water Level Finish (ft. bgs.): NA

Sample/Int/Type
ELEVATION
Recovery (feet)
PID Headspace (ppm)
Analytical Sample
Geologic Column
Water Level (ft. bgs.)

DEPHT (feet bgs.)
ELEVATION
Sample Run Number
Sample/Int/Type
Recovery (feet)
PID Headspace (ppm)
Analytical Sample
Geologic Column
Water Level (ft. bgs.)

(0.0 - 6.0') Hydrovac; no lithology recorded.
(6.0 - 6.5') Fly ASH; wet; dark gray (10YR 2/1).
(16.5 - 17.0') PEAT; moist; black (10YR 2/1).
(17.0 - 18.0') SILT, medium plasticity; trace clay; little organics; moist; medium stiff; very dark grayish brown (10YR 3/2).
(18.0 - 23.5') CLAY, high plasticity; trace silt; dry; medium stiff; olive (5Y 4/3).
NOTE: Color change to light yellow brown (2.5Y 6/4) with olive yellow mottling (2.5Y 6/6) at 19.0' bgs.
NOTE: Clay becomes soft from 21.0 to 23.5' bgs.
(23.5 - 71.0') CLAY, medium to high plasticity; trace silt; little granule to large pebble, subrounded to subangular; dry; medium stiff to stiff; brownish yellow (10YR 6/6).
NOTE: Color change to brown (10YR 4/3) at 28.0' bgs.

Remarks:  bgs = below ground surface
Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.
Stratigraphic Description

Well/Boring ID: JRW MW-15002
Client: Consumers Energy
Location: JR Whiting Facility
4525 East Erie Road
Erie, MI 48133
Weather Conditions: 55 F Cloudy

Date Start: 10/27/15
Date Finish: 10/28/15
Drilling Company: Stock Drilling
Driller's Name: Austin G.
Drilling Method: Hydrovac/Sonic
Sampling Method: Continuous
Rig Type: Sonic
Water Level Start (ft. bgs.): 6.0
Water Level Finish (ft. btoc.): NA

Sample/Int/Type

ELEVATION

DEPTH (feet bgs.)
Sample Run Number
Sample Int/Type
Recovery (feet)
PID Headspace (ppm)
Analytical Sample
Geologic Column

30
-30

5
31.0-41.0'
12.0
NA

40
-40

6
41.0-51.0'
10.3
NA

50
-50

7
51.0-61.0'
12.0
NA

NOTE: Color change to dark gray (10YR 4/1) at 31.0' bgs.

NOTE: Clay is stiff at 41.0' bgs.

NOTE: Little very large pebbles to small cobbles starting at 57.0' bgs.

Cement/Bentonite (0.0-76.0' bgs)
2" PVC Well Casing (-3.0-81.0' bgs)

Remarks: bg = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.
**Stratigraphic Description**

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 - 65</td>
<td>65</td>
<td>8</td>
<td>61.0-71.0'</td>
<td>10.3</td>
<td>NA</td>
<td>Stratigraphic Description</td>
<td>Stratigraphic Description</td>
</tr>
<tr>
<td>70 - 70</td>
<td>70</td>
<td>9</td>
<td>71.0-81.0'</td>
<td>5.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 - 80</td>
<td>80</td>
<td>10</td>
<td>81.0-91.0'</td>
<td>1.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 - 90</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95 - 95</td>
<td>95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(71.0 - 91.0') LIMESTONE BEDROCK, sedimentary rock, very fine grained, homogeneous grain size and distribution; reacts with HCL when crushed; little large pores infilled with dark calcite crystals; rock core is hard to very hard; light gray (10YR 7/1).

NOTE: Very low recovery from 81.0 to 91.0' bgs.

End of boring 91.0' bgs.

**Remarks:**

Hydrovac to 6.0' bgs.

Groundwater encountered at 6.0' bgs.

No odor or staining observed.
**Date Start:** 10/28/15  
**Date Finish:** 10/29/15  
**Drilling Company:** Stock Drilling  
**Driller's Name:** Austin G.  
**Drilling Method:** Hydrovac/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 6.0  
**Water Level Finish (ft. bgs.):** NA  

<table>
<thead>
<tr>
<th>Depth (ft bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Lith/LType</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 6.0'</td>
<td>1</td>
<td>0.0 - 6.0'</td>
<td>0.0</td>
<td>NA</td>
<td></td>
<td>(6.0 - 6.0') Hydrovac; no lithology recorded.</td>
</tr>
<tr>
<td>6.0 - 11.0'</td>
<td>2</td>
<td>6.0 - 11.0'</td>
<td>6.0</td>
<td>NA</td>
<td></td>
<td>(6.0 - 16.8') Fly ASH; wet; black (10YR 2/1).</td>
</tr>
<tr>
<td>11.0 - 21.0'</td>
<td>3</td>
<td>11.0 - 21.0'</td>
<td>9.7</td>
<td>NA</td>
<td></td>
<td>(16.8 - 18.4') PEAT and SILT; little organics; moist; dark gray brown (10YR 4/2).</td>
</tr>
<tr>
<td>21.0 - 31.0'</td>
<td>4</td>
<td>21.0 - 31.0'</td>
<td>12.7</td>
<td>NA</td>
<td></td>
<td>(26.0 - 71.0') CLAY, medium to high plasticity; trace silt; little granule to large pebbles, subrounded to subangular; dry; medium stiff to stiff; very dark gray (10YR 3/1).</td>
</tr>
</tbody>
</table>

**Remarks:** bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.
### Stratigraphic Description

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample Int. Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>30</td>
<td>30</td>
<td>Sp 30</td>
<td>10.6</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>35</td>
<td>35</td>
<td>Sp 35</td>
<td>11.3</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>40</td>
<td>Sp 40</td>
<td>12.3</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>45</td>
<td>45</td>
<td>Sp 45</td>
<td>11.3</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>50</td>
<td>Sp 50</td>
<td>11.3</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>55</td>
<td>55</td>
<td>Sp 55</td>
<td>12.3</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>60</td>
<td>60</td>
<td>Sp 60</td>
<td>12.3</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

- Clay is stiff at 33.0' bgs.
- Clay is stiff to very stiff at 41.0' bgs.
- Trace small to large cobbles, subrounded to subangular in sample from 51.0 to 61.0' bgs.
- Clay is stiff at 60.5' bgs.
- Clay is stiff at 60.5' bgs.

**Well/Boring Construction**

- Cement/Bentonite (0.0-75.0' bgs)
- 2" PVC Well Casing (-3.0-81.0' bgs)

**Analysis**

- Project: DE000722.0005.00006
- Template: ARCADIS_Analytical Boring-Well 2013_New Logo
- Data File: JRW MW-15003.dat
- Date: 12/15/2015
- Created/Edited by: C. Jeffers

**Well/Boring ID:** JRW MW-15003

**Client:** Consumers Energy

**Location:** JR Whiting Facility
4525 East Erie Road
Erie, MI 48133

**Weather Conditions:** 60 F Cloudy, rain

**Remarks:**

- Hydrovac to 6.0' bgs.
- Groundwater encountered at 6.0' bgs.
- No odor or staining observed.

**Additional Details:**

- Date Start: 10/28/15
- Date Finish: 10/29/15
- Drilling Company: Stock Drilling
- Sampling Method: Continuous
- Sampling Method: Sonic
- Water Level Start (ft. bgs.): 6.0
- Water Level Finish (ft. btoc.): NA

**Client:** Consumers Energy

**Location:** JR Whiting Facility
4525 East Erie Road
Erie, MI 48133
### Sample Run Number

<table>
<thead>
<tr>
<th>Sample/Int/Type</th>
<th>DEPTH (feet bgs)</th>
<th>ELEVATION</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Stratigraphic Description</th>
<th>Geologic Column</th>
<th>Water Level (ft. bgs)</th>
<th>Well/Boring Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>61.0-71.0</td>
<td>10.1</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
<td>65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>71.0-81.0</td>
<td>4.0</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>81.0-91.0</td>
<td>7.0</td>
<td>NA</td>
<td></td>
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<td>80</td>
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<td>90</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>95</td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

bgs = below ground surface

Hydrovac to 6.0' bgs.

Groundwater encountered at 6.0' bgs.

No odor or staining observed.
**Stratigraphic Description**

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample INT/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.0 - 6.0')</td>
<td>Hydrovac; no lithology recorded.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6.0 - 9.0')</td>
<td>Fly ASH; trace bottom ash; wet; black (10YR 2/1).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9.0 - 13.0')</td>
<td>SILT; trace clay; little organics, roots; trace peat; moist; soft; dark gray (10YR 4/1).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(13.0 - 17.0')</td>
<td>CLAY, high plasticity; little silt; trace bottom ash; moist; soft; brown (10YR 4/3).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17.0 - 19.0')</td>
<td>SILT and PEAT; little organics; trace medium to very coarse sand; medium stiff to soft; very dark brown (10YR 2/2).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(19.0 - 23.0')</td>
<td>CLAY, medium to high plasticity; trace silt; dry; medium stiff; olive (5Y 4/4) with brownish yellow mottling (10YR 6/8).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(23.0 - 80.5')</td>
<td>CLAY, medium plasticity; trace coarse sand to large pebbles; subrounded to subangular; dry; stiff; dark brown (10YR 3/3).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- bgs = below ground surface

Hydrovac to 6.0' bgs.

Groundwater encountered at 6.0' bgs.

No odor or staining observed.
### Stratigraphic Description

**Well/Boring ID:** JRW MW-15004  
**Client:** Consumers Energy  
**Location:** JR Whiting Facility  
4525 East Erie Road  
Erie, MI 48133  
**Weather Conditions:** 46 F Overcast  

**Date Start:** 10/30/15  
**Date Finish:** 11/02/15  
**Drilling Company:** Stock Drilling  
**Driller's Name:** Austin G.  
**Drilling Method:** Hydorac/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Surface Elevation:** 590.8  
**Well/Boring ID:** JRW MW-15004  
**Casing Elevation:** 592.52  
**Easting:** 13375045.59  
**Northing:** 107881.56  
**Water Level Start (ft. bgs.):** 6.0  
**Water Level Finish (ft. btoc.):** NA  
**Sampling Method:** Continuous  
**Drilling Method:** Hydorac/Sonic  
**Driller's Name:** Austin G.  
**Drilling Company:** Stock Drilling  
**Date Start:** 10/30/15  
**Date Finish:** 11/02/15  
**Rig Type:** Sonic  
**Weather Conditions:** 46 F Overcast  

### Geologic Column

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Stratigraphic Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 ≤ 35</td>
<td>5</td>
<td>31.0-41.0'</td>
<td>12.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 ≤ 40</td>
<td>6</td>
<td>41.0-51.0'</td>
<td>12.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 ≤ 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 ≤ 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 ≤ 55</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>60 ≤ 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65 ≤ 65</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**  

- Clay is very stiff to hard; little granule to large pebbles; trace very large pebbles to small cobbles, subrounded to subangular at 41.0' bgs.  
- Hydrovac to 6.0' bgs.  
- Groundwater encountered at 6.0' bgs.  
- No odor or staining observed.
Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.
**Stratigraphic Description**

<table>
<thead>
<tr>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
<th>Stratigraphic Description</th>
<th>Water Level Start (ft. bgs.)</th>
<th>Well/Boring Construction</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.0-6.0'</td>
<td>0.0</td>
<td>NA</td>
<td></td>
<td></td>
<td>(0.0 - 6.0') Hydrovac; no lithology recorded.</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6.0-11.0'</td>
<td>5.0</td>
<td>NA</td>
<td></td>
<td></td>
<td>(6.0 - 31.0') Fly ASH; trace bottom ash; wet; black (10YR 2/1).</td>
<td>5.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>11.0-21.0'</td>
<td>8.3</td>
<td>NA</td>
<td></td>
<td></td>
<td>NOTE: No recovery, material too soft from 21.0 to 31.0' bgs.</td>
<td>8.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>21.0-31.0'</td>
<td>0.0</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**

bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.
Date Start: 11/02/15
Date Finish: 11/03/15
Drilling Company: Stock Drilling
Driller's Name: Austin G.
Drilling Method: Hydrovac/Sonic
Sampling Method: Continuous
Rig Type: Sonic
Water Level Start (ft. bgs.): 6.0
Water Level Finish (ft. bgs.): NA

Sample/Int/Type

DEPTH (feet bgs.) ELEVATION Sample Run Number Sample/int/Type Recovery (feet) PID Headspace (ppm) Analytical Sample Geologic Column

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>ELEVATION</th>
<th>Sample Run Number</th>
<th>Sample/int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>35</td>
<td>5</td>
<td>31.0 - 41.0'</td>
<td>10.2</td>
<td>NA</td>
<td></td>
<td>(31.0 - 33.0') PEAT and SILT; trace organics, roots; moist to wet; dark grayish brown (10YR 3/2).</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>6</td>
<td>41.0 - 51.0'</td>
<td>12.2</td>
<td>NA</td>
<td></td>
<td>(33.0 - 49.0') CLAY, medium plasticity; little granule to medium pebbles; trace large pebbles, subrounded to subangular; trace silt; dry; stiff; very dark gray (10YR 3/1).</td>
</tr>
<tr>
<td>45</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NOTE: Trace very large pebbles to large cobbles, subrounded to subangular; clay becomes hard from 41.0 to 49.0' bgs.</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(49.0 - 54.0') SILT and SAND, rapid dilatancy, very fine; wet; medium stiff to soft; very dark gray (10YR 3/1).</td>
</tr>
<tr>
<td>55</td>
<td>55</td>
<td>7</td>
<td>51.0 - 61.0'</td>
<td>10.0</td>
<td>NA</td>
<td></td>
<td>(54.0 - 80.5') CLAY, medium plasticity; little granule to medium pebbles; trace large pebbles, subrounded to subangular; trace silt; dry; stiff; very dark gray (10YR 3/1).</td>
</tr>
<tr>
<td>60</td>
<td>60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>65</td>
<td>65</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.

Cement/Bentonite (0.0-81.0' bgs)
2" PVC Well Casing (-3.0-86.0' bgs)
**Well/Boring ID:** JRW MW-15005  
**Client:** Consumers Energy  
**Location:** JR Whiting Facility  
4525 East Erie Road  
Erie, MI 48133

**Date Start:** 11/02/15  
**Date Finish:** 11/03/15  
**Drilling Company:** Stock Drilling  
**Driller's Name:** Austin G.  
**Drilling Method:** Hydrovac/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic

**Water Level Start (ft. bgs.):** 6.0  
**Water Level Finish (ft. btoc.):** NA

<table>
<thead>
<tr>
<th>Depth (ft. bgs.)</th>
<th>Sample Run Number</th>
<th>Sample Int/Type</th>
<th>Recovery (ft.)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>61.0-71.0'</td>
<td>12.3</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>71.0-81.0'</td>
<td>7.3</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>81.0-91.0'</td>
<td>5.1</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>91.0-96.0'</td>
<td>3.7</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Stratigraphic Description:**

- **(80.5 - 96.0') LIMESTONE BEDROCK,** sedimentary rock, very fine grained, homogeneous grain size and distribution; reacts with HCL when crushed; little large pores infilled with dark calcite crystals; rock core is hard to very hard; light gray (10YR 7/1).
- **NOTE:** Limestone is porous with calcite crystals infilling in openings at 89.0' bgs.
- **NOTE:** very fine limestone slurry layer from 94.0 to 95.0' bgs.
- **End of boring 96.0' bgs.**

**Remarks:**

- Groundwater encountered at 6.0' bgs.  
- No odor or staining observed.
**Stratigraphic Description**

- **Well/Boring:** JRW MW-15006
- **Construction:** Continuous
- **Casing Elevation:** 590.3
- **Easting:** 1337428.80
- **Nordthing:** 107843.22
- **Surface Elevation:** 590.3
- **Well/Boring ID:** JRW MW-15006
- **Client:** Consumers Energy
- **Location:** JR Whiting Facility
  - 4525 East Erie Road
  - Erie, MI 48133
- **Weather Conditions:** 42 F Sunny
- **Date Start:** 11/03/15
- **Date Finish:** 11/05/15
- **Driller's Name:** Austin G.
- **Drilling Company:** Stock Drilling
- **Drilling Method:** Hydrovac/Sonic
- **Sampling Method:** Continuous
- **Rig Type:** Sonic
- **Water Level Start (ft. bgs.):** 6.0
- **Water Level Finish (ft. btoc.):** NA

**Water Level Start (ft. bgs.):** 6.0
**Water Level Finish (ft. btoc.):** NA

### Stratigraphic Description

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 - 6.0'</td>
<td>1</td>
<td>0.0 - 6.0'</td>
<td>0.0</td>
<td>NA</td>
<td>(6.0 - 6.0') Hydrovac; no lithology recorded.</td>
<td></td>
</tr>
<tr>
<td>6.0 - 11.0'</td>
<td>2</td>
<td>6.0 - 11.0'</td>
<td>5.7</td>
<td>NA</td>
<td>(6.0 - 25.0') Fly and Bottom ASH; wet; black (10YR 2/1).</td>
<td></td>
</tr>
<tr>
<td>11.0 - 21.0'</td>
<td>3</td>
<td>11.0 - 21.0'</td>
<td>10.6</td>
<td>NA</td>
<td>(25.0 - 47.0') CLAY, medium to high plasticity; little granules to large pebbles, subrounded to subangular; trace silt; dry; medium stiff; brown (10YR 4/3).</td>
<td></td>
</tr>
</tbody>
</table>

### Remarks:

- Hydrovac to 6.0' bgs.
- Groundwater encountered at 6.0' bgs.
- No odor or staining observed.

