



A CMS Energy Company

Date: October 17, 2017

To: Operating Record

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

RE: Groundwater Monitoring System Certification, §257.91(f)  
Former BC Cobb Power Plant, Bottom Ash Pond and Ponds 0-8

### 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 BC Cobb Bottom Ash Pond and Ponds 0-8, which established the following locations for determining background groundwater quality and detection monitoring.

Background:

BCC MW-15002	BCC MW-15003	BCC MW-15004
BCC MW-15005	BCC MW-15006	BCC MW-15007
BCC MW-15008		

Downgradient:

BCC MW-15009	BCC MW-15010	BCC MW-15011
BCC MW-15012	BCC MW-15013	BCC MW-15014
BCC MW-15018	BCC MW-15019	BCC MW-15020
BCC MW-15021	BCC MW-15022	BCC MW-15023

**“Groundwater Monitoring System Certification  
BC Cobb Bottom Ash Pond and Ponds 0-8”  
October 17, 2017  
Page 2**

Provided herein, as required by §257.91(f), is certification from a qualified professional engineer that the groundwater monitoring system at Consumers Energy BC Cobb Bottom Ash Pond and Ponds 0-8 meets the requirements of §257.91.

**CERTIFICATION**

Professional Engineer Certification Statement [40 CFR 257.91]

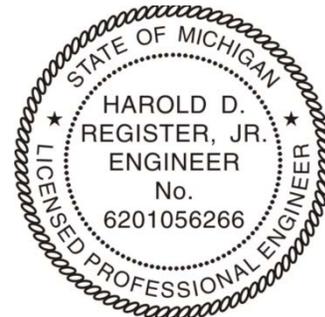
I hereby certify that, having reviewed the attached documentation and being familiar with the provisions of Title 40 of the Code of Federal Regulations §257.91 (40 CFR Part 257.91), I attest that this Groundwater Monitoring System has been designed and constructed to meet the requirements of 40 CFR 257.91. 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.