---

*Remarks: bgs = below ground surface*
Stratigraphic Description

**Well/Boring Construction**

**Casing Elevation:**

**Easting:**

**Surface Elevation:**

**Well/Boring ID:**

**Client:** Consumers Energy

**Location:** JR Whiting Facility
4525 East Erie Road
Erie, MI 48133

**Weather Conditions:** 42 F Sunny

---

**Date Start:** 11/03/15
**Date Finish:** 11/05/15
**Drilling Company:** Stock Drilling
**Driller's Name:** Austin G.
**Sampling Method:** Continuous
**Rig Type:** Sonic
**Water Level Start (ft. bgs.):** 6.0
**Water Level Finish (ft. btoc.):** NA

**Drilling Method:** Hydrovac/Sonic
**Sampling Method:** Continuous
**Sampling Method:** Sonic
**Water Level Start (ft. bgs.):** 6.0
**Water Level Finish (ft. btoc.):** NA

**Rig Type:** Sonic

**Sampling Method:** Continuous
**Sampling Method:** Sonic
**Water Level Start (ft. bgs.):** 6.0
**Water Level Finish (ft. btoc.):** NA

**Well/Boring ID:** JRW MW-15006
**Client:** Consumers Energy

**Location:** JR Whiting Facility
4525 East Erie Road
Erie, MI 48133

**Weather Conditions:** 42 F Sunny

---

**Depth (feet bgs.)**

**Elevation**

**Sample Run Number**

**Sample/Method Type**

**Recovery (feet)**

**PID Headspace (ppm)**

**Analytical Sample**

**Geologic Column**

**Water Level (feet bgs.)**

---

**Sample Run Number**

**Sample/Method Type**

**Recovery (feet)**

**PID Headspace (ppm)**

**Analytical Sample**

**Geologic Column**

**Water Level (feet bgs.)**

---

**NOTE:** Clay becomes medium stiff to soft; color change to very dark gray (10YR 3/1) at 31.0' bgs.

**NOTE:** Clay becomes stiff at 38.0' bgs.

**NOTE:** Trace very large pebbles to small cobbles, subrounded to subangular at 41.0' bgs.

---

**Remarks:** bgs = below ground surface

Hydrovac to 6.0' bgs.
Groundwater encountered at 6.0' bgs.
No odor or staining observed.

---

**Cement/Bentonite**

(0.0-74.0' bgs)

**2" PVC Well Casing**

(-3.0-81.0' bgs)
### Stratigraphic Description

<table>
<thead>
<tr>
<th>DEPTH (feet bgs.)</th>
<th>Sample Run Number</th>
<th>Sample/Int/Type</th>
<th>Recovery (feet)</th>
<th>PID Headspace (ppm)</th>
<th>Analytical Sample</th>
<th>Geologic Column</th>
</tr>
</thead>
<tbody>
<tr>
<td>65 - 65</td>
<td>8</td>
<td>61.0-71.0'</td>
<td>12.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70 - 70</td>
<td>9</td>
<td>71.0-81.0'</td>
<td>4.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 - 80</td>
<td>10</td>
<td>81.0-91.0'</td>
<td>5.0</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90 - 90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>95 - 95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **NOTE:** Some granule to medium pebbles; little large pebbles to very large pebbles; trace small to large cobbles, subrounded to subangular at 68.0' bgs.
- **(71.0 - 91.0') LIMESTONE BEDROCK, sedimentary rock, very fine grained, homogeneous grain size and distribution; reacts with HCL when crushed; little large pores infilled with dark calcite crystals; rock core is hard to very hard; light gray (10YR 7/1).**

---

### Remarks:

- **bgs = below ground surface**
- Hydrovac to 6.0' bgs.
- Groundwater encountered at 6.0' bgs.
- No odor or staining observed.
### Soil Description

#### Udden-Wenworth Scale
**Modified ARCADIS, 2008**

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Millimeters</th>
<th>Inches</th>
<th>Standard Sieve #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder</td>
<td>256 - 4066</td>
<td>10.08+</td>
<td></td>
</tr>
<tr>
<td>Large cobble</td>
<td>128 - 256</td>
<td>5.04 - 10.00</td>
<td></td>
</tr>
<tr>
<td>Small cobble</td>
<td>64 - 128</td>
<td>2.52 - 5.04</td>
<td></td>
</tr>
<tr>
<td>Very large pebble</td>
<td>32 - 64</td>
<td>0.16 - 2.52</td>
<td></td>
</tr>
<tr>
<td>Large pebble</td>
<td>16 - 32</td>
<td>0.63 - 1.26</td>
<td></td>
</tr>
<tr>
<td>Medium pebble</td>
<td>8 - 16</td>
<td>0.31 - 0.63</td>
<td></td>
</tr>
<tr>
<td>Small pebble</td>
<td>4 - 8</td>
<td>0.16 - 0.31</td>
<td>No. 5 +</td>
</tr>
<tr>
<td>Granule</td>
<td>2 - 4</td>
<td>0.08 - 0.16</td>
<td>No. 5 - No. 10</td>
</tr>
<tr>
<td>Very coarse sand</td>
<td>1 - 2</td>
<td>0.04 - 0.08</td>
<td>No. 10 - No. 18</td>
</tr>
<tr>
<td>Coarse sand</td>
<td>1/2 - 1</td>
<td>0.02 - 0.04</td>
<td>No. 18 - No. 35</td>
</tr>
<tr>
<td>Medium sand</td>
<td>1/4 - 1/2</td>
<td>0.01 - 0.02</td>
<td>No. 35 - No. 60</td>
</tr>
<tr>
<td>Fine sand</td>
<td>1/8 - 1/4</td>
<td>0.005 - 0.1</td>
<td>No. 60 - No. 120</td>
</tr>
<tr>
<td>Very fine sand</td>
<td>1/16 - 1/4</td>
<td>0.002 - 0.005</td>
<td>No. 120 - No. 230</td>
</tr>
<tr>
<td>Silt (subgroups not included)</td>
<td>1/256 - 1/16</td>
<td>Not applicable (analyze by pipette or hydrometer)</td>
<td></td>
</tr>
<tr>
<td>Clay (subgroups not included)</td>
<td>1/2048 - 1/256</td>
<td>.00002 - 0.0002</td>
<td></td>
</tr>
</tbody>
</table>

#### Fine-grained Soil - Consistency

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very soft</td>
<td>N-value &lt; 2 or easily penetrated several inches by thumb.</td>
</tr>
<tr>
<td>Soft</td>
<td>N-value 2-4 or easily penetrated one inch by thumb.</td>
</tr>
<tr>
<td>Medium stiff</td>
<td>N-value 5-15 or indented about 1/4 inch by thumb with great effort.</td>
</tr>
<tr>
<td>Very stiff</td>
<td>N-value 16-30 or readily indented by thumbnail.</td>
</tr>
<tr>
<td>Hard</td>
<td>N-value &gt; 30 or indented by thumbnail with difficulty.</td>
</tr>
</tbody>
</table>

#### Coarse-grained Soil - Density

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very loose</td>
<td>N-value 1-4</td>
</tr>
<tr>
<td>Loose</td>
<td>N-value 5-10</td>
</tr>
<tr>
<td>Medium dense</td>
<td>N-value 11-30</td>
</tr>
<tr>
<td>Dense</td>
<td>N-value 31-50</td>
</tr>
<tr>
<td>Very dense</td>
<td>N-value &gt;50</td>
</tr>
</tbody>
</table>

#### Modifier Percent of Total Sample (by volume)

<table>
<thead>
<tr>
<th>Modifier</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>and</td>
<td>30 - 50</td>
</tr>
<tr>
<td>some</td>
<td>21 - 35</td>
</tr>
<tr>
<td>little</td>
<td>10 - 20</td>
</tr>
<tr>
<td>trace</td>
<td>&lt;10</td>
</tr>
</tbody>
</table>

#### Consistency Criteria

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonplastic</td>
<td>A 1/8 inch (3 mm) thread cannot be rolled at any water content.</td>
</tr>
<tr>
<td>Low</td>
<td>The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.</td>
</tr>
<tr>
<td>Medium</td>
<td>The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.</td>
</tr>
<tr>
<td>High</td>
<td>It takes considerable time rolling and inverting to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be turned without crumbling when drier than the plastic limit.</td>
</tr>
</tbody>
</table>

#### Consistency Criteria

<table>
<thead>
<tr>
<th>Moistness</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Absence of moisture, dry to touch. Dusty.</td>
</tr>
<tr>
<td>Wet (saturated)</td>
<td>Visible free water, soil is usually below the water table.</td>
</tr>
</tbody>
</table>

#### Angular, Subangular, Subrounded, Rounded

<table>
<thead>
<tr>
<th>Description</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular</td>
<td>Particles have sharp edges and relatively plane sides with unpolished surfaces.</td>
</tr>
<tr>
<td>Subangular</td>
<td>Particles are similar to angular description but have rounded edges.</td>
</tr>
<tr>
<td>Subrounded</td>
<td>Particles have nearly plane sides but have well-rounded corners and edges.</td>
</tr>
<tr>
<td>Rounded</td>
<td>Particles have smoothly curved sides and no edges.</td>
</tr>
</tbody>
</table>
Photograph #1

Description of Photograph: View of the various soil types encountered during the monitoring well installation activities at the Site.

Site Location: Consumers Energy Co. JR Whiting Generating Facility Erie, Michigan

Photograph Taken By: Lance Rogers

Date of Photograph: October 27, 2015

---

Photograph #2

Description of Photograph: View of the various soil types encountered during the monitoring well installation activities at the Site.

Consumers Energy Co. JR Whiting Generating Facility Erie, Michigan

Photograph Taken By: Lance Rogers

Date of Photograph: October 23, 2015
Photograph #3

Description of Photograph: View of the various soil types encountered during the monitoring well installation activities at the Site.

Site Location: Consumers Energy Co. JR Whiting Generating Facility Erie, Michigan

Photograph Taken By: Lance Rogers

Date of Photograph: October 27, 2015

Photograph #4

Description of Photograph: View of the various soil types encountered during the monitoring well installation activities at the Site.

Consumers Energy Co. JR Whiting Generating Facility Erie, Michigan

Photograph Taken By: Lance Rogers

Date of Photograph: October 29, 2015
APPENDIX C

Hydraulic Test Logs
Slug Test Analysis Results for JRW MW-15001 -Test 2

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location: Erie, MI

SOLUTION

Aquifer Model: Confined
Solution Method: KGS Model

\[ K_r = 7.7 \text{ ft/day} \quad S_s = 2.0E-5 \text{ ft}^{-1} \]

\[ K_z/K_r = \_ \_ \_ \_ \]

AQUIFER DATA

Saturated Thickness: 18. ft

WELL DATA (JRW-MW-15001)

Initial Displacement: 1.177 ft
Static Water Column Height: 69.28 ft
Total Well Penetration Depth: 18. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
**Slug Test Analysis Results for JRW MW-15001 -Test 3**

**Prepared By:** Arcadis  
**Prepared For:** Consumer Energy

**Project:**  
**Location:** Erie, MI

### SOLUTION
- **Aquifer Model:** Confined
- **Solution Method:** KGS Model
- $Kr = 12. \text{ ft/day}$  
- $Ss = 9.0E-10 \text{ ft}^{-1}$  
- $Kz/Kr = 1.$

### AQUIFER DATA
- **Saturated Thickness:** 18. ft

### WELL DATA (JRW-MW-15001)
- **Initial Displacement:** 2.02 ft
- **Static Water Column Height:** 69.28 ft
- **Total Well Penetration Depth:** 18. ft
- **Screen Length:** 10. ft
- **Casing Radius:** 0.083 ft
- **Well Radius:** 0.25 ft
Slug Test Analysis Results for JRW MW-15003 -Test 1

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location: Erie, MI

SOLUTION
Aquifer Model: Confined Solution Method: KGS Model

\[ Kr = 20. \text{ ft/day} \]
\[ Ss = 0.00016 \text{ ft}^{-1} \]
\[ Kz/Kr = 1. \]

AQUIFER DATA

Saturated Thickness: 20. ft

WELL DATA (JRW-MW-15003)

Initial Displacement: 1.114 ft
Static Water Column Height: 74. ft
Total Well Penetration Depth: 20. ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
Slug Test Analysis Results for JRW MW-15003 -Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy
Project: Location: Erie, MI

**SOLUTION**
- Aquifer Model: Confined
- Solution Method: KGS Model
- \( Kr = 20. \text{ ft/day} \)
- \( Ss = 2.3 \times 10^{-5} \text{ ft}^{-1} \)
- \( \frac{Kz}{Kr} = 1. \)

**AQUIFER DATA**
- Saturated Thickness: 20. ft

**WELL DATA (JRW-MW-15003)**
- Initial Displacement: 2.138 ft
- Static Water Column Height: 74. ft
- Total Well Penetration Depth: 20. ft
- Screen Length: 10. ft
- Casing Radius: 0.083 ft
- Well Radius: 0.25 ft
Slug Test Analysis Results for JRW MW-15005 - Test 1

Prepared By: Arcadis  Prepared For: Consumer Energy

Project: Location: Erie, MI

SOLUTION
Aquifer Model: Confined Solution Method: KGS Model

\[ K_r = 18. \text{ ft/day} \]
\[ S_s = 5.6E-12 \text{ ft}^{-1} \]
\[ K_z/K_r = 1 \]

AQUIFER DATA
Saturated Thickness: 15.5 ft

WELL DATA (JRW-MW-15005)
Initial Displacement: 0.981 ft
Static Water Column Height: 74.54 ft
Total Well Penetration Depth: 15.5 ft
Screen Length: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
Slug Test Analysis Results for JRW MW-15005 -Test 2

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Erie, MI

SOLUTION
Aquifer Model: Confined
Solution Method: KGS Model

Kr = 8.4 ft/day
Kz/Kr = 1
Ss = 1.5E-6 ft⁻¹

AQUIFER DATA
Saturated Thickness: 15.5 ft

WELL DATA (JRW-MW-15005)
Initial Displacement: 1.131 ft
Static Water Column Height: 74.54 ft
Total Well Penetration Depth: 15.5 ft
Screen Length: 10 ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
Slug Test Analysis Results for JRW MW-15010 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy
Project: Location:

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
\[ K = 20. \text{ ft/day} \]
\[ y_0 = 1.7 \text{ ft} \]

AQUIFER DATA
Saturated Thickness: 8. ft

WELL DATA (JRW-MW-15010)
Initial Displacement: 1.642 ft
Static Water Column Height: 28.57 ft
Total Well Penetration Depth: 8. ft
Screen Length: 3. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
Slug Test Analysis Results for JRW MW-15011 - Test 2

Prepared By: Arcadis  Prepared For: Consumer Energy
Project: Location: Erie, MI

**SOLUTION**
Aquifer Model: Confined
Solution Method: Hvorslev
K = 1.5 ft/day  y0 = 1.7 ft

**AQUIFER DATA**
Saturated Thickness: 7 ft

**WELL DATA (JRW-MW-15011)**
Initial Displacement: 1.69 ft
Static Water Column Height: 56.55 ft
Total Well Penetration Depth: 7 ft
Screen Length: 3 ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
 Slug Test Analysis Results for JRW MW-15012 - Test1  

<table>
<thead>
<tr>
<th>Prepared By:</th>
<th>Prepared For:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arcadis</td>
<td>Consumer Energy</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Project:</th>
<th>Location:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Erie, MI</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOLUTION  
Aquifer Model: Confined  
Solution Method: Cooper-Bredhoeft-Papadopulos  
\[ T = 30. \text{ ft}^2/\text{day} \]  
\[ S = 0.00053 \]

AQUIFER DATA  
Saturated Thickness: 13.  
WELL DATA (JRW-MW-15012)  

Initial Displacement: 0.831 ft  
Static Water Column Height: 61.1 ft  
Total Well Penetration Depth: 12. ft  
Screen Length: 2. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.25 ft
Slug Test Analysis Results for JRW MW-15012 - Test 3

Prepared By: Arcadis
Prepared For: Consumer Energy

Project: Location: Erie, MI

SOLUTION
Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
\[ T = 31 \text{ ft}^2/\text{day} \]
\[ S = 0.00065 \]

AQUIFER DATA
Saturated Thickness: 13.

WELL DATA (JRW-MW-15012)
Initial Displacement: 1.625 ft
Static Water Column Height: 61.1 ft
Total Well Penetration Depth: 12. ft
Screen Length: 2. ft
Casing Radius: 0.083 ft
Well Radius: 0.25 ft
Arcadis of Michigan, LLC

28550 Cabot Drive
Suite 500
Novi, Michigan 48377
Tel 248 994 2240
Fax 248 994 2241

www.arcadis.com
2016 Monitoring Well Design, Installation
Development, and Decommissioning

JR Whiting Electric Generation Facility
Erie, Michigan

December 2016

Prepared For
Consumers Energy Company

Vincent E. Buening, CPG
Senior Project Manager

David B. McKenzie, PE
Senior Project Engineer
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Section 1
Introduction

TRC Engineers Michigan, Inc. (TRC) has prepared this Monitoring Well Design, Installation, Development, and Decommissioning Report to summarize monitoring well installation and well decommissioning (also often referred to as well abandonment) activities conducted from October 18, 2016 to December 2, 2016 at the J.R. Whiting electric generation facility (JRW), located at 4525 East Erie Road, Erie, Michigan (Site). This effort specifically documents six monitoring well installations overseen by FK Engineering Associates (FKE) around Pond 6 that has been identified as an inactive CCR surface impoundment as defined in 40 CFR Part 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals (CCR) from Electric Utilities and three monitoring well installations to measure background conditions to the disposal areas. Additionally, the abandonment of six existing monitoring wells around Pond 6 was also overseen by FKE. These monitoring wells had been constructed in 1979, 1982, and 1993 with galvanized steel casing and stainless steel well screens and were found to have compromised integrity. The six new wells replace the six abandoned wells in kind.