Harold D. Register, Jr.  
Signature

October 17, 2017  
Date of Certification

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

6201056266  
Professional Engineer Certification Number



10/17/2017

**ENCLOSURES**

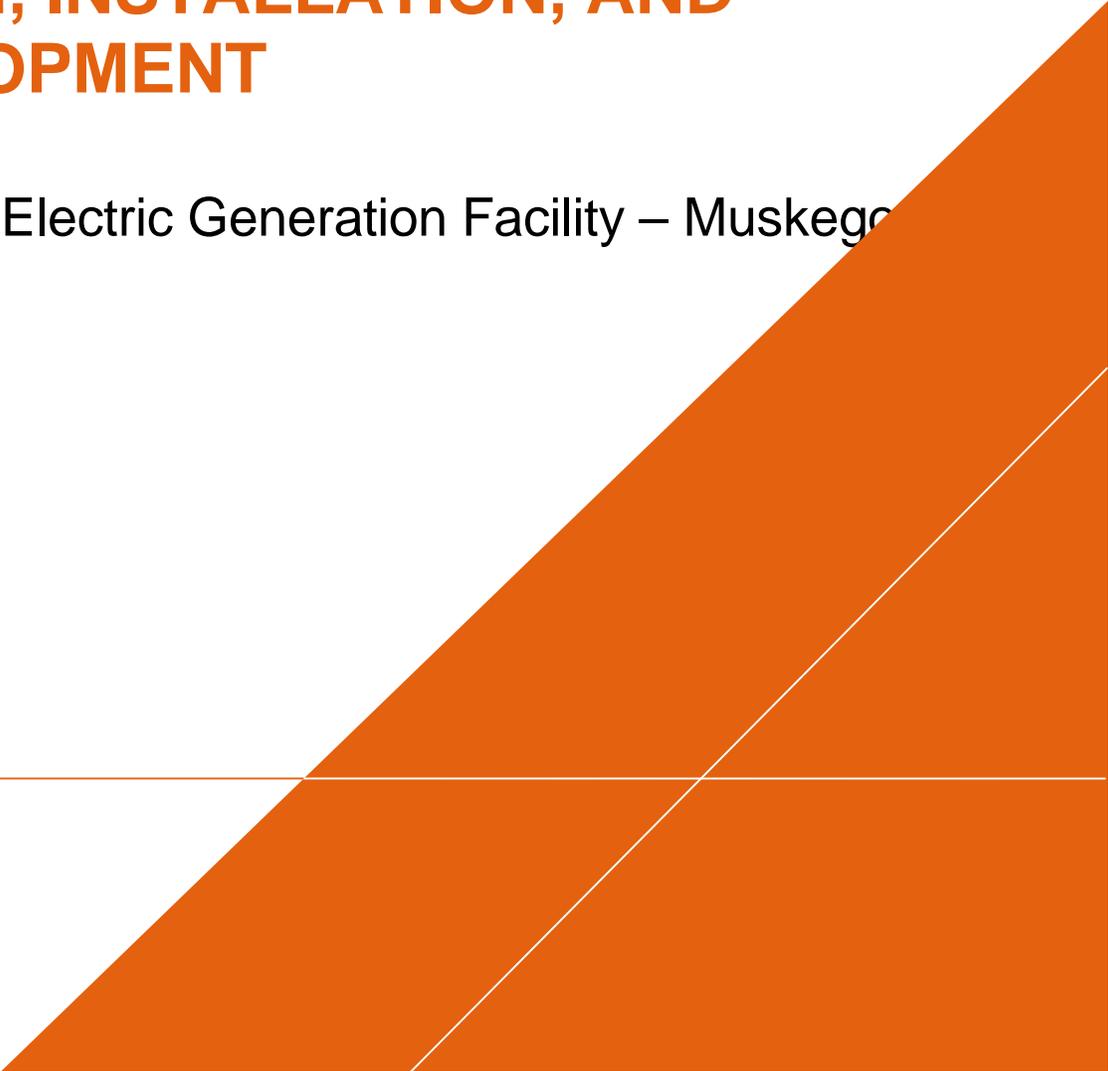
ARCADIS (2016). *“Summary of Monitoring Well Design, Installation, and Development”*

Consumers Energy Company

# **SUMMARY OF MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT**

B.C. Cobb Electric Generation Facility – Muskegon  
Michigan

May 13, 2016

A large, solid orange geometric shape, resembling a right-angled triangle or a trapezoid, is positioned in the bottom right corner of the page. It is oriented with its hypotenuse facing upwards and to the right. A thin white diagonal line runs from the bottom-left corner of this shape towards the top-right corner. A thin white horizontal line crosses the page, passing through the orange shape.



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Gregory E. Zellmer, P.G.  
Certified Project Manager/Senior Geologist

Mark Robert Klemmer, PE  
Printed Name of Registered Professional Engineer

---

Signature of Registered Professional Engineer  
Registration Number: 62010-49167 State: MI

Date: \_\_\_\_\_

## Summary of Monitoring Well Design, Installation, and Development

B.C. Cobb Electric Generation Facility –  
Muskegon, MI

Prepared for:  
Consumers Energy Company  
Jackson, Michigan

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Date:  
May 13, 2016

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## 1 INTRODUCTION

ARCADIS has prepared this Summary of Monitoring Well Design, Installation, and Development (Report) to summarize monitoring well installation activities at the BC Cobb electric generation facility (BCC), located in Muskegon, 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) in Landfills and Surface Impoundments (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

Twenty-three (23) soil borings were completed using rotosonic-drilling methods operated by Mateco Drilling Company of Grand Rapids, 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 is extracted from the ground and emptied into a clear plastic liner for logging. This process was repeated until the total depth of the boring is 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 aquifer unit for completion of monitoring wells. Monitoring wells were installed through the

## B.C. COBB MONITORING WELL DESIGN, INSTALLATION, AND DEVELOPMENT

rotasonic 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. The length of the monitoring well screens at the Site varied from 3 feet to 10 feet, and the length of the screen intervals was determined based on observations of each location during the soil boring activities. A medium-grained sand pack was placed around each well screen to a height 2 feet above the top of the well screen. A 2-foot thick bentonite grout seal was placed on top of the well screen. The remainder of the annular space was sealed with a cement-bentonite grout to a depth approximately 1.5-foot below ground surface.