This Report summarizes the groundwater monitoring well installation and well abandonment activities by FKE, including drilling procedures, well decommissioning procedures, well locations, well construction details, well decommissioning details, well development activities, boring logs, and hydraulic testing results. The methodologies used in the field activities conform to state guidance, and recognized and generally accepted good engineering practices.
Section 2
Objectives

The objectives of this report are to document the work completed by FKE at the Site, including:

- Advancement of soil borings—Section 3.1
- Monitoring well installation—Section 3.2
- Monitoring well development—Section 3.3
- Hydraulic testing—Section 3.4
- Monitoring well abandonment—Section 3.5
Section 3
Field Activities

Well installation and abandonment activities were performed from October 18 to December 2, 2016 by Cascade Drilling, LLC (Cascade) under continuous oversight performed by FK Engineering Associates (FKE) with technical assistance provided by TRC. Field activities were preceded by an on-site project kick-off meeting on October 14, 2016 to discuss the project approach and health & safety protocols.

The well drilling consisted of the installation of nine groundwater monitoring wells designated as JRW MW-16001 through JRW MW-16009 and the proper decommissioning of six existing wells previously designated as JRW MW-15007 through JRW MW-15012. The locations of the new and abandoned wells are shown on Drawing SG-22374, Sheet 1, Rev. C.

3.1 Soil/Bedrock Borings

Prior to the start of drilling at each proposed well location, a 5-foot deep hand-augered boring was advanced to verify underground utility clearance by FKE. Then Cascade completed nine (9) soil/bedrock borings using rotosonic-drilling methods to sufficient depth to install monitoring wells in the upper portion of the bedrock aquifer as directed by FKE with technical input from TRC. Rotosonic drilling uses powered equipment to collect subsurface-soil and bedrock samples. The rotosonic drill rig advances a length of pipe into the ground through a combination of hydraulic force and high-frequency vibration. The high-frequency vibrations allow the pipe to advance through various types of soil and bedrock producing a high-quality, continuous soil core within the pipe. Each length of pipe was extracted from the ground and emptied into a clear plastic liner for logging. This process was repeated until the total depth of the boring was reached.

Continuous soil cores were collected during drilling to provide detailed lithological and stratigraphic data. FKE’s on-site engineer inspected each core, classified the contents, and recorded the observations on a boring log field sheet (Appendix A). A photographic log showing the typical soil and bedrock types observed at the Site during soil boring advancement is included as Appendix B. All soil borings were completed as monitoring wells, and details of the monitoring wells installation are provided in the following section.

3.2 Monitoring Well Installation

Once the total depth of each soil/bedrock boring was reached, Cascade installed a permanent monitoring well as directed by FKE with technical input from TRC in the uppermost usable limestone bedrock aquifer unit for completion of monitoring wells. Monitoring wells were
installed through the rotosonic drill rig piping allowing the driller to construct the monitoring well, while simultaneously removing the drill piping. Monitoring wells were constructed with 2-inch inside diameter Schedule 40, polyvinyl chloride (PVC) screens and PVC risers. At each location, the screen tip was positioned at the bottom of the borehole and within the limestone bedrock. Each well screen is 10 feet long except for at monitoring well JRW-MW-16008 which is 5 feet long, and all screens have a slot size of 0.010-inch (10 slot). A medium-grained sand pack was placed around each well screen to a height of at least 4 feet above the top of the well screen, and at least a 3-foot thick bentonite pellet seal was placed on top of the sand pack. The remaining annular space was tremie-grouted with a cement-bentonite grout.

An above-ground, lockable, steel protective cover and a concrete well pad were installed at each monitoring well. In addition, three bollards were installed around the protective covers at each well except at JRW MW-16008, where only two bollards were installed due to limited space. The total well depth and screened interval below the ground surface (bgs) for each monitoring well is shown in Table 1. Well construction logs are included in Appendix A; well locations are shown on Drawing SG-22374, Sheet 1, Rev. C. Wells were labeled according to Consumers Energy’s site-specific nomenclature provided to FKE and TRC. The CE construction manager supplied keyed-alike locks for each well that match the existing well keys.

3.3 Monitoring Well Development

Newly installed monitoring wells were allowed to set for a minimum of 48 hours, after which the wells were developed. Well development was conducted by FKE using air lifting techniques using a tremie pipe to surge and evacuate until the water flowed relatively clear. Following development with the air lifting technique, FKE used a submersible pump and/or air driven pump that was surged across the well screen while groundwater was pumped from the well. During pumping, the evacuated groundwater was monitored for turbidity and pH. Well development continued until the turbidity stabilized under 10 Nephelometric Turbidity Units (NTUs) and pH was stable and below 8.2 pH units at each monitoring well. FKE collected NTU and pH measurements using hand-held monitoring devices. Initially, all the monitoring wells were developed by FKE with a submersible pump that discharged water at a rate of approximately 2 to 2.5 gallons per minute. Wells that had groundwater with a pH reading higher than 8.2 were subsequently further developed by FKE with an air driven pump that was capable of discharging water at 5 to 6 gallons per minute until their pH values stabilized below 8.2 pH units and the turbidity was stabilized to below 10 NTUs.

The volume of groundwater removed during well development, along with the stabilized water level prior to development, and the stabilized turbidity during well development are summarized in Table 1.
3.4 Hydraulic Testing

For single well recovery testing (herein after referred to as “slug testing”) activities, FKE performed four to five slug tests at each of the new monitoring wells. FKE performed each slug test generally by releasing a volume displacement apparatus that induced an immediate water table shift within the well. This resulting water table recovery within the well was monitored using a pressure transducer set to record at 0.25-second intervals, or logarithmic intervals to measure static head, displacement and recovery data. This information was used by FKE to provide an estimate of aquifer hydraulic conductivity (K) in the uppermost portion of the limestone bedrock unit.

The data collected was analyzed by FKE using analytical solutions found in the hydraulic software program AQTESOLV (Version 4.5) using the specific well construction parameters and depth into the limestone unit. The slug test data were evaluated using the confined Hvorslev (1951) and the confined Bouwer and Rice (1976) solutions. The results indicated an estimated hydraulic conductivity range from 3.6 to 11.9 feet per day with an average of 6.9 feet per day. A summary of the results of the hydraulic conductivity tests are presented in Table 2, and full results are included in Appendix C.

3.5 Monitoring Well Decommissioning

Existing wells JRW MW-15007 through JRW MW-15012 located around the perimeter of Pond 6 were decommissioned by Cascade under FKE oversight by first removing the steel vaults and concrete barriers around each well, and then over-drilling using a 6-inch diameter roto-sonic casing. Over-drilling to the full depth of the well was accomplished at all wells except JRW MW-15007 and JRW MW-15008. Following over-drilling and well casing extraction, each borehole was tremie grouted with cement-bentonite to grade. Table 3 summarizes the measured well depth and bentonite plug placement (where applicable) prior to over-drilling, the over-drilling depth, and the amount of well casing recovered during the decommissioning of each well.
Tables
## Table 1
Monitoring Well Construction and Development Summary
Consumers Energy Co.
J.R. Whiting Generating Facility
Erie, Michigan

<table>
<thead>
<tr>
<th>MW ID</th>
<th>Former MW ID</th>
<th>Site Coordinates</th>
<th>Date Installed</th>
<th>Geologic Unit of Screen Interval</th>
<th>Well Construction</th>
<th>Screen Interval (ft bgs)</th>
<th>Static DTW (ft below TOC)</th>
<th>Total Depth</th>
<th>Gallons Removed</th>
<th>Final Turbity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ponds 1 &amp; 2 MW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JRW MW-15001</td>
<td>---</td>
<td>108330.83 13374236.18</td>
<td>10/26/2015</td>
<td>Limestone</td>
<td>2” PVC, 10 slot</td>
<td>10</td>
<td>78 - 89</td>
<td>21.34</td>
<td>91.25</td>
<td>1,450</td>
</tr>
<tr>
<td>JRW MW-15002</td>
<td>---</td>
<td>108651.05 13374586.78</td>
<td>10/26/2015</td>
<td>Limestone</td>
<td>2” PVC, 10 slot</td>
<td>10</td>
<td>81 - 91</td>
<td>21.89</td>
<td>94.39</td>
<td>750</td>
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<tr>
<td>JRW MW-15003</td>
<td>---</td>
<td>108321.86 13374980.23</td>
<td>10/29/2015</td>
<td>Limestone</td>
<td>2” PVC, 10 slot</td>
<td>10</td>
<td>81 - 91</td>
<td>19.87</td>
<td>94.28</td>
<td>412.5</td>
</tr>
<tr>
<td>JRW MW-15004</td>
<td>---</td>
<td>107881.56 13375045.59</td>
<td>10/28/2015</td>
<td>Limestone</td>
<td>2” PVC, 10 slot</td>
<td>10</td>
<td>86 - 96</td>
<td>23.27</td>
<td>99.60</td>
<td>70</td>
</tr>
<tr>
<td>JRW MW-15005</td>
<td>---</td>
<td>107545.15 13374686.90</td>
<td>11/2/2015</td>
<td>Limestone</td>
<td>2” PVC, 10 slot</td>
<td>10</td>
<td>86 - 96</td>
<td>25.28</td>
<td>99.48</td>
<td>114</td>
</tr>
<tr>
<td>JRW MW-15006</td>
<td>---</td>
<td>107843.22 13374281.80</td>
<td>11/4/2015</td>
<td>Limestone</td>
<td>2” PVC, 10 slot</td>
<td>10</td>
<td>81 - 91</td>
<td>25.30</td>
<td>94.36</td>
<td>650</td>
</tr>
</tbody>
</table>

| Pond 6 MW |              |                        |               |                                 |                   |                         |                          |              |                  |                   |
| JRW MW-16001 | ---          | 111255.91 13374012.08  | 10/25/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 71 - 81                  | 17.41        | 83.92            | 780               |
| JRW MW-16002 | ---          | 10463.38 13374460.66   | 10/24/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 81 - 91                  | 13.00        | 94.44            | 480               |
| JRW MW-16003 | ---          | 109667.92 13374452.98  | 10/23/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 73 - 83                  | 14.10        | 85.95            | 700               |
| JRW MW-16004 | ---          | 108834.64 13374076.00  | 10/23/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 75 - 85                  | 14.45        | 88.76            | 1,700             |
| JRW MW-16005 | ---          | 110597.27 13373630.27  | 10/25/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 78 - 88                  | 17.22        | 91.32            | 970               |
| JRW MW-16006 | ---          | 109719.88 13373640.49  | 10/19/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 79 - 89                  | 16.11        | 91.60            | 1,260             |

| Background MW |              |                        |               |                                 |                   |                         |                          |              |                  |                   |
| JRW MW-16007 | ---          | 108397.13 13372561.93  | 10/19/2016    | Limestone                       | 2” PVC, 10 slot   | 10                      | 68 - 78                  | 7.58         | 81.00            | 650               |
| JRW MW-16008 | ---          | 108021.97 13372562.48  | 10/27/2016    | Limestone                       | 2” PVC, 10 slot   | 5                       | 68 - 73                  | 7.93         | 76.23            | 1,900             |
| JRW MW-16009 | ---          | 107653.55 13372573.73  | 10/18/2016    | Limestone                       | 2” PVC, 10 slot   | 5                       | 69 - 79                  | 7.70         | 81.95            | 160               |

| Decommissioned MW |              |                        |               |                                 |                   |                         |                          |              |                  |                   |
| JRW MW-15007 | 82-MW-1      | 109293.21 13373656.23  | 5/4/1982      | Dolomite/Limestone              | 2” SS with galvanized riser | 3                     | 84 - 87                  | Not developed |
| JRW MW-15008 | 82-MW-2      | 110906.21 13373613.03  | 5/4/1982      | Dolomite/Limestone              | 2” SS with galvanized riser | 3                     | 94 - 97                  | Not developed |
| JRW MW-15009 | 79-MW-3      | 109884.39 13374455.32  | 5/4/1982      | Dolomite/Limestone              | 2” SS with galvanized riser | 3                     | 60 - 63                  | Not developed |
| JRW MW-15101 | 93-MW-4      | 110458.57 13373631.59  | 5/4/1982      | Dolomite/Limestone              | 2” SS with galvanized riser | 3                     | 62 - 65                  | Not developed |
| JRW MW-15111 | 93-MW-5      | 109790.80 13373648.04  | 5/4/1982      | Dolomite/Limestone              | 2” SS with galvanized riser | 3                     | 59 - 59                  | Not developed |
| JRW MW-15122 | 93-MW-6      | 110169.45 13374636.62  | 7/1/1993      | Dolomite/Limestone              | 2” SS with galvanized riser | 3                     | 66 - 69                  | Not developed |

Notes:
- ft = feet
- bgs = below ground surface
- TOC = top of casing
- NR = Not recorded
- NA = Not applicable
- msl = mean sea level
<table>
<thead>
<tr>
<th>MONITORING WELL NO.</th>
<th>AVERAGE HYDRAULIC CONDUCTIVITY FROM ANALYTICAL SOLUTIONS (FT/D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JRW MW-16001</td>
<td>4.74</td>
</tr>
<tr>
<td>JRW MW-16002</td>
<td>3.56</td>
</tr>
<tr>
<td>JRW MW-16003</td>
<td>6.09</td>
</tr>
<tr>
<td>JRW MW-16004</td>
<td>4.50</td>
</tr>
<tr>
<td>JRW MW-16005</td>
<td>9.95</td>
</tr>
<tr>
<td>JRW MW-16006</td>
<td>9.41</td>
</tr>
<tr>
<td>JRW MW-16007</td>
<td>3.51</td>
</tr>
<tr>
<td>JRW MW-16008</td>
<td>11.85</td>
</tr>
<tr>
<td>JRW MW-16009</td>
<td>8.63</td>
</tr>
<tr>
<td>Average Pond 6 Wells</td>
<td>6.375</td>
</tr>
<tr>
<td>Average Background Wells</td>
<td>8.00</td>
</tr>
<tr>
<td>Average All Wells</td>
<td>6.92</td>
</tr>
</tbody>
</table>

FT/D = Feet per day.
<table>
<thead>
<tr>
<th>MONITORING WELL NO.</th>
<th>MEASURED WELL DEPTH (FT)</th>
<th>BENTONITE PLUG DEPTH WITHIN WELL (FT) (BEFORE OVER-DRILLING)</th>
<th>OVER-DRILLED DEPTH (FT)</th>
<th>WELL CASING REMOVED (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JRW MW-15007</td>
<td>99.5</td>
<td>99.5 to 93.7</td>
<td>73</td>
<td>11</td>
</tr>
<tr>
<td>JRW MW-15008</td>
<td>110.3</td>
<td>110.3 to 55</td>
<td>53</td>
<td>9</td>
</tr>
<tr>
<td>JRW MW-15009</td>
<td>71.5</td>
<td>71.5 to 66</td>
<td>72</td>
<td>49</td>
</tr>
<tr>
<td>JRW MW-15010</td>
<td>44.0</td>
<td>44 to 37</td>
<td>46</td>
<td>28</td>
</tr>
<tr>
<td>JRW MW-15011</td>
<td>73.3</td>
<td>73.3 to 63</td>
<td>74</td>
<td>44</td>
</tr>
<tr>
<td>JRW MW-15012</td>
<td>73.5</td>
<td>None</td>
<td>74</td>
<td>52</td>
</tr>
</tbody>
</table>
Elevations are NAVD88 from Benchmark (BM) Q 178 per NGS Data Sheet (Not Shown, Approximately 1.1 miles West of Northeast Corner Section 15. On 11-19-2015, a level loop was performed between BM and Control Point (CP) #3081. A second loop was done from CP to Traverse Point (TP) #1918 and to TP #2168. On 11-20-15, a loop was performed utilizing TP #1918 to determine elevations on Monitoring Wells at Top of Pipe on Pond 1 & 2 and TP #1 (not shown). Another loop was performed from TP #2168, determining elevations for MWs and TP #4 & #2 on Pond 6. Ground elevations at base of MW pipe were obtained on 11-10-15 by GPS observation.

2016 Update
On 11-30-16, a level loop was performed from Control Point (CP) #3081 and Monitoring Wells #16007, #16008, and #16009. Another loop was performed from CP #3081 and Monitoring Wells #16004, #16003, #16002, #16001, #16005, and #16006. Both Top of Casing and Ground (Top of Concrete at Base) were included in level loop.

NOTE: Previous Wells #15007 thru #15012 now abandoned/removed or to be abandoned/removed.
Appendix A
Soil Boring and Monitoring Well Construction Logs
SUMMARY OF SOIL NOMENCLATURE

Soils are to be classified by the fraction which has the greatest impact on the engineering behavior. Soils will be described according to a strength or density followed by color then by primary and secondary/tertiary components (i.e. soft gray silty clay or loose brown silty sand). United Soil Classification System (USCS) descriptors (ASTM D2487) may also be used. Soils which exhibit unconfined shear strength will in most cases be described as cohesive soils regardless of their clay content whereas soils without unconfined strength will be described as cohesionless soils.

<table>
<thead>
<tr>
<th>COHESIVE SOIL</th>
<th>COHESIONLESS SOIL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong></td>
<td><strong>Strength</strong></td>
</tr>
<tr>
<td>Unconfined Compressive Strength (psf) (Primary)</td>
<td>Pocket Penetrometer Test (tsf) (Primary)</td>
</tr>
<tr>
<td>Very Soft</td>
<td>0-500</td>
</tr>
<tr>
<td>Soft</td>
<td>500-1000</td>
</tr>
<tr>
<td>Medium</td>
<td>1000-2000</td>
</tr>
<tr>
<td>Stiff</td>
<td>2000-4000</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>4000-8000</td>
</tr>
<tr>
<td>Hard</td>
<td>8000-16000</td>
</tr>
<tr>
<td>Very Hard</td>
<td>&gt;16000</td>
</tr>
</tbody>
</table>

MATERIAL SIZES AND IDENTIFIER GUIDE

- **Gravel**: 3/16 inches (No. 4 Sieve) to 3 inches. Generally rounded rock particles.
- **Coarse Sand**: 3/16 inches to 2 mm (No. 10 Sieve). Grains easily seen.
- **Medium Sand**: 2 mm to 0.425 mm (No. 40 Sieve). Grains can be seen and felt.
- **Fine Sand**: 0.425 mm to 0.075 mm (No. 200 Sieve). Grains can be felt.
- **Silt**: 0.075 mm to 0.005 mm. Easily cracks when rolled. Gritty feel. Dilatant.
- **Clay**: <0.005 mm. Can be rolled. No particle size visible.

SECONDARY/TERTIARY SOIL COMPONENTS

Use secondary components when other than the primary soil appears in significant percentages. Generally the secondary component will compromise between 12 and 30 percent of the total soil weight. Tertiary components would be described as “little” and “trace” when the tertiary components are between 5 and 12 percent and less than 5 percent, respectively. The tertiary components would be inserted after the secondary and primary description (i.e. soft gray silty clay with little gravel and trace sand).

SAMPLE CODES

- **S**: Split Spoon Sample
- **LS**: Split Spoon Sample with Liner
- **BS**: Bag Sample
- **AU**: Auger Sample
- **ST**: Shelby Tube Sample
- **P**: Piston Tube Sample

This system is based on the USCS and MDOT’s Uniform Field Soil Classification System.
SUMMARY OF ROCK NOMENCLATURE

The rock classification system is generally based on FHWA-NHI-01-031 and noted references therein.

ROCK TYPE
Should be classified according to origin into one of the three major groups: igneous, sedimentary, and metamorphic (i.e. Limestone, Shale, etc.)

COLOR
Use basic colors (i.e. brown, gray, etc.) and combinations of colors if applicable (i.e. brown-gray) and the color’s intensity (light, medium, dark).

GRAIN SIZE/SHAPE
Grain size terminology should be based on the following:

- **Very Coarse (VCO)**: Grain sizes greater than popcorn kernels, >1/4 in.
- **Coarse (CO)**: Individual grains can be easily seen by naked eye, 1/4 - 1/8 in.
- **Medium (MD)**: Individual grains can be seen by naked eye, up to 1/8 in.
- **Fine (FN)**: Individual grains can be barely seen by naked eye
- **Amorphous (AM)**: Individual grains cannot be seen by naked eye

In addition, the shape of the grains should be used when applicable (i.e. rounded, sharp, etc.).

STRATIFICATION/BEDDING
Stratification features should be described according to the following:

- **Very Thick (VTH)**: >3 feet or not visible
- **Thick (TH)**: 1-3 feet
- **Medium (M)**: 2 - 12 in.
- **Thin (TN)**: 1/2 - 2 in.
- **Very Thin (VTN)**: 1/4 - 1/2 in.
- **Laminated (LAM)**: >1/4 in.

In addition if layers are angled make note with respect to the horizontal.

WEATHERING/ALTERATION
Weathering is physical disintegration due to atmospheric processes; while alteration is due to geothermal processes. Terms and abbreviations should be used according to the following:

- **Fresh (FR)**: No discoloration or any other effect of weathering/alteration.
- **Slight (SL)**: Slightly discolored with little to no effect on strength.
- **Moderate (MOD)**: Discolored and is in a weakened state but less than half is decomposed. Large sample cannot be broken by hand.
- **High (HI)**: More than half is decomposed. Large sample can be broken by hand.
- **Complete (CPL)**: Almost completely decomposed with some original fabric intact.
- **Residual Soil (RS)**: Completely decomposed with no original rock fabric left. Can be easily broken by hand.
DISCONTINUITIES

Rock discontinuities are breaks or fractures separating the rock and should be classified according to the following:

**Type**
- Crack (C)  An incomplete fracture
- Joint (J)  A fracture with little to no visible displacement
- Shear (S)  A fracture with visible displacement that may have slickness or is polished
- Fault (F)  A major fracture with major displacement with possible clayey gouge

**Spacing**
- Very Wide (VW)  3 - 1 feet
- Wide (W)  1 - 0.5 feet
- Open (O)  6-4 in.
- Tight (TG)  4-2 in.
- Very Tight (VTG)  < 2 in.

**Orientation**
- Horizontal (H)  0 - 5 degrees
- Low Angle (LA)  5 - 30 degrees
- Moderate Angle (MA)  30 - 60 degrees
- Steep Angle (SA)  60 - 85 degrees
- Vertical (V)  85 - 90 degrees

**Surface Texture**
- Slickened (SLK)  Surface has smooth, glassy finish with visual evidence of striations
- Smooth (SM)  Surface appears smooth and feels so to the touch
- Slightly Rough (SR)  Asperities on the discontinuity surface are distinguishable and can be felt
- Rough (R)  Some ridges and side-angle steps are evident: asperities are clearly visible and discontinuity surface feels very abrasive
- Very Rough (VR)  Near vertical steps and ridges occur on the discontinuity surface

**Infilling**
- Surface Stain (Su)  Clay (Cl)
- Spotty (Sp)  Calcite (Ca)
- Partially Filled (Pa)  Chlorite (Ch)
- Filled (Fi)  Iron Oxide (Fe)
- None (No)  Gypsum/Talc (Gy)
- Healed (H)
- None (No)
- Pyrite (Py)
- Quartz (Qz)
- Sand (Sd)
HARDNESS
Should be assessed by a scratch test with terms and abbreviations according to the following:

- **Soft (SO)**: Reserved for plastic material only.
- **Friable (FRI)**: Easily crumbled by hand and is too soft to be cut with a pocket knife.
- **Low Hardness (LH)**: Can be gouged deeply or carved with a pocket knife.
- **Moderately Hard (MH)**: Can be readily scratched by a knife blade. Scratch leaves a heavy trace of dust and scratch is readily visible after powder is blown away.
- **Hard (HD)**: Can be scratched with difficulty. Scratch produces little powder and is often faintly visible. Traces of the knife steel may be visible.
- **Very Hard (VHD)**: Cannot be scratched with a pocket knife.

DEFECTS
The following descriptions can be described as few, occasional, or frequent:

- **Fossil (FOS)**: Preserved remain or trace of animals, plants, and other organisms from the distant past.
- **Pit**: <3/16 inch
- **Vug**: >3/16 inch and <2 inches
- **Cavity (Cav)**: >2 inches
- **Carbonaceous Band (CB)**: Black carbon styolitic deposit than can be straight or wavy
- **Solution Feature (SF)**: Features formed by water and acids dissolving calcium carbonate sedimentary rock

The following descriptions can be described as light, moderate, or dense:

- **Hydrocarbon Staining (HCS)**: Staining due to petroleum products being released from the rock

ROCK RECOVERY
Rock recovery is defined as:

\[
Recovery (\%) = 100 \times \frac{\text{Length of Core Recovered}}{\text{Length of Core Run}}
\]

ROCK QUALITY DESIGNATION (RQD)
RQD is defined as:

\[
RQD (\%) = 100 \times \frac{\text{Length of Core Recovered > 4 inches}}{\text{Length of Core Run}}
\]
Total Depth: 81.0 ft
Drilling Date: 10/25/2016
Inspector: N. Bassett, P.E.
Contractor: Cascade Drilling
Driller: L. Young
Equipment: 6007 Truck-Mount
Casing Diameter: 2 in
Casing Length: 71 ft
Casing Type: PVC (SCH 40)
Screen Diameter: 2 in
Screen Length: 10 ft
Screen Mesh: 2 in
Screen Type: 0.01 in Slotted PVC
Protective Casing: 3 ft 2 in Stick-Up

Notes:
1) *Denotes Pocket Penetrometer Value
2) **Indicates Clay rich sample packaged for hydraulic permeability testing.
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.
## Subsurface Profile

### Ground Surface
- **Elevation:** 589.2 ft

### Soil Sample Data

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Run Number</th>
<th>Recovery (%)</th>
<th>Sample Type/No.</th>
<th>Unconfin. Comp St (psf)</th>
<th>Detail</th>
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<tbody>
<tr>
<td>530.2</td>
<td>Run #6</td>
<td>100</td>
<td>BS-11</td>
<td>&gt;9000*</td>
<td></td>
</tr>
<tr>
<td>523.2</td>
<td>Run #7</td>
<td>100</td>
<td>BS-12</td>
<td>&gt;9000*</td>
<td></td>
</tr>
<tr>
<td>516.2</td>
<td>Run #8</td>
<td>50</td>
<td>BS-13</td>
<td>&gt;9000*</td>
<td></td>
</tr>
<tr>
<td>510.2</td>
<td>Run #9</td>
<td>67</td>
<td>BS-14</td>
<td>-</td>
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</tr>
<tr>
<td>508.2</td>
<td></td>
<td></td>
<td>BS-15</td>
<td>-</td>
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<tr>
<td>500.2</td>
<td></td>
<td></td>
<td>BS-16</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

### Installation Schematic

- **Top of Casing**
  - **Elevation:** 592.3 ft
  - **Depth:** 60 ft
- **Cement Grout**
  - 64.0 ft
  - 67.0 ft
- **Bentonite Pellets**
- **Filter Sand**
  - 70 ft
  - 71.0 ft
- **End of Boring**
  - 81.0 ft

---

**Note:**
- **Hard to Very Hard**
  - Gray SILTY CLAY with trace sand and gravel (brittle, breaks into small fragments) (MH–CH)

---

**Project Information**

- **Project Name:** J.R. Whiting Observation Wells
- **Project Location:** J.R. Whiting Generating Facility, Erie, MI
- **Project No:** 16–085
- **Checked By:** Z. Carr, P.E.
### Monitor Well JRW MW-16003

**Project Name:** J.R. Whiting Observation Wells  
**Project Location:** J.R. Whiting Generating Facility, Erie, MI

#### Subsurface Profile

<table>
<thead>
<tr>
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<th>PROF.</th>
<th>GROUND SURFACE ELEVATION: 586.2</th>
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<tbody>
<tr>
<td>584.2</td>
<td>FILL: Brown SILTY CLAY with Organic Material (MH-CH)</td>
<td>2.0</td>
</tr>
<tr>
<td>580</td>
<td>FILL: BOTTOM ASH and FLY ASH (clay drain tile fragment at 4 ft)</td>
<td>10</td>
</tr>
<tr>
<td>570</td>
<td>Stiff to Very Stiff Brown SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>20.0</td>
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<tr>
<td>560</td>
<td>Medium Brown SILTY CLAY with Trace Sand (MH-CH)</td>
<td>30</td>
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<tr>
<td>550</td>
<td>Stiff to Very Stiff Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>40</td>
</tr>
<tr>
<td>543.7</td>
<td>Hard to Very Hard Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>50</td>
</tr>
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#### Soil Sample Data

<table>
<thead>
<tr>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST. (psi)</th>
<th>DETAIL</th>
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<tbody>
<tr>
<td>RUN #1</td>
<td>100</td>
<td>BS-1</td>
<td>-</td>
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<tr>
<td>RUN #2</td>
<td>100</td>
<td>BS-2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>RUN #3</td>
<td>100</td>
<td>BS-3</td>
<td>4000*</td>
<td></td>
</tr>
<tr>
<td>RUN #4</td>
<td>100</td>
<td>BS-4A</td>
<td>1000*</td>
<td></td>
</tr>
<tr>
<td>RUN #5</td>
<td>100</td>
<td>BS-4B</td>
<td>4000*</td>
<td></td>
</tr>
<tr>
<td>RUN #6</td>
<td>100</td>
<td>BS-4C**</td>
<td>&gt;9000*</td>
<td></td>
</tr>
</tbody>
</table>

#### Installation Schematic

- 2 ft 10 in Stick-Up

---

**Total Depth:** 85.0 ft  
**Drilling Date:** 10/23/2016  
**Inspector:** J. Elsey  
**Contractor:** Cascade Drilling  
**Driller:** I. Young  
**Equipment:** 6000 Truck-Mount  
**Casing Diameter:** 2 in  
**Casing Length:** 75 ft  
**Casing Type:** PVC (SCH 40)  
**Screen Diameter:** 2 in  
**Screen Length:** 10 ft  
**Screen Mesh:** 2 in  
**Screen Type:** 0.01 in Slotted PVC

**Protective Casing:** 2 ft 10 in Stick-Up  
**Coordinates:** Northing-109687.92 Easting-1337452.98

**Notes:**
1) * - Denotes Pocket Penetrometer Value  
2) ** - Indicates Clay rich sample packaged for hydraulic permeability testing.  
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.
<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE</th>
<th>ELEVATION: 586.2</th>
<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST (psi)</th>
<th>DETAIL</th>
<th>TOP OF CASING ELEVATION: 589.0</th>
<th>DEPTH (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>530</td>
<td></td>
<td>533.7 Very Stiff Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>52.6</td>
<td>60</td>
<td>Run #6</td>
<td>100</td>
<td>BS-5</td>
<td>7000*</td>
<td></td>
<td>TREMIED CEMENT GROUT</td>
<td>60</td>
</tr>
<tr>
<td>522.2</td>
<td></td>
<td>Hard to Very Hard Gray SILTY CLAY with Trace Sand, Gravel (possible cobbles/boulders) (MH-CH)</td>
<td>64.0</td>
<td>Run #7</td>
<td>100</td>
<td>BS-5A</td>
<td>&gt;9000*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>520</td>
<td></td>
<td>520.2 SANDY CLAY with Little Gravel (CH-SC)</td>
<td>66.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BENTONITE PELLETS</td>
<td>69.0</td>
</tr>
<tr>
<td>516.2</td>
<td></td>
<td>Hard to Very Hard Gray SILTY CLAY with Little Gravel and (possible cobbles/boulders) (MH-CH)</td>
<td>70.0</td>
<td>Run #8</td>
<td>100</td>
<td>BS-7</td>
<td>&gt;9000*</td>
<td></td>
<td></td>
<td>FILTER SAND</td>
<td>73.0</td>
</tr>
<tr>
<td>510</td>
<td></td>
<td>LIMESTONE (sand seam at 82 ft) (odoriferous &amp; reacted with HCL)</td>
<td>80</td>
<td>Run #9</td>
<td>40</td>
<td>BS-11</td>
<td>-</td>
<td></td>
<td></td>
<td>END OF BORING</td>
<td>83.0</td>
</tr>
<tr>
<td>500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>
**SUBSURFACE PROFILE**

<table>
<thead>
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<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 586.5</th>
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</thead>
<tbody>
<tr>
<td>585.0</td>
<td>FILL: Black SILTY CLAY with Organic Material (Mh-CH)</td>
<td>1.5</td>
</tr>
<tr>
<td>580</td>
<td>FILL: Black FLY ASH</td>
<td></td>
</tr>
<tr>
<td>574.5</td>
<td>Very Stiff Brown SILTY CLAY with Trace Sand and Gravel (Mh-CH)</td>
<td>12.0</td>
</tr>
<tr>
<td>570</td>
<td>Stiff Brown SILTY CLAY with Trace Sand and Gravel (Mh-CH)</td>
<td>16.0</td>
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<tr>
<td>560.5</td>
<td>Stiff Gray SILTY CLAY with Trace Gravel (Mh-CH)</td>
<td>26.0</td>
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<td>554.0</td>
<td>Very Stiff Gray SILTY CLAY with Trace Gravel (Mh-CH)</td>
<td>32.5</td>
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<tr>
<td>551.0</td>
<td>Hard to Very Hard Gray SILTY CLAY with Trace Gravel (Mh-CH)</td>
<td>35.5</td>
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<tr>
<td>546.5</td>
<td>Very Stiff Gray SILTY CLAY with Trace Gravel (Mh-CH)</td>
<td>40.0</td>
</tr>
<tr>
<td>545.5</td>
<td>Hard to Very Hard Gray SILTY CLAY with Trace Gravel (possible cobbles/boulders below 54 ft)</td>
<td>41.0</td>
</tr>
<tr>
<td>540</td>
<td></td>
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</tr>
</tbody>
</table>

**TOTAL DEPTH:** 85.0 ft

**NOTES:**
1) * - Denotes Pocket Penetrometer Value
2) ** - Indicates Clay rich sample packaged for hydraulic permeability testing.
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.

**INSTALLATION SCHEMATIC**
- 2 ft 10 in Stick-Up
- TREMED CEMENT GROUT

**Casing Information:**
- Diameter: 2 in
- Length: 75 ft
- Type: PVC (SCH 40)
- Screen Diameter: 2 in
- Screen Length: 10 ft
- Screen Mesh: 2 in
- Screen Type: 0.01 in Slotted PVC

**Protective Casing:** 2 ft 10 In Stick-Up
NO: JRW MW-16004

Project Name: J.R. Whiting Observation Wells
Project Location: J.R. Whiting Generating Facility, Erie, MI

FK Engineering Associates
Project No: 16-085
Checked By: Z. Carr, P.E.