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-22370**. 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 consisted of the gentle swabbing of the entire screened interval with a surge block. After surging the well screen, water was evacuated using a submersible pump. A "flow-thru cell" and a turbidity meter were utilized to monitor indicator parameters (turbidity, pH, temperature, oxygen 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 fluid 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

Groundwater Parameter	Stabilization Criteria
pH	3 readings within +/- 0.1 Standard Units
Specific Conductance (SpC)	3 readings within +/- 3% mS/cms
Temperature	3 readings within +/- 3%
Oxygen Reduction Potential (ORP)	3 readings within +/- 10 mV
Turbidity	3 readings within +/- 10% or <1 when < 10 NTU
Dissolved Oxygen (DO)	3 readings within +/- 0.3 mg/L

### 3.4 Hydraulic Testing

On November 9, 2015, Arcadis conducted hydraulic tests (slug tests) at six monitoring wells (BCC-MW-15001, BCC-MW-15005, BCC-MW-15008, BCC-MW-15017, BCC-MW-15020, and BCC-MW-15021) at the Site. During the slug testing activities, three tests were completed at each of the monitoring wells. Well construction logs are included in **Appendix A**; well construction details are summarized in **Table 1**.

The slug tests at these wells were completed to estimate hydraulic conductivity (K) by introducing a displacement by removing a known volume of water or depressing the water level by compressed air and measuring the recovery. The tests at BCC-MW-15017, BCC-MW-15020, BCC-MW-15021 and BCC-MW-15001 were completed using the pneumatic slug test method where a manifold and pump was used to depress the water level. The tests at BCC-MW-15005 and BCC-MW-15008 were completed using a disposable bailer to remove a known volume of water. The bailer used at both wells was 1.5-inches in diameter and 36-inches long. All wells used have casing and screen diameters of 2-inches and filter pack diameter of 8-inches. BCC-MW-15017, BCC-MW-15020, BCC-MW-15021 and BCC-MW-15001 were screened below the water table (7.09 to 28.9 feet below the water table) at the time of development and hydraulic testing. BCC-MW-15005 was screened approximately 0.5 feet below the water table and BCC-MW-15008 was screened across the water table at the time of development and hydraulic testing. At all the wells, a pressure transducer was set to record at 0.5 second intervals to measure static water elevation, displacement, and water recovery data.

All tests at the six monitoring wells reached full recovery within approximately 40 seconds. Recovery data collected from the wells were analyzed using the applicable analytical solution with AQTESOLV® for Windows®. Based on diagnostic analyses, the solution utilized at most of the recovery data was the unconfined KGS model (1994) that accounts for partial penetration effects. The unconfined Bouwer and Rice (1976 and 1989) solution was utilized for recovery data at BCC-MW-15008, which is screened across the water table. The results indicated an estimated hydraulic conductivity range from 30 to 107 feet per day (ft/d) with an average of 58 ft/d and a geometric mean of 54 ft/d. The results of this test seem to be a reasonable fit with the interbedded sands in the formation. The monitoring well locations where slug tests were conducted are shown on **Drawing SG-22370** and the results of the hydraulic conductivity tests are presented in **Table 3** and **Appendix B**.