SUBSURFACE PROFILE

<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>PROFILE GROUND SURFACE ELEVATION: 586.5</th>
<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP ST (psi)</th>
<th>DETAIL</th>
<th>TOP OF CASING ELEVATION: 589.4</th>
<th>DEPTH (FT)</th>
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</thead>
<tbody>
<tr>
<td>530</td>
<td>Hard to Very Hard Gray Silty Clay with Trace Gravel (possible cobbles/boulders below 54 ft) (MH-CH)</td>
<td>60</td>
<td>RUN #6</td>
<td>100</td>
<td>BS-7</td>
<td>8000*</td>
<td>TREMIED CEMENT GROUT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>523.5</td>
<td>Very Shff Silty Clay with Trace Gravel (possible cobbles/boulders) (MH-CH)</td>
<td>63.0</td>
<td>RUN #7</td>
<td>100</td>
<td>BS-8</td>
<td>&gt;9000*</td>
<td></td>
<td>BENTONITE PELLETS</td>
<td>67.0</td>
</tr>
<tr>
<td>520</td>
<td>LIMESTONE (reacted to HCL)</td>
<td>70</td>
<td>RUN #8</td>
<td>100</td>
<td>BS-9</td>
<td>6000*</td>
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<td>FILTER SAND</td>
<td>75.0</td>
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<tr>
<td>517.5</td>
<td></td>
<td>70</td>
<td>RUN #9</td>
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<td>END OF BORING</td>
<td>85.0</td>
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<tr>
<td>501.5</td>
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<td></td>
<td></td>
<td>BS-11</td>
<td>-</td>
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</tbody>
</table>

500

490

480
Total Depth: 88.0 ft
Drilling Date: 10/25/2016
Inspector: R. Bassett, P.E.
Contractor: Cascade Drilling
Driller: I. Young
Equipment: 6007 Truck-Mount

Notes:
1) * Denotes Pocket Penetrometer Value
2) ** Indicates Clay rich sample packaged for hydraulic permeability testing.
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.
## Subsurface Profile

<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 589.3</th>
<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST (psi)</th>
<th>DETAIL</th>
<th>TOP OF CASING ELEVATION: 592.1</th>
<th>DEPTH (FT)</th>
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<td>530</td>
<td></td>
<td></td>
<td>60</td>
<td>run #6</td>
<td>100</td>
<td>BS-9</td>
<td>&gt;9000*</td>
<td></td>
<td>TREMIE CEMENT GROUT</td>
<td>60</td>
</tr>
<tr>
<td>522.3</td>
<td></td>
<td></td>
<td>67.0</td>
<td>run #7</td>
<td>100</td>
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<td>-</td>
<td></td>
<td></td>
<td>66.0</td>
</tr>
<tr>
<td>520.8</td>
<td></td>
<td>Very Hard SANDY CLAY/CLAYEY</td>
<td>68.5</td>
<td>run #8</td>
<td>50</td>
<td>BS-11</td>
<td>-</td>
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<td>BENTONITE PELLETS</td>
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<tr>
<td>516.3</td>
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<td>INTERFACE ZONE: FRAGMENTED ROCK</td>
<td>73.0</td>
<td>run #9</td>
<td>50</td>
<td>BS-12</td>
<td>-</td>
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<td>FILTER SAND</td>
<td>72.0</td>
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<tr>
<td>510</td>
<td></td>
<td>LIMESTONE (odoriferous &amp; reacted with HCL)</td>
<td>80</td>
<td>run #10</td>
<td>50</td>
<td>BS-13</td>
<td>-</td>
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<td></td>
<td></td>
<td>BS-14</td>
<td>-</td>
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<td>END OF BORING</td>
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**Monitoring Well JRW MW-16006**

**Project Name:** J.R. Whiting Observation Wells  
**Project Location:** J.R. Whiting Generating Facility, Erie, MI

---

### Subsurface Profile

<table>
<thead>
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<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 588.3</th>
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<tbody>
<tr>
<td>586.8</td>
<td>FILL: Brown SILTY CLAY with Trace Sand and Organic Material (MH-CH)</td>
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</tr>
<tr>
<td>580</td>
<td>FILL: Black FLY ASH with Trace Clay and Organic Material</td>
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</tr>
<tr>
<td>573.3</td>
<td>Stiff to Very Stiff Brown and Gray SILTY CLAY with Trace Gravel (MH-CH)</td>
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</tr>
<tr>
<td>570</td>
<td>Stiff Gray SILTY CLAY with Trace Gravel (MH-CH)</td>
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</tr>
<tr>
<td>561.3</td>
<td>Very Stiff Gray SILTY CLAY with Trace Gravel (MH-Cit)</td>
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<tr>
<td>547.3</td>
<td>Hard Gray SILTY CLAY with Trace Gravel (MH-Cit)</td>
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<tr>
<td>540</td>
<td>Gray Alternating Layers of SILT and SAND (ML-SM)</td>
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### Soil Sample Data

<table>
<thead>
<tr>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST. (psf)</th>
<th>DETAIL</th>
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<tbody>
<tr>
<td>RUN #1</td>
<td>100</td>
<td>BS-1</td>
<td>-</td>
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<tr>
<td>RUN #2</td>
<td>100</td>
<td>BS-2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>RUN #3</td>
<td>100</td>
<td>BS-3</td>
<td>5000*</td>
<td></td>
</tr>
<tr>
<td>RUN #4</td>
<td>100</td>
<td>BS-4</td>
<td>4000*</td>
<td></td>
</tr>
<tr>
<td>RUN #5</td>
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<tr>
<td>RUN #6</td>
<td>100</td>
<td>BS-6</td>
<td>3000*</td>
<td></td>
</tr>
</tbody>
</table>

### Installation Schematic

- **TOP OF CASING ELEVATION: 591.0**
- 2 ft 9 in Stick-Up

---

**Notes:**
1) * Denotes Pocket Penetrometer Value  
2) ** Indicates Clay rich sample packaged for hydraulic permeability testing.  
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.

---

**Total Depth:** 89.0 ft  
**Drilling Date:** 10/19/2016  
**Inspector:** N. Bassett, P.E.  
**Contractor:** Cascade Drilling  
**Driller:** L. Young  
**Equipment:** 600T Truck-Mount  

**Casing Diameter:** 2 in  
**Casing Length:** 79 ft  
**Casing Type:** PVC (SCH 40)  
**Screen Diameter:** 2 in  
**Screen Length:** 10 ft  
**Screen Mesh:** 2 in  
**Screen Type:** 0.01 in Slotted PVC

**Protective Casing:** 2 ft 9 in Stick-Up  
**Coordinates:** Northing-109719.88 Easting-13373640.49

**FIGURE NO. 8**
### Subsurface Profile

- **Elevation:** 579.5

<table>
<thead>
<tr>
<th>ELV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE</th>
<th>DEPTH (FT)</th>
<th>RECOVERY (%)</th>
<th>RUN NUMBER</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST (psi)</th>
<th>DETAIL</th>
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<td>TOPOSOIL</td>
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<td>0.5</td>
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<tr>
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<td>STIFF BROWN SILTY CLAY with Trace Organic Material (MH–CH)</td>
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<td>100</td>
<td>RUN #2</td>
<td>BS-2</td>
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<td>572.5</td>
<td>BROWN SILTY SAND (SM)</td>
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<td></td>
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<tr>
<td>570</td>
<td>MEDIUM TO STIFF BROWN and GRAY SILTY CLAY with Trace Gravel (MH–CH)</td>
<td>10</td>
<td>100</td>
<td>RUN #3</td>
<td>BS-3</td>
<td>3000*</td>
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<td>16.0</td>
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<td>RUN #4</td>
<td>BS-4</td>
<td>3000*</td>
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<tr>
<td>560</td>
<td>STIFF to VERY STIFF BROWN SILTY CLAY with Trace Gravel (MH–CH)</td>
<td>20</td>
<td>100</td>
<td>RUN #5</td>
<td>BS-5**</td>
<td>&gt;9000**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>555.5</td>
<td></td>
<td></td>
<td>26.0</td>
<td></td>
<td>RUN #6</td>
<td>BS-6</td>
<td>–</td>
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<tr>
<td>550</td>
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<td></td>
<td>30</td>
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<td>RUN #7</td>
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<tr>
<td>546.5</td>
<td>HARD GRAY SILTY CLAY with Trace Gravel (2 INCH SAND SEAM AT 39.5&quot;) (MH–CH)</td>
<td>33.0</td>
<td>100</td>
<td>RUN #8</td>
<td>BS-8</td>
<td>–</td>
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<td>36.0</td>
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<td>RUN #9</td>
<td>BS-9</td>
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<td>540</td>
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<td></td>
<td>40</td>
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<td>RUN #10</td>
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<td>535.0</td>
<td></td>
<td></td>
<td>44.5</td>
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<td>534.5</td>
<td></td>
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<td>45.0</td>
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<td>50</td>
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</table>

**Total Depth:** 78.3 ft

**Notes:**
1) * -- Denotes Pocket Penetrometer Value
2) ** -- Indicates Clay rich sample packaged for hydraulic permeability testing.
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.
4) Driller noted continuous loss of drilling wash water during Run #8.
Monitoring Well JRW MW-16008

Project Name: J.R. Whiting Observation Wells
Project Location: J.R. Whiting Generating Facility, Erie, MI

FK Engineering Associates
Project No: 16-085
Checked By: Z. Carr, P.E.

<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 580.0</th>
<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST. (psi)</th>
<th>DETAIL</th>
<th>INSTALLATION SCHEMATIC</th>
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<tbody>
<tr>
<td>580</td>
<td></td>
<td>579.0 Fill: Gravel Base Material</td>
<td>1.0</td>
<td>Run #1</td>
<td>90</td>
<td>BS-1A</td>
<td>500*</td>
<td></td>
<td>2 ft 10 in Stick-Up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>578.0 Fill: Very Stiff to Hard Brown SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>4.0</td>
<td></td>
<td></td>
<td>BS-1B</td>
<td>500*</td>
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<tr>
<td></td>
<td></td>
<td>Fill: Medium Brown and Gray SILTY CLAY with Little Fly Ash and Trace Sand and Gravel (sand seam at 9 ft) (MH-CH)</td>
<td>10.0</td>
<td>Run #2</td>
<td>100</td>
<td>BS-2</td>
<td>500*</td>
<td></td>
<td></td>
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<tr>
<td>550</td>
<td></td>
<td>559.5 Soft to Medium Medium Brown and Gray SILTY CLAY (gravel seam at 16.5 ft) (MH-CH)</td>
<td>20.5</td>
<td>Run #3</td>
<td>100</td>
<td>BS-3</td>
<td>1000*</td>
<td>TREMIED CEMENT GROUT</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>550.0 Medium Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>30.0</td>
<td>Run #4</td>
<td>100</td>
<td>BS-4</td>
<td>2000*</td>
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<tr>
<td></td>
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<td>545.5 Very Stiff Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>35.0</td>
<td>Run #5</td>
<td>100</td>
<td>BS-5</td>
<td>&gt;9000*</td>
<td>BENTONITE CHIPS</td>
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<tr>
<td></td>
<td></td>
<td>540.0 Hard to Very Hard Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>40.0</td>
<td></td>
<td></td>
<td>BS-6</td>
<td>&gt;9000*</td>
<td></td>
<td></td>
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<tr>
<td></td>
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<td>530.0 Total Depth: 75.0 ft</td>
<td>50.0</td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Notes:
1) * — Denotes Pocket Penetrometer Value
2) ** — Indicates Clay rich sample packaged for hydraulic permeability testing.
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.
4) During well construction, first bentonite chips added up to 57 ft bgs, then approx. 60 gallons of grout was added. Grout was lost around well casing, so additional Bentonite chips were added to 40 ft bgs followed by cement grout up to grade.

Total Depth: 75.0 ft
Drilling Date: 10/27/2016
Inspector: J. Estey
Contractor: Cascade Drilling
Driller: R. Addison
Equipment: 200C Compact Size Track-Mount
Casing Diameter: 2 in
Casing Length: 68 ft
Casing Type: PVC (SCH 40)
Screen Diameter: 2 in
Screen Length: 5 ft
Screen Mesh: 2 in
Screen Type: 0.01 in Slotted PVC
Protective Casing: 2 ft 10 in Stick-Up

W S H

Coordinates: Northing-108021.97 Easting-13372562.48

FIGURE NO. 10
SUBSURFACE PROFILE

GROUND SURFACE ELEVATION: 580.0

<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST (psi)</th>
<th>DETAIL</th>
<th>TOP OF CASING ELEVATION: 582.8</th>
<th>DEPTH (FT)</th>
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<tbody>
<tr>
<td>530</td>
<td></td>
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<td></td>
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<tr>
<td>525.0</td>
<td>Hard to Very Hard Gray SILTY CLAY with Trace Sand and Gravel (MH-CH)</td>
<td>55.0</td>
<td>RUN #6</td>
<td>100</td>
<td>BS-7</td>
<td>-</td>
<td>BENTONITE CHIPS</td>
<td>61.0</td>
<td>60</td>
</tr>
<tr>
<td>521.5</td>
<td>Very Hard Gray SANDY CLAY/CLAYEY SAND (Cl-SC)</td>
<td>58.5</td>
<td>RUN #7</td>
<td>80</td>
<td>BS-8</td>
<td>-</td>
<td>FILTER SAND</td>
<td>68.0</td>
<td>70</td>
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<tr>
<td>517.5</td>
<td>INTERFACE ZONE: FRAGMENTED ROCK with Silty Clay and Sand (alimentary)</td>
<td>62.5</td>
<td>RUN #8</td>
<td>50</td>
<td>BS-9</td>
<td>-</td>
<td></td>
<td>73.0</td>
<td>75.0</td>
</tr>
<tr>
<td>510</td>
<td>LIMESTONE (reacted to HCL)</td>
<td>70</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>505.0</td>
<td></td>
<td>75.0</td>
<td></td>
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500

490

480

470
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<th>ELEV. (FT)</th>
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<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP. ST. (psf)</th>
<th>DETAIL</th>
<th>TOP OF CASING ELEVATION: 582.8</th>
<th>DEPTH (FT)</th>
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<tbody>
<tr>
<td>570</td>
<td></td>
<td>FILL: Brown SILTY CLAY and Organic Material (MH-CH)</td>
<td>573.9</td>
<td>RUN #1</td>
<td>100</td>
<td>BS-1</td>
<td>8000*</td>
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<td>2 ft 8 in Stick-Up</td>
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<td>571.4</td>
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<td>FILL: Brown SILTY CLAY and FLY ASH mix</td>
<td>571.4</td>
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<td></td>
<td>BS-2</td>
<td>6000*</td>
<td></td>
<td></td>
<td>2</td>
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<tr>
<td>560</td>
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<td>Soft to Medium Brown SILTY CLAY (MH-CH)</td>
<td>564.9</td>
<td>RUN #2</td>
<td>100</td>
<td>BS-3</td>
<td>--</td>
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<td></td>
<td>10</td>
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<td>563.9</td>
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<td>MEDIUM TO STIFF BROWN SILTY CLAY (MH-CH)</td>
<td>563.9</td>
<td>RUN #3</td>
<td>100</td>
<td>BS-4</td>
<td>2000*</td>
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<td>TRENCH CEMENT GROUT</td>
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<td>555.9</td>
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<td>MEDIUM TO STIFF GRAY SILTY CLAY with Trace Gravel (MH-CH)</td>
<td>555.9</td>
<td>RUN #4</td>
<td>100</td>
<td>BS-5</td>
<td>2000*</td>
<td></td>
<td></td>
<td>30</td>
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<td>VERY STIFF GRAY SILTY CLAY with Trace Gravel (MH-CH)</td>
<td>548.9</td>
<td>RUN #5</td>
<td>100</td>
<td>BS-6</td>
<td>5000*</td>
<td></td>
<td></td>
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<td>545.9</td>
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<td>HARD GRAY SILTY CLAY with Trace Gravel (MH-CH)</td>
<td>545.9</td>
<td>RUN #6</td>
<td>100</td>
<td>BS-7</td>
<td>&gt;9000*</td>
<td></td>
<td></td>
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<tr>
<td>538.9</td>
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<td>GRAY SILTY SAND (SM) with Trace Gravel (MH-CH) at 45 ft</td>
<td>538.9</td>
<td></td>
<td></td>
<td>BS-8</td>
<td>&gt;9000*</td>
<td></td>
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<td>536.4</td>
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<td>HARD GRAY SILTY CLAY with Trace Gravel (MH-CH)</td>
<td>536.4</td>
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<td></td>
<td>BS-9</td>
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<td></td>
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<tr>
<td>533.9</td>
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<td>GRAY SAND (SP) with Trace Gravel (MH-CH)</td>
<td>533.9</td>
<td></td>
<td></td>
<td>BS-10</td>
<td>--</td>
<td></td>
<td></td>
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</table>

Total Depth: 79.0 ft

Notes:
1) * - Denotes Pocket Penetrometer Value
2) ** - Indicates Clay rich sample packaged for hydraulic permeability testing.
3) No groundwater observations made during or upon completion of drilling due to water added during drilling.
4) Driller advanced Run #9 without water due to plugging issues.
<table>
<thead>
<tr>
<th>ELEV. (FT)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 579.9</th>
<th>DEPTH (FT)</th>
<th>RUN NUMBER</th>
<th>RECOVERY (%)</th>
<th>SAMPLE TYPE/NO.</th>
<th>UNCONF. COMP ST (psf)</th>
<th>DETAIL</th>
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<th>DEPTH (FT)</th>
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<tr>
<td>520</td>
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<td>Hard Gray SILTY CLAY with Trace Gravel with Sand and Silt Seams (MH–CH)</td>
<td>523.9</td>
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<td>100</td>
<td>BS-11</td>
<td>&gt;9000*</td>
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<td>TREMIED CEMENT GROUT</td>
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<tr>
<td>514.4</td>
<td>INTERFACE ZONE: FRAGMENTED ROCK with Silty Clay</td>
<td>60</td>
<td>RUN #7</td>
<td>75</td>
<td>BS-12</td>
<td>6000*</td>
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</tr>
<tr>
<td>510</td>
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<td></td>
<td>510</td>
<td>RUN #8</td>
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<td>BS-13</td>
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<td>BENTONITE PELLETS</td>
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<td>RUN #10</td>
<td>100</td>
<td>BS-19</td>
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<td>END OF BORING</td>
<td>79.0</td>
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*Additional details such as soil type and properties are not transcribed due to the graphical representation.
LOG OF HAND AUGER BORING NO: HAB-1

Project Name: J.R. Whiting Well Installation
Project Location: J. R. Whiting Generating Facility, Erie, Michigan

SUBSURFACE PROFILE

SOIL SAMPLE DATA

<table>
<thead>
<tr>
<th>ELEV. (ft)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 589.2</th>
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<tr>
<td>589</td>
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<tr>
<td>588</td>
<td></td>
<td>FILL: Brown SILTY CLAY with Trace Organic Material</td>
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<tr>
<td>587</td>
<td></td>
<td>BS-1 - - - - -</td>
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<tr>
<td>586</td>
<td></td>
<td>1 BS-2 - - - - -</td>
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<tr>
<td>585</td>
<td></td>
<td>2 BS-3 - - - - -</td>
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<tr>
<td>584</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>584.2</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>END OF BORING</td>
<td>5 BS-4 - - - - -</td>
<td></td>
</tr>
</tbody>
</table>

Total Depth: 5 FT
Drilling Date: 10/19/16
Inspector: J. Elsey

Drilling Method: 4-inch diameter bucket-type hand auger.