# TABLES



Table 1  
Monitoring Well Construction and Development Summary  
Consumers Energy Co.  
B.C. Cobb Generating Facility  
Muskegon, Michigan

MW ID	Northing	Easting	Ground Surface Elevation (ft above msl)	TOC Elevation (ft above msl)	Date Installed	Geologic Unit of Screen Interval	Well Construction	Well Screen Length (ft)	Screen Interval (ft) bgs)	Development Details			
										Static DTW (ft below TOC)	Total Depth	Gallons Removed	Final Turbidity (NTU)
<b>Downgradient MW</b>													
BCC MW-15009	645606.92	12623622.98	586.3	589.27	10/14/2015	Sand (14 - 17.2 ft bgs) and Clay/silt (17.2 - 24 ft bgs)	2" PVC, 10 slot	10	14 - 24	7.51	26.79	180	8.65
BCC MW-15010	645690.69	12623979.47	585.2	588.11	10/15/2015	Sand w/little silt and organic matter	2" PVC, 10 slot	10	12 - 22	6.93	25.09	200	5.99
BCC MW-15011	645780.29	12623765.87	592.3	595.22	10/15/2015	Sand w/some silt	2" PVC, 10 slot	10	21 - 31	13.03	33.66	150	8.09
BCC MW-15012	645889.92	12623545.99	594.5	597.39	10/15/2015	Sand	2" PVC, 10 slot	10	21 - 31	13.79	34.25	150	9.88
BCC MW-15013	645716.41	12623389.21	595.9	598.5	10/16/2015	Sand with clay/silt and organic material from 36.5 - 37.5 ft bgs	2" PVC, 10 slot	10	30 - 40	16.38	43.03	100	8.38
BCC MW-15014	645925.93	12623318.73	596.2	599.04	10/16/2015	Sand/silty sand	2" PVC, 10 slot	8	23 - 31	15.50	34.00	150	9.61
BCC MW-15015	646138.93	12623024.09	593.9	596.75	10/19/2015	Sand with clay/silt and organic material from 29 - 29.5 ft bgs	2" PVC, 10 slot	10	20 - 30	12.16	30.18	140	9.79
BCC MW-15016	646227.56	12622459.26	586.2	589.05	10/19/2015	Sand (35-40.5)/Clay (40.5-45)	2" PVC, 10 slot	10	35 - 40	8.65	42.93	150	6.50
BCC MW-15017	646354.69	12622085.55	585.7	588.61	10/20/2015	Sand	2" PVC, 10 slot	10	35 - 40	8.53	42.8	150	7.89
BCC MW-15018	646789.54	12622179.74	589.4	592.43	10/20/2015	Sand	2" PVC, 10 slot	5	37.5 - 42.5	11.78	45.08	120	4.68
BCC MW-15019	647103.13	12622369.93	589.4	592.42	10/20/2015	Sand	2" PVC, 10 slot	5	37 - 42	12.22	45.09	140	6.21
BCC MW-15020	647436.97	12622626.85	589.5	592.23	10/21/2015	Sand	2" PVC, 10 slot	5	35 - 40	12.19	42.89	150	3.12
BCC MW-15021	646654.84	12623310.03	590.7	593.73	10/21/2015	Sand	2" PVC, 10 slot	3	39.5 - 42.5	14.00	45.64	150	4.98
BCC MW-15022	646263.16	12623634.96	592.6	595.82	10/23/2015	Sand	2" PVC, 10 slot	6	24 - 30	12.28	34.01	150	9.86
BCC MW-15023	647125.15	12622999.24	585.4	588.08	10/23/2015	Sand/silty sand	2" PVC, 10 slot	7.5	12 - 19.5	3.81	22.33	140	1.02
<b>Background MW</b>													
BCC MW-15001	645763.32	12624262.18	583.6	586.52	10/12/2015	Sand w/organic seam at 18.8' bgs	2" PVC, 10 slot	10	10 - 20	5.96	23.06	175	9.80
BCC MW-15002	645701.73	12624512.86	583.8	586.87	10/12/2015	Sand	2" PVC, 10 slot	5	15 - 20	6.45	23.14	150	4.31
BCC MW-15003	645555.93	12624726.22	584.1	587.12	10/13/2015	Sand	2" PVC, 10 slot	5	13 - 18	6.77	21.14	150	6.62
BCC MW-15004	645491.68	12624824.48	587.7	590.57	10/13/2015	Sand	2" PVC, 10 slot	10	5 - 15	10.27	18.01	NR	5.15
BCC MW-15005	645166.74	12624783.15	584.8	587.77	10/13/2015	Sand	2" PVC, 10 slot	10	5 - 15	7.61	18.12	150	5.84
BCC MW-15006	645291.65	12624610.52	584.9	587.81	10/13/2015	Sand	2" PVC, 10 slot	10	5 - 15	7.45	16.95	150	8.21
BCC MW-15007	645409.39	12624188.85	584.5	587.43	10/14/2015	Sand	2" PVC, 10 slot	6	4 - 10	6.78	13.08	140	9.37
BCC MW-15008	645340.01	12623510.47	584.8	587.76	10/14/2015	Sand	2" PVC, 10 slot	5	4 - 9	7.11	11.95	170	10.0