Plugging Procedure: Borehole backfilled with soil cuttings to prevailing grade.

Water Level Observation: No groundwater encountered during or upon completion of drilling.

Notes: 1) Drilled to clear boring location for the sonic drilling of JRW MW-16001.
**LOG OF HAND AUGER BORING NO: HAB-2**

**Project Name:** J.R. Whiting Well Installation  
**Project Location:** J. R. Whiting Generating Facility, Erie, Michigan

**SOIL SAMPLE DATA**

| ELEV. (ft) | PROFILE | GROUND SURFACE ELEVATION:  
| 585.8 |

| FILL: Brown SILTY CLAY with Trace Organic Material |

<table>
<thead>
<tr>
<th>DEPTH (ft)</th>
<th>SAMPLE NO.</th>
<th>HOUSEHOLD TESTS (Blows/6 inches)</th>
<th>MOIST. CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
<th>UNCONF. COMP ST (PSF)</th>
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</table>

| FILL: Gray BOTTOM/ FLY ASH with Occasional Clay Seams |

| 583        | 2          |                                 |                   |                  |                     |
| 582        | 3          |                                 |                   |                  |                     |
| 581        | 4          |                                 |                   |                  |                     |
| 580.8      | 5          |                                 |                   |                  |                     |

**END OF BORING**

**Total Depth:** 5 FT  
**Drilling Date:** 10/21/16  
**Inspector:** N. Bassett, P.E.

**Drilling Method:** 4-inch diameter bucket-type hand auger.

**Plugging Procedure:** Borehole backfilled with soil cuttings to prevailing grade.

**Water Level Observation:** No groundwater encountered during or upon completion of drilling.

**Notes:** 1) Drilled to clear boring location for the sonic drilling of JRW MW-16002.

**GPS Coordinates:**

---

**Figure No. 13**
## LOG OF HAND AUGER BORING NO: HAB-3

**Project Name:** J.R. Whiting Well Installation  
**Project Location:** J. R. Whiting Generating Facility, Erie, Michigan

### SUBSURFACE PROFILE

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<thead>
<tr>
<th>ELEV (ft)</th>
<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 586.2</th>
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</thead>
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<td>586</td>
<td></td>
<td>FILL: Brown SILTY CLAY with Trace Organic Material</td>
</tr>
<tr>
<td>585</td>
<td></td>
<td>FILL: Brown SILTY CLAY with Little Fly Ash</td>
</tr>
<tr>
<td>584</td>
<td></td>
<td>FILL: Gray FLY ASH and BOTTOM ASH (bottom ash increases with depth)</td>
</tr>
<tr>
<td>583</td>
<td></td>
<td></td>
</tr>
<tr>
<td>582</td>
<td></td>
<td>END OF BORING</td>
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</tbody>
</table>

<table>
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<th>DEPTH (ft)</th>
<th>SAMPLE NO.</th>
<th>HOUSEH TESTS (Blows/ft inches)</th>
<th>MOIST CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
<th>UNCONF. COMP ST (PSF)</th>
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<tr>
<td>1</td>
<td>BS-1</td>
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<td>5</td>
<td>BS-5</td>
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**Total Depth:** 5 FT  
**Drilling Date:** 10/19/16  
**Inspector:** J. Elsey

**Water Level Observation:** No groundwater encountered during or upon completion of drilling.

**Drilling Method:** 4-inch diameter bucket-type hand auger.  
**Notes:** 1) Drilled to clear boring location for the sonic drilling of JRW MW-16003.

**Plugging Procedure:** Borehole backfilled with soil cuttings to prevailing grade.  
**GPS Coordinates:**

---

Figure No. 14
**LOG OF HAND AUGER BORING NO: HAB-4**

**Project Name:** J.R. Whiting Well Installation  
**Project Location:** J. R. Whiting Generating Facility, Erie, Michigan  
**Checked By:** Z. Carr, P.E

### SUBSURFACE PROFILE

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<td>FILL: Dark Brown to Black SILTY CLAY with Trace Organic Material</td>
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<tr>
<td>585</td>
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</tr>
<tr>
<td>584</td>
<td></td>
<td>FILL: Gray FLY ASH</td>
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<tr>
<td>583</td>
<td></td>
<td></td>
</tr>
<tr>
<td>582</td>
<td></td>
<td>FILL: Gray FLY ASH and BOTTOM ASH (bottom ash increases with depth)</td>
</tr>
<tr>
<td>581.5</td>
<td></td>
<td>END OF BORING</td>
</tr>
</tbody>
</table>

### SOIL SAMPLE DATA

<table>
<thead>
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<th>DEPTH (ft)</th>
<th>SAMPLE NO.</th>
<th>HOUSE TESTS (Blows/6 inches)</th>
<th>MOIST. CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
<th>UNCONF. COMPST (PSF)</th>
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**Total Depth:** 5 FT  
**Drilling Date:** 10/19/16  
**Inspector:** J. Elsey

**Drilling Method:** 4-inch diameter bucket-type hand auger.  
**Notes:** 1) Drilled to clear boring location for the sonic drilling of JRW MW-16004.

**Plugging Procedure:** Borehole backfilled with soil cuttings to prevailing grade.  

**Water Level Observation:** No groundwater encountered during or upon completion of drilling.

**GPS Coordinates:**

Figure No. 15
**LOG OF HAND AUGER BORING NO: HAB-5**

**Project Name:** J.R. Whiting Well Installation  
**Project Location:** J. R. Whiting Generating Facility, Erie, Michigan

**SUBSURFACE PROFILE**

<table>
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**SOIL SAMPLE DATA**

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<th>DEPTH (ft)</th>
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<th>HOUSEHOLD TESTS (Blows/6 inches)</th>
<th>MOIST. CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
<th>UNCONF. COMPST (PSF)</th>
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</tr>
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<td>2.7</td>
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</tr>
<tr>
<td>3.9</td>
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<td>BS-5</td>
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</tr>
</tbody>
</table>

**FILL:** Brown SILTY CLAY with Trace Gravel and Organic Material

**FILL:** Brown SILTY CLAY with Trace Fly Ash

**FILL:** Gray FLY ASH

**END OF BORING**

**Total Depth:** 5 FT  
**Drilling Date:** 10/19/16  
**Inspector:** J. Elsey

**Water Level Observation:** No groundwater encountered during or upon completion of drilling.

**Drilling Method:** 4-inch diameter bucket-type hand auger.

**Plugging Procedure:** Borehole backfilled with soil cuttings to prevailing grade.

**Notes:**
1) Drilled to clear boring location for the sonic drilling of JRW MW-16005.

**GPS Coordinates:**

---

Figure No. 16
LOG OF HAND AUGER BORING NO: HAB-6

**Project Name:** J.R. Whiting Well Installation  
**Project Location:** J. R. Whiting Generating Facility, Erie, Michigan

**SUBSURFACE PROFILE**

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<th>PROFILE</th>
<th>GROUND SURFACE ELEVATION: 588.3</th>
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<tbody>
<tr>
<td>588</td>
<td></td>
<td></td>
</tr>
<tr>
<td>587</td>
<td></td>
<td>FILL: Brown SILTY CLAY with Trace Organic Material</td>
</tr>
<tr>
<td>587.3</td>
<td>1.0</td>
<td>BS-1 - - - - - - -</td>
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</tr>
<tr>
<td>586</td>
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<td></td>
</tr>
<tr>
<td>585</td>
<td></td>
<td>FILL: Gray/Black FLY ASH (clay seams from 2ft to 3ft)</td>
</tr>
<tr>
<td>583.3</td>
<td>5.0</td>
<td>BS-4 - - - - - - -</td>
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<td>END OF BORING</td>
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**SOIL SAMPLE DATA**

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<th>DEPTH (ft)</th>
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<th>HOUSEH TESTS (Blows/6 inches)</th>
<th>MOIST. CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
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<td>BS-4</td>
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**Total Depth:** 5 FT  
**Drilling Date:** 10/19/16  
**Inspector:** J. Elsey

**Drilling Method:** 4-inch diameter bucket-type hand auger.  
**Notes:** 1) Drilled to clear boring location for the sonic drilling of JRW MW-16006.

**Borehole backfilled with soil cuttings to prevailing grade.**  

**Water Level Observation:** No groundwater encountered during or upon completion of drilling.

**GPS Coordinates:**

Figure No. 17
LOG OF HAND AUGER BORING NO: HAB-7

Project Name: J.R. Whiting Well Installation
Project Location: J. R. Whiting Generating Facility, Erie, Michigan

Subsurface Profile

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<td>578.5</td>
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</table>

**Ground Surface Elevation:** 579.5

**Soil Sample Data**

<table>
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<tr>
<th>DEPTH (ft)</th>
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<th>HOUSEHOLD TESTS (Blows/6 inches)</th>
<th>MOIST. CONTENT (%)</th>
<th>DRY DENSITY (PCF)</th>
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</table>

**Total Depth:** 5 FT

**Drilling Date:** 10/18/16

**Inspector:** J. Elsey

**Drilling Method:** 4-inch diameter bucket-type hand auger.

**Notes:**
1) Drilled to clear boring location for the sonic drilling of JRW MW-16007.
2) Used chisel to penetrate asphalt encountered at 1ft.

**Plugging Procedure:** Borehole backfilled with soil cuttings to prevailing grade.

**Water Level Observation:** No groundwater encountered during or upon completion of drilling.

**GPS Coordinates:**
LOG OF HAND AUGER BORING NO: HAB-8

Project Name: J.R. Whiting Well Installation
Project Location: J. R. Whiting Generating Facility, Erie, Michigan

FK Engineering Associates
Project No: 16-085
Checked By: Z. Carr, P.E

SUBSURFACE PROFILE

SOIL SAMPLE DATA

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<tr>
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<td>FILL: GRAVEL BASE MATERIAL</td>
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<td>579.3</td>
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<tr>
<td>578</td>
<td></td>
<td>FILL: GRAVEL BASE MATERIAL</td>
</tr>
<tr>
<td>577</td>
<td></td>
<td>FILL: Brown SILTY CLAY with Trace Sand and Gravel</td>
</tr>
<tr>
<td>576</td>
<td></td>
<td>FILL: Brown and Gray SILTY CLAY with Little Black Fly Ash and Trace Sand and Gravel</td>
</tr>
<tr>
<td>575</td>
<td></td>
<td>Brown SAND</td>
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<td>574</td>
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</table>

Depth (ft) | SAMPLE NO. | HOUSEHOLD TESTS (Bows/6 inches) | MOIST. CONTENT (%) | DRY DENSITY (pcf) | UNCONF. COMP ST (psf) |
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Total Depth: 5 FT
Drilling Date: 10/27/16
Inspector: J. Elsey

Drilling Method: 4-inch diameter bucket-type hand auger.

Plugging Procedure: Borehole backfilled with soil cuttings to prevailing grade.

Water Level Observation: Groundwater observed at 4.8 ft during drilling and 4.2 ft upon completion of drilling.

Notes:
1) Drilled to clear boring location for the sonic drilling of JRW MW-16008.
2) Used chisel to penetrate asphalt encounetered at 0.5ft.

GPS Coordinates:

Figure No. 19
**LOG OF HAND AUGER BORING NO: HAB-9**

**Project Name:** J.R. Whiting Well Installation  
**Project Location:** J. R. Whiting Generating Facility, Erie, Michigan

### SUBSURFACE PROFILE

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<td>FILL: Gray SAND with Little Gravel and Trace Fly Ash</td>
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<td>578</td>
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<td>577.9</td>
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<tr>
<td>577</td>
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<td>FILL: Brown SILTY CLAY</td>
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<tr>
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<td>574.9</td>
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### SOIL SAMPLE DATA

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<th>DEPTH (ft)</th>
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<td>BS-5</td>
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**Total Depth:** 5 FT  
**Drilling Date:** 10/18/16  
**Inspector:** J. Elsey

**Drilling Method:**  
4-inch diameter bucket-type hand auger.

**Plugging Procedure:**  
Borehole backfilled with soil cuttings to prevailing grade.

**Water Level Observation:**  
No groundwater encountered during or upon completion of drilling.

**Notes:**  
1) Drilled to clear boring location for the sonic drilling of JRW MW-16009.

**GPS Coordinates:**  

**Figure No.** 20
Appendix B
Photographic Log

Photographs of Clay to Bedrock Transition (individual well locations)
Photograph of clay to bedrock transitions at JRW MW-16001:

JRW MW-16001 66-76 feet bgs
Photograph of clay to bedrock transitions at JRW MW-16002:

JRW MW-16002 66-76 feet bgs
Photograph of clay to bedrock transitions at JRW MW-16003:

JRW MW-16003 66-76 feet bgs
Photograph of clay to bedrock transitions at JRW MW-16004:

JRW MW-16004 66-76 feet bgs
Photograph of clay to bedrock transitions at JRW MW-16005:

*JRW MW-16005 66-76 feet bgs*
Photograph of clay to bedrock transitions at JRW MW-16006:
Photograph of clay to bedrock transitions at JRW MW-16007:

JRW MW-16007 56-66 feet bgs
Photograph of clay to bedrock transitions at JRW MW-16008:

JRW MW-16008 50-60 feet bgs – Run 6
Photograph of clay to bedrock transitions at JRW MW-16008:

JRW MW-16008 60-70 feet bgs – Run 7
Photograph of clay to bedrock transitions at JRW MW-16009:
Photograph of clay to bedrock transitions at JRW MW-16009:

JRW MW-16009 66-76 feet bgs
Appendix C

Hydraulic Test Results

Individual Well Locations
JR MW-16001 SLUG IN 1

Data Set: S:\\..\MW-16001 Slug in 1.aqt
Date: 11/08/16 Time: 08:38:58

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16001
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16001)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 66.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.161 ft/day
y0 = 1.638 ft
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16001  
Test Date: 11/1/16

**AQUIFER DATA**

Saturated Thickness: 13 ft  
Anisotropy Ratio (Kz/Kr): 1

**WELL DATA (JR MW-16001 )**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 13 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 66.3 ft  
Screen Length: 10 ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Hvorslev  
K = 4.672 ft/day  
y0 = 1.642 ft
JR MW-16001 SLUG IN 2
Data Set: S:\...\MW-16001 Slug in 1.aqt
Date: 11/08/16
Time: 08:42:55

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16001
Test Date: 11/1/16

AQUIFER DATA
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16001)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 66.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.666 ft/day
y0 = 1.583 ft
**JR MW-16001 SLUG IN 2**

Data Set: S:\...\MW-16001 Slug in 1.aqt
Date: 11/08/16
Time: 08:44:25

**PROJECT INFORMATION**

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16001
Test Date: 11/1/16

**AQUIFER DATA**

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-16001 )**

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 66.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined
Solution Method: Hvorslev

\[ K = 5.652 \text{ ft/day} \]

\[ y_0 = 1.583 \text{ ft} \]
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft

Static Water Column Height: 66.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 4.545 ft/day
y0 = 1.855 ft
Data Set: S:\..\MW-16001 Slug in 1.aqt
Date: 11/08/16
Time: 08:49:31

Project Information
Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16001
Test Date: 11/1/16

AQUIFER DATA
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16001)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 66.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
K = 6.686 ft/day
y0 = 1.854 ft
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16001  
Test Date: 11/1/16

**AQUIFER DATA**

Saturated Thickness: 13. ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-16001)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 13. ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 66.3 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Bouwer-Rice  
$K = 3.865 \text{ ft/day}$  
$y_0 = 1.704 \text{ ft}$
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16001  
Test Date: 11/1/16

**AQUIFER DATA**

Saturated Thickness: 13. ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-16001)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 13. ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 66.3 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Hvorslev  
K = 5.686 ft/day  
y0 = 1.704 ft
Data Set: S:\...\MW-16002.aqt
Date: 11/08/16
Time: 08:57:00

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16002
Test Date: 10/31/16

AQUIFER DATA
Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16002)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 79.5 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.016 ft/day
y0 = 1.514 ft
Data Set: S:\...\MW-16002.aqt
Date: 11/08/16  Time: 08:58:55

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16002
Test Date: 10/31/16

AQUIFER DATA
Saturated Thickness: 15 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16002)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 15 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 79.5 ft
Screen Length: 10 ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
\[ K = 4.31 \text{ ft/day} \]
\[ y_0 = 1.514 \text{ ft} \]
### PROJECT INFORMATION

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16002  
**Test Date:** 10/31/16

### AQUIFER DATA

- **Saturated Thickness:** 15 ft
- **Anisotropy Ratio (Kz/Kr):** 1

### WELL DATA (JR MW-16002)

- **Initial Displacement:** 2.34 ft
- **Total Well Penetration Depth:** 15 ft
- **Casing Radius:** 0.0833 ft
- **Static Water Column Height:** 79.5 ft
- **Screen Length:** 10 ft
- **Well Radius:** 0.25 ft

### SOLUTION

- **Aquifer Model:** Confined
- **Solution Method:** Bouwer-Rice
- **K:** 2.897 ft/day
- **y0:** 1.509 ft
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16002  
Test Date: 10/31/16

**AQUIFER DATA**

Saturated Thickness: 15. ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-1602)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 15. ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 79.5 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Hvorslev  
K = 4.14 ft/day  
y0 = 1.509 ft
**JR MW-16002 SLUG IN 3**

Data Set: S:\...\MW-16002.aqt
Date: 11/08/16
Time: 09:06:33

**PROJECT INFORMATION**

Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16002
Test Date: 10/31/16

**AQUIFER DATA**

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-16002)**

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 15. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 79.5 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined
Solution Method: Bouwer-Rice

\[ K = 3.355 \text{ ft/day} \]
\[ y_0 = 1.724 \text{ ft} \]
DATA SET: S:\...\MW-16002.aqt

DATE: 11/08/16
TIME: 09:08:20

PROJECT INFORMATION

COMPANY: FK Engineering
CLIENT: Consumer's Energy
PROJECT: 16-085
LOCATION: Erie, Michigan
TEST WELL: JR MW-16002
TEST DATE: 10/31/16

AQUIFER DATA

SATURATED THICKNESS: 15 ft
ANISOTROPY RATIO (Kz/Kr): 1

WELL DATA (JR MW-16002)

INITIAL DISPLACEMENT: 2.34 ft
TOTAL WELL PENETRATION DEPTH: 15 ft
CASING RADIUS: 0.0833 ft
STATIC WATER COLUMN HEIGHT: 79.5 ft
SCREEN LENGTH: 10 ft
WELL RADIUS: 0.25 ft

SOLUTION

AQUIFER MODEL: Confined
SOLUTION METHOD: Hvorslev

K = 4.174 ft/day
y0 = 1.572 ft
### PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16002  
Test Date: 10/31/16

### AQUIFER DATA

Saturated Thickness: 15. ft  
Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (JR MW-16002)

- Initial Displacement: 2.34 ft  
- Total Well Penetration Depth: 15. ft  
- Casing Radius: 0.0833 ft  
- Static Water Column Height: 79.5 ft  
- Screen Length: 10. ft  
- Well Radius: 0.25 ft

### SOLUTION

- Aquifer Model: Confined  
- Solution Method: Bouwer-Rice  
- $K = 2.713$ ft/day  
- $y_0 = 1.394$ ft
### JR MW-16002 SLUG IN 4

**Data Set:** S:\...\MW-16002.aqt  
**Date:** 11/08/16  
**Time:** 09:11:17

### PROJECT INFORMATION

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16002  
**Test Date:** 10/31/16

### AQUIFER DATA

- **Saturated Thickness:** 15. ft  
- **Anisotropy Ratio (Kz/Kr):** 1.

### WELL DATA (JR MW-16002)

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 15. ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 79.5 ft  
- **Screen Length:** 10. ft  
- **Well Radius:** 0.25 ft

### SOLUTION

- **Aquifer Model:** Confined  
- **Solution Method:** Hvorslev  
- **K:** 3.877 ft/day  
- **y0:** 1.394 ft
### JR MW-16003 SLUG IN 1

**Data Set:** S:\...\MW-16003.aqt  
**Date:** 11/08/16  
**Time:** 09:18:52

### PROJECT INFORMATION

- **Company:** FK Engineering  
- **Client:** Consumer’s Energy  
- **Project:** 16-085  
- **Location:** Erie, Michigan  
- **Test Well:** JR MW-16003  
- **Test Date:** 11/1/16

### AQUIFER DATA

- **Saturated Thickness:** 13 ft  
- **Anisotropy Ratio (Kz/Kr):** 1

### WELL DATA (JR MW-16003)

- **Initial Displacement:** 2.345 ft  
- **Total Well Penetration Depth:** 13 ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 71.1 ft  
- **Screen Length:** 10 ft  
- **Well Radius:** 0.25 ft

### SOLUTION

- **Aquifer Model:** Confined  
- **Solution Method:** Bouwer-Rice  
- **K:** 5.31 ft/day  
- **y0:** 1.47 ft
PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16003
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16003)

Initial Displacement: 2.345 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.1 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

\[ K = 7.811 \text{ ft/day}\]

\[ y_0 = 1.47 \text{ ft}\]
# PROJECT INFORMATION

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16003  
**Test Date:** 11/1/16

---

# AQUIFER DATA

- **Saturated Thickness:** 13. ft  
- **Anisotropy Ratio (Kz/Kr):** 1.

---

# WELL DATA (JR MW-16003)

- **Initial Displacement:** 2.345 ft  
- **Total Well Penetration Depth:** 13. ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 71.1 ft  
- **Screen Length:** 10. ft  
- **Well Radius:** 0.25 ft

---

# SOLUTION

- **Aquifer Model:** Confined  
- **Solution Method:** Bouwer-Rice  
- **K:** 4.235 ft/day  
- **y0:** 1.215 ft
**JR MW-16003 Slug IN 2**

Data Set: S:\...\MW-16003.aqt  
Date: 11/08/16  
Time: 09:23:11

**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16003  
Test Date: 11/1/16

**AQUIFER DATA**

Saturated Thickness: 13. ft  

Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-16003)**

Initial Displacement: 2.345 ft  
Total Well Penetration Depth: 13. ft  
Casing Radius: 0.0833 ft

Static Water Column Height: 71.1 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Hvorslev

\[ K = 6.232 \text{ ft/day} \]  
[y_0 = 1.215 \text{ ft}]
### JR MW-16003 SLUG IN 3

**Data Set:** S:\...\MW-16003.aqt  
**Date:** 11/08/16  
**Time:** 09:26:04

### PROJECT INFORMATION

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16003  
**Test Date:** 11/1/16

### AQUIFER DATA

- **Saturated Thickness:** 13. ft  
- **Anisotropy Ratio (Kz/Kr):** 1.

### WELL DATA (JR MW-16003)

- **Initial Displacement:** 2.345 ft  
- **Total Well Penetration Depth:** 13. ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 71.1 ft  
- **Screen Length:** 10. ft  
- **Well Radius:** 0.25 ft

### SOLUTION

**Aquifer Model:** Confined  
**Solution Method:** Bouwer-Rice  
**K:** 5.097 ft/day  
**y0:** 1.329 ft
Data Set: S:\..\MW-16003.aqt
Date: 11/08/16 Time: 09:25:24

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16003
Test Date: 11/1/16

AQUIFER DATA
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16003)
Initial Displacement: 2.345 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.1 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
K = 7.493 ft/day
y0 = 1.328 ft
 JR MW-16003 SLUG IN 4
Data Set: S:\...\MW-16003.aqt
Date: 11/08/16 Time: 09:28:45

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16003
Test Date: 11/1/16

AQUIFER DATA
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16003)
Initial Displacement: 2.345 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.1 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 4.671 ft/day
y0 = 1.356 ft
JR MW-16003 SLUG IN 4

Data Set: S:\\MW-16003.aqt
Date: 11/08/16 Time: 09:29:28

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16003
Test Date: 11/1/16

AQUIFER DATA

WELL DATA (JR MW-16003)
Initial Displacement: 2.345 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 71.1 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
K = 7.888 ft/day
y0 = 1.556 ft
PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 16. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16004)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.669 ft/day
y0 = 1.987 ft
Data Set: S:\..\MW-16004.aqt
Date: 11/07/16
Time: 15:51:30

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 16. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16004)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 5.68 ft/day
y0 = 2.173 ft
Data Set: S:\...\MW-16004.aqt
Date: 11/07/16 Time: 15:55:38

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA
Saturated Thickness: 16. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16004)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 3.942 ft/day
y0 = 1.983 ft
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer’s Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16004  
Test Date: 11/1/16

**AQUIFER DATA**

Saturated Thickness: 16 ft  
Anisotropy Ratio (Kz/Kr): 1

**WELL DATA (JR MW-16004)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 16 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 73 ft  
Screen Length: 10 ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Hvorslev  
K = 5.563 ft/day  
y0 = 1.983 ft
Data Set: S:\\..\MW-16004.aqt
Date: 11/07/16

Time (sec)

Displacement (ft)

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 16. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16004)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

\[ K = 3.583 \text{ ft/day} \]

\[ y_0 = 2.381 \text{ ft} \]
### PROJECT INFORMATION

- **Company:** FK Engineering  
- **Client:** Consumer's Energy  
- **Project:** 16-085  
- **Location:** Erie, Michigan  
- **Test Well:** JR MW-16004  
- **Test Date:** 11/1/16

### AQUIFER DATA

- **Saturated Thickness:** 16 ft  
- **Anisotropy Ratio (Kz/Kr):** 1

### WELL DATA (JR MW-16004)

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 16 ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 73 ft  
- **Screen Length:** 10 ft  
- **Well Radius:** 0.25 ft

### SOLUTION

- **Aquifer Model:** Confined  
- **Solution Method:** Hvorslev  
- **K:** 5.055 ft/day  
- **y0:** 2.38 ft
PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 16. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16004)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

\[ K = 3.384 \text{ ft/day} \]
\[ y_0 = 1.955 \text{ ft} \]
Data Set: S:\...\MW-16004.aqt
Date: 11/07/16
Time: 16:05:24

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 16. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16004)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 4.774 ft/day
y0 = 1.955 ft
### AQUIFER DATA

- **Saturated Thickness:** 16 ft
- **Anisotropy Ratio (Kz/Kr):** 1

### WELL DATA (JR MW-16004)

- **Initial Displacement:** 2.34 ft
- **Total Well Penetration Depth:** 16 ft
- **Casing Radius:** 0.0833 ft

### SOLUTION

- **Aquifer Model:** Confined
- **Solution Method:** Bouwer-Rice
- **K:** $3.886 \text{ ft/day}$
- **y0:** $2.001 \text{ ft}$
JR MW-16004 SLUG IN 5

Data Set: S:\..\MW-16004.aqt
Date: 11/07/16
Time: 16:07:33

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16004
Test Date: 11/1/16

AQUIFER DATA

Saturated Thickness: 16 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16004)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 16 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73 ft
Screen Length: 10 ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 5.482 ft/day
y0 = 2.001 ft
### Project Information

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16005  
**Test Date:** 11/3/16

### Aquifer Data

- **Saturated Thickness:** 15 ft  
- **Anisotropy Ratio (Kz/Kr):** 1

### Well Data (JR MW-16005)

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 15 ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 73.2 ft  
- **Screen Length:** 10 ft  
- **Well Radius:** 0.25 ft

### Solution

- **Aquifer Model:** Confined  
- **Solution Method:** Bouwer-Rice  
- **K:** 6.296 ft/day  
- **y0:** 1.324 ft
**Data Set:** S:\\..\MW-16005.aqt  
**Date:** 11/07/16  
**Time:** 16:14:24

**PROJECT INFORMATION**

**Company:** FK Engineering  
**Client:** Consumer’s Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16005  
**Test Date:** 11/3/16

**AQUIFER DATA**

- **Saturated Thickness:** 15. ft  
- **Anisotropy Ratio (Kz/Kr):** 1.

**WELL DATA (JR MW-16005)**

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 15. ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 73.2 ft  
- **Screen Length:** 10. ft  
- **Well Radius:** 0.25 ft

**SOLUTION**

- **Aquifer Model:** Confined  
- **Solution Method:** Hvorslev  
- **K = 9.859 ft/day**  
- **y0 = 1.452 ft**
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16005  
Test Date: 11/3/16

**AQUIFER DATA**

Saturated Thickness: 15. ft  
Anisotropy Ratio (Kz/Kr): 1.

**WELL DATA (JR MW-16005)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 15. ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 73.2 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Bouwer-Rice  
\( K = 9.309 \text{ ft/day} \)  
\( y_0 = 2.007 \text{ ft} \)
### JR MW-16005 SLUG IN 2

Data Set: S:\...\MW-16005.aqt  
Date: 11/07/16  
Time: 16:19:41

### PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16005  
Test Date: 11/3/16

### AQUIFER DATA

<table>
<thead>
<tr>
<th>Saturated Thickness: 15. ft</th>
<th>Anisotropy Ratio (Kz/Kr): 1.</th>
</tr>
</thead>
</table>

### WELL DATA (JR MW-16005)

<table>
<thead>
<tr>
<th>Initial Displacement: 2.34 ft</th>
<th>Static Water Column Height: 73.2 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Well Penetration Depth: 15. ft</td>
<td>Screen Length: 10. ft</td>
</tr>
<tr>
<td>Casing Radius: 0.0833 ft</td>
<td>Well Radius: 0.25 ft</td>
</tr>
</tbody>
</table>

### SOLUTION

<table>
<thead>
<tr>
<th>Aquifer Model: Confined</th>
<th>Solution Method: Hvorslev</th>
</tr>
</thead>
<tbody>
<tr>
<td>K = 12.7 ft/day</td>
<td>y0 = 1.917 ft</td>
</tr>
</tbody>
</table>
### PROJECT INFORMATION

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16005  
**Test Date:** 11/3/16

### AQUIFER DATA

- **Saturated Thickness:** 15. ft  
- **Anisotropy Ratio (Kz/Kr):** 1.

### WELL DATA (JR MW-16005)

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 15. ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 73.2 ft  
- **Screen Length:** 10. ft  
- **Well Radius:** 0.25 ft

### SOLUTION

- **Aquifer Model:** Confined  
- **Solution Method:** Bouwer-Rice  
- **K = 7.965 ft/day**  
- **y0 = 1.597 ft**
### JR MW-16005 SLUG IN 3

Data Set: S:\..\MW-16005.aqt  
Date: 11/07/16  
Time: 16:23:23

### PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16005  
Test Date: 11/3/16

### AQUIFER DATA

- Saturated Thickness: 15. ft  
- Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (JR MW-16005)

- Initial Displacement: 2.34 ft  
- Total Well Penetration Depth: 15. ft  
- Casing Radius: 0.0833 ft  
- Static Water Column Height: 73.2 ft  
- Screen Length: 10. ft  
- Well Radius: 0.25 ft

### SOLUTION

- Aquifer Model: Confined  
- Solution Method: Hvorslev  
- $K = 11.91$ ft/day  
- $y_0 = 1.671$ ft
Data Set: S:\\MW-16005.aqt
Date: 11/07/16  Time: 16:26:45

PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16005  
Test Date: 11/3/16

AQUIFER DATA

Saturated Thickness: 15. ft  
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16005)

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 15. ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 73.2 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined  
Solution Method: Bouwer-Rice  
K = 9.359 ft/day  
y0 = 1.633 ft
**PROJECT INFORMATION**

<table>
<thead>
<tr>
<th>Company</th>
<th>FK Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Consumer's Energy</td>
</tr>
<tr>
<td>Project</td>
<td>16-085</td>
</tr>
<tr>
<td>Location</td>
<td>Erie, Michigan</td>
</tr>
<tr>
<td>Test Well</td>
<td>JR MW-16005</td>
</tr>
<tr>
<td>Test Date</td>
<td>11/3/16</td>
</tr>
</tbody>
</table>

**AQUIFER DATA**

<table>
<thead>
<tr>
<th>Saturated Thickness</th>
<th>15. ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anisotropy Ratio (Kz/Kr)</td>
<td>1.</td>
</tr>
</tbody>
</table>

**WELL DATA (JR MW-16005)**

<table>
<thead>
<tr>
<th>Initial Displacement</th>
<th>2.34 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Well Penetration Depth</td>
<td>15. ft</td>
</tr>
<tr>
<td>Casing Radius</td>
<td>0.0833 ft</td>
</tr>
<tr>
<td>Static Water Column Height</td>
<td>73.2 ft</td>
</tr>
<tr>
<td>Screen Length</td>
<td>10. ft</td>
</tr>
<tr>
<td>Well Radius</td>
<td>0.25 ft</td>
</tr>
</tbody>
</table>

**SOLUTION**

<table>
<thead>
<tr>
<th>Aquifer Model</th>
<th>Confined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solution Method</td>
<td>Hvorslev</td>
</tr>
<tr>
<td>K</td>
<td>12.19 ft/day</td>
</tr>
<tr>
<td>y0</td>
<td>1.559 ft</td>
</tr>
</tbody>
</table>
**PROJECT INFORMATION**

- **Company:** FK Engineering
- **Client:** Consumer's Energy
- **Project:** 16-085
- **Location:** Erie, Michigan
- **Test Well:** JR MW-16006
- **Test Date:** 11/2/16

**AQUIFER DATA**

- **Saturated Thickness:** 13. ft
- **Anisotropy Ratio (Kz/Kr):** 1.

**WELL DATA (JR MW-16006)**

- **Initial Displacement:** 2.34 ft
- **Total Well Penetration Depth:** 13. ft
- **Casing Radius:** 0.0833 ft
- **Static Water Column Height:** 75. ft
- **Screen Length:** 10. ft
- **Well Radius:** 0.25 ft

**SOLUTION**

- **Aquifer Model:** Confined
- **Solution Method:** Bouwer-Rice
- **K:** 7.198 ft/day
- **y0:** 1.537 ft
**JR MW-16006 SLUG IN 1**

Data Set: S:\..\MW-16006.aqt  
Date: 11/07/16  
Time: 16:33:13

**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16006  
Test Date: 11/2/16

**AQUIFER DATA**


**WELL DATA (JR MW-16006)**

| Initial Displacement: 2.34 ft | Static Water Column Height: 75. ft |
| Total Well Penetration Depth: 13. ft | Screen Length: 10. ft |
| Casing Radius: 0.0833 ft | Well Radius: 0.25 ft |

**SOLUTION**

| Aquifer Model: Confined | Solution Method: Hvorslev |
| K = 10.6 ft/day | y0 = 1.61 ft |
DATA SET: S:\..\MW-16006.aqt  
DATE: 11/07/16  
TIME: 16:44:16

PROJECT INFORMATION

COMPANY: FK Engineering  
CLIENT: Consumer's Energy  
PROJECT: 16-085  
LOCATION: Erie, Michigan  
TEST WELL: JR MW-16006  
TEST DATE: 11/2/16

AQUIFER DATA

SATURATED THICKNESS: 13. ft  
ANISOTROPY RATIO (Kz/Kr): 1.

WELL DATA (JR MW-16006)

INITIAL DISPLACEMENT: 2.34 ft  
TOTAL WELL PENETRATION DEPTH: 13. ft  
casing radius: 0.0833 ft

STATIC WATER COLUMN HEIGHT: 75. ft  
SCREEN LENGTH: 10. ft  
WELL RADIUS: 0.25 ft

SOLUTION

AQUIFER MODEL: Confined  
SOLUTION METHOD: Bouwer-Rice  
K = 8.603 ft/day  
y0 = 1.509 ft
JR MW-16006 SLUG IN 2

Data Set: S:\..\MW-16006.aqt
Date: 11/07/16

Time: 16:45:46

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16006
Test Date: 11/2/16

AQUIFER DATA

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16006)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 75. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 12.09 ft/day
y0 = 1.441 ft
Project Information

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16006
Test Date: 11/2/16

Aquifer Data

Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

Well Data (JR MW-16006)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 75. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

Solution

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.663 ft/day
y0 = 1.539 ft
**Data Set:** S:\\...\MW-16006.aqt  
**Date:** 11/07/16  
**Time:** 16:48:08

**PROJECT INFORMATION**

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16006  
**Test Date:** 11/2/16

**AQUIFER DATA**

- **Saturated Thickness:** 13. ft  
- **Anisotropy Ratio (Kz/Kr):** 1.

**WELL DATA (JR MW-16006)**

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 13. ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 75. ft  
- **Screen Length:** 10. ft  
- **Well Radius:** 0.25 ft

**SOLUTION**

- **Aquifer Model:** Confined  
- **Solution Method:** Hvorslev  
- **K:** 11.27 ft/day  
- **y0:** 1.539 ft
Data Set: S:\..\MW-16006.aqt
Date: 11/07/16
Time: 16:51:25

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16006
Test Date: 11/2/16

AQUIFER DATA
Saturated Thickness: 13. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16006)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 75. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 7.415 ft/day
y0 = 1.614 ft
**PROJECT INFORMATION**

- **Company:** FK Engineering
- **Client:** Consumer's Energy
- **Project:** 16-085
- **Location:** Erie, Michigan
- **Test Well:** JR MW-16006
- **Test Date:** 11/2/16

**AQUIFER DATA**

- **Saturated Thickness:** 13 ft
- **Anisotropy Ratio (Kz/Kr):** 1

**WELL DATA (JR MW-16006)**

- **Initial Displacement:** 2.34 ft
- **Total Well Penetration Depth:** 13 ft
- **Casing Radius:** 0.0833 ft
- **Static Water Column Height:** 75 ft
- **Screen Length:** 10 ft
- **Well Radius:** 0.25 ft

**SOLUTION**

- **Aquifer Model:** Confined
- **Solution Method:** Hvorslev
- **K:** 10.42 ft/day
- **y0:** 1.542 ft
**JR MW-16007 SLUG IN 1**

Data Set: S:\\..\\MW-16007.aqt  
Date: 11/07/16  
Time: 16:57:58

**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16007  
Test Date: 10/31/16

**AQUIFER DATA**

- Saturated Thickness: 14.3 ft  
- Anisotropy Ratio (Kz/Kr): 1

**WELL DATA (JR MW-16007)**

- Initial Displacement: 2.34 ft  
- Static Water Column Height: 73 ft  
- Total Well Penetration Depth: 14 ft  
- Screen Length: 10 ft  
- Casing Radius: 0.0833 ft  
- Well Radius: 0.25 ft

**SOLUTION**

- Aquifer Model: Confined  
- Solution Method: Bouwer-Rice  
- $K = 3.816$ ft/day  
- $y_0 = 1.07$ ft
Data Set: S:\\..\MW-16007.aqt
Date: 11/07/16 Time: 16:58:34

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16007
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 14.3 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16007)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 14. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 4.849 ft/day
y0 = 1.071 ft
JR MW-16007 SLUG IN 2

Data Set: S:\...\MW-16007.aqt
Date: 11/07/16
Time: 17:04:23

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16007
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 14.3 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16007)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 14. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.664 ft/day
y0 = 0.9841 ft
JR MW-16007 SLUG IN 2

Data Set: S:\..\MW-16007.aqt
Date: 11/07/16
Time: 17:03:06

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16007
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 14.3 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16007)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 14. ft
Casing Radius: 0.0833 ft
Static Water Column Height: 73. ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.385 ft/day
y0 = 0.9842 ft
## PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16007  
Test Date: 10/31/16

## AQUIFER DATA

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saturated Thickness</td>
<td>14.3 ft</td>
</tr>
<tr>
<td>Anisotropy Ratio (Kz/Kr)</td>
<td>1</td>
</tr>
</tbody>
</table>

## WELL DATA (JR MW-16007)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Displacement</td>
<td>2.34 ft</td>
</tr>
<tr>
<td>Total Well Penetration Depth</td>
<td>14. ft</td>
</tr>
<tr>
<td>Casing Radius</td>
<td>0.0833 ft</td>
</tr>
<tr>
<td>Static Water Column Height</td>
<td>73. ft</td>
</tr>
<tr>
<td>Screen Length</td>
<td>10. ft</td>
</tr>
<tr>
<td>Well Radius</td>
<td>0.25 ft</td>
</tr>
</tbody>
</table>

## SOLUTION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquifer Model</td>
<td>Confined</td>
</tr>
<tr>
<td>Solution Method</td>
<td>Bouwer-Rice</td>
</tr>
<tr>
<td>K</td>
<td>3.04 ft/day</td>
</tr>
<tr>
<td>y0</td>
<td>1.063 ft</td>
</tr>
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</table>
### JR MW-16007 SLUG IN 3

Data Set: S:\...\MW-16007.aqt  
Date: 11/07/16  
Time: 17:10:28

### PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16007  
Test Date: 10/31/16

### AQUIFER DATA

Saturated Thickness: 14.3 ft  
Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (JR MW-16007)

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 14. ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 73. ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

### SOLUTION

Aquifer Model: Confined  
Solution Method: Hvorslev  
\[ K = 3.734 \text{ ft/day} \]  
\[ y0 = 1.006 \text{ ft} \]
## JR MW-16007 SLUG IN 4

Data Set: S:\...\MW-16007.aqt  
Date: 11/07/16  
Time: 17:17:00

### PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16007  
Test Date: 10/31/16

### AQUIFER DATA

Saturated Thickness: 14.3 ft  
Anisotropy Ratio (Kz/Kr): 1

### WELL DATA (JR MW-16007)

- Initial Displacement: 2.34 ft  
- Total Well Penetration Depth: 14 ft  
- Casing Radius: 0.0833 ft  
- Static Water Column Height: 73 ft  
- Screen Length: 10 ft  
- Well Radius: 0.25 ft

### SOLUTION

- Aquifer Model: Confined  
- Solution Method: Bouwer-Rice  
- $K = 2.889$ ft/day  
- $y0 = 0.9357$ ft
**PROJECT INFORMATION**

- **Company:** FK Engineering  
- **Client:** Consumer’s Energy  
- **Project:** 16-085  
- **Location:** Erie, Michigan  
- **Test Well:** JR MW-16007  
- **Test Date:** 10/31/16

**AQUIFER DATA**

- **Saturated Thickness:** 14.3 ft  
- **Anisotropy Ratio (Kz/Kr):** 1

**WELL DATA (JR MW-16007)**

- **Initial Displacement:** 2.34 ft  
- **Total Well Penetration Depth:** 14 ft  
- **Casing Radius:** 0.0833 ft  
- **Static Water Column Height:** 73 ft  
- **Screen Length:** 10 ft  
- **Well Radius:** 0.25 ft

**SOLUTION**

- **Aquifer Model:** Confined  
- **Solution Method:** Hvorslev  
- **K:** 3.671 ft/day  
- **y0:** 0.9359 ft
# JR MW-16008 Slug In 1

Data Set: S:\..\MW-16008.aqt
Date: 11/07/16
Time: 17:26:45

## PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16008
Test Date: 11/4/16

## AQUIFER DATA

Saturated Thickness: 12.5 ft
Anisotropy Ratio (Kz/Kr): 1.

## WELL DATA (JR MW-16008)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 10.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 67.2 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

## SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

\[
K = 8.826 \text{ ft/day} \\
y_0 = 1.846 \text{ ft}
\]
## JR MW-16008 SLUG IN 1

**Data Set:** S:\..\MW-16008.aqt  
**Date:** 11/07/16  
**Time:** 17:26:12

### PROJECT INFORMATION

**Company:** FK Engineering  
**Client:** Consumer’s Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16008  
**Test Date:** 11/4/16

### AQUIFER DATA

**Saturated Thickness:** 12.5 ft  
**Anisotropy Ratio (Kz/Kr):** 1.

### WELL DATA (JR MW-16008)

**Initial Displacement:** 2.34 ft  
**Total Well Penetration Depth:** 10.5 ft  
**Casing Radius:** 0.0833 ft  
**Static Water Column Height:** 67.2 ft  
**Screen Length:** 5. ft  
**Well Radius:** 0.25 ft

### SOLUTION

**Aquifer Model:** Confined  
**Solution Method:** Hvorslev  
**K:** 11.56 ft/day  
**y0:** 1.846 ft
Data Set: S:\..\MW-16008.aqt
Date: 11/07/16
Time: 17:29:00

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16008
Test Date: 11/4/16

AQUIFER DATA
Saturated Thickness: 12.5 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16008)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 10.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 67.2 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 11.02 ft/day
y0 = 2.119 ft
**PROJECT INFORMATION**

**Company:** FK Engineering  
**Client:** Consumer's Energy  
**Project:** 16-085  
**Location:** Erie, Michigan  
**Test Well:** JR MW-16008  
**Test Date:** 11/4/16

**AQUIFER DATA**

**Saturated Thickness:** 12.5 ft  
**Anisotropy Ratio (Kz/Kr):** 1

**WELL DATA (JR MW-16008)**

**Initial Displacement:** 2.34 ft  
**Total Well Penetration Depth:** 10.5 ft  
**Casing Radius:** 0.0833 ft  
**Static Water Column Height:** 67.2 ft  
**Screen Length:** 5.0 ft  
**Well Radius:** 0.25 ft

**SOLUTION**

**Aquifer Model:** Confined  
**Solution Method:** Hvorslev  
**K:** 14.44 ft/day  
**y0:** 2.119 ft
JR MW-16008 SLUG IN 3

Data Set: S:\...\MW-16008.aqt
Date: 11/07/16
Time: 17:33:37

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16008
Test Date: 11/4/16

AQUIFER DATA

Saturated Thickness: 12.5 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16008)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 10.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 67.2 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 9,947 ft/day
y0 = 1.867 ft
**PROJECT INFORMATION**

- **Company:** FK Engineering
- **Client:** Consumer's Energy
- **Project:** 16-085
- **Location:** Erie, Michigan
- **Test Well:** JR MW-1608
- **Test Date:** 11/4/16

**AQUIFER DATA**

- **Saturated Thickness:** 12.5 ft
- **Anisotropy Ratio (Kz/Kr):** 1

**WELL DATA (JR MW-16008)**

- **Initial Displacement:** 2.34 ft
- **Total Well Penetration Depth:** 10.5 ft
- **Casing Radius:** 0.0833 ft
- **Static Water Column Height:** 67.2 ft
- **Screen Length:** 5. ft
- **Well Radius:** 0.25 ft

**SOLUTION**

- **Aquifer Model:** Confined
- **Solution Method:** Hvorslev
- **K:** 13.02 ft/day
- **y0:** 1.866 ft
PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16008
Test Date: 11/4/16

AQUIFER DATA

Saturated Thickness: 12.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16008)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 10.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 67.2 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 11.26 ft/day
y0 = 1.914 ft
Data Set: S:\...\MW-16008.aqt
Date: 11/07/16
Time: 17:35:53

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16008
Test Date: 11/4/16

AQUIFER DATA
Saturated Thickness: 12.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16008)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 10.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 67.2 ft
Screen Length: 5. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
K = 14.76 ft/day
y0 = 1.914 ft
JR MW-16009 SLUG IN 1

Data Set: S:\\MW-16009.aqt
Date: 11/07/16
Time: 17:40:30

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16009
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16009)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 53.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 8.415 ft/day
y0 = 2.03 ft
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16009  
Test Date: 10/31/16

**AQUIFER DATA**

Saturated Thickness: 13.5 ft  
Anisotropy Ratio (Kz/Kr): 1

**WELL DATA (JR MW-16009)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 13.5 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 53.3 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Hvorslev  
\( K = 12.29 \text{ ft/day} \)  
\( y_0 = 2.03 \text{ ft} \)
**PROJECT INFORMATION**

Company: FK Engineering  
Client: Consumer’s Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16009  
Test Date: 10/31/16

**AQUIFER DATA**

Saturated Thickness: 13.5 ft  
Anisotropy Ratio (Kz/Kr): 1

**WELL DATA (JR MW-16009)**

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 13.5 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 53.3 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

**SOLUTION**

Aquifer Model: Confined  
Solution Method: Bouwer-Rice  
\[ K = 7.481 \text{ ft/day} \]  
\[ y_0 = 2.233 \text{ ft} \]
JR MW-16009 SLUG IN 2

Data Set: S:\..\MW-16009.aqt
Date: 11/07/16
Time: 17:43:00

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16009
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16009)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 53.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 10.92 ft/day
y0 = 2.233 ft
JR MW-16009 SLUG IN 3

Data Set: S:\...\MW-16009.aqt
Date: 11/07/16  Time: 17:45:33

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16009
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16009)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 53.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
K = 6.468 ft/day
Solution Method: Bouwer-Rice
y0 = 2.132 ft
Data Set: S:\...\MW-16009.aqt
Date: 11/07/16
Time: 17:45:00

PROJECT INFORMATION
Company: FK Engineering
Client: Consumer’s Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16009
Test Date: 10/31/16

AQUIFER DATA
Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 1

WELL DATA (JR MW-16009)
Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 53.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION
Aquifer Model: Confined
Solution Method: Hvorslev
K = 9.446 ft/day
y0 = 2.132 ft
JR MW-16009 SLUG IN 4

Data Set: S:\...\MW-16009.aqt
Date: 11/07/16
Time: 17:47:14

PROJECT INFORMATION

Company: FK Engineering
Client: Consumer's Energy
Project: 16-085
Location: Erie, Michigan
Test Well: JR MW-16009
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 13.5 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16009)

Initial Displacement: 2.34 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.0833 ft
Static Water Column Height: 53.3 ft
Screen Length: 10. ft
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 5.703 ft/day
y0 = 2.273 ft
PROJECT INFORMATION

Company: FK Engineering  
Client: Consumer's Energy  
Project: 16-085  
Location: Erie, Michigan  
Test Well: JR MW-16009  
Test Date: 10/31/16

AQUIFER DATA

Saturated Thickness: 13.5 ft  
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (JR MW-16009)

Initial Displacement: 2.34 ft  
Total Well Penetration Depth: 13.5 ft  
Casing Radius: 0.0833 ft  
Static Water Column Height: 53.3 ft  
Screen Length: 10. ft  
Well Radius: 0.25 ft

SOLUTION

Aquifer Model: Confined  
Solution Method: Hvorslev  
K = 8.327 ft/day  
y0 = 2.273 ft