Notes:  
ft = feet  
bgs = below ground surface  
TOC = top of casing  
NTU = Nephelometric Turbidity Units  
NR = Not recorded

**Table 3**  
**Estimated Hydraulic Conductivity (K) Values**  
**Consumers Energy Co.**  
**B.C. Cobb Generating Facility**  
**Muskegon, Michigan**

Well ID	Test	Initial Displacement (ft)	Expected (calculated) Displacement (ft)	K (ft/d)	K (cm/sec)	Slug Test Solution
BCC MW-15017	2	0.804	1.15	39	1.38E-02	KGS Model (Hyder et. al, 1994)
	3	1.393	2.31	38	1.34E-02	KGS Model (Hyder et. al, 1994)
	Average				39	1.36E-02
BCC MW-15020	1	0.98	1.15	30	1.06E-02	KGS Model (Hyder et. al, 1994)
	3	1.911	2.31	35	1.24E-02	KGS Model (Hyder et. al, 1994)
	Average				33	1.15E-02
BCC MW-15021	1	0.936	1.15	62	2.19E-02	KGS Model (Hyder et. al, 1994)
	3	1.973	2.31	55	1.94E-02	KGS Model (Hyder et. al, 1994)
	Average				59	2.06E-02
BCC MW-15001	2	0.962	1.25	62	2.19E-02	KGS Model (Hyder et. al, 1994)
	3	1.828	2.31	56	1.98E-02	KGS Model (Hyder et. al, 1994)
	Average				59	2.08E-02
BCC MW-15005	1	1.191	1.69	90	3.18E-02	KGS Model (Hyder et. al, 1994)
	2	0.72	1.69	107	3.78E-02	KGS Model (Hyder et. al, 1994)
	Average				99	3.48E-02
BCC MW-15008	1	0.951	1.69	71	2.51E-02	Bouwer-Rice (1976)
	3	1.359	1.69	45	1.59E-02	Bouwer-Rice (1976)
	Average				58	2.05E-02
<b>Over all Average</b>				<b>58</b>	<b>2.03E-02</b>	
<b>Over all Geometric mean</b>				<b>54</b>	<b>1.89E-02</b>	
<b>Minimum</b>				<b>30</b>	<b>1.06E-02</b>	
<b>Maximum</b>				<b>107</b>	<b>3.78E-02</b>	

Note:  
cm/sec = centimeters per second  
ft = feet  
ft/d = feet per day

**References**

Bouwer, H., 1989. The Bouwer and Rice slug test--an update, Ground Water, vol. 27, no. 3, pp. 304-309

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

Butler, J.J., Jr., 1998. The Design, Performance, and Analysis of Slug Tests, Lewis Publishers, Boca Raton, 252p.

Hyder, Z, J.J. Butler, Jr., C.D. McElwee and W. Liu, 1994. Slug tests in partially penetrating wells, Water Resources Research, vol. 30, no. 11, pp. 2945-2957

# FIGURES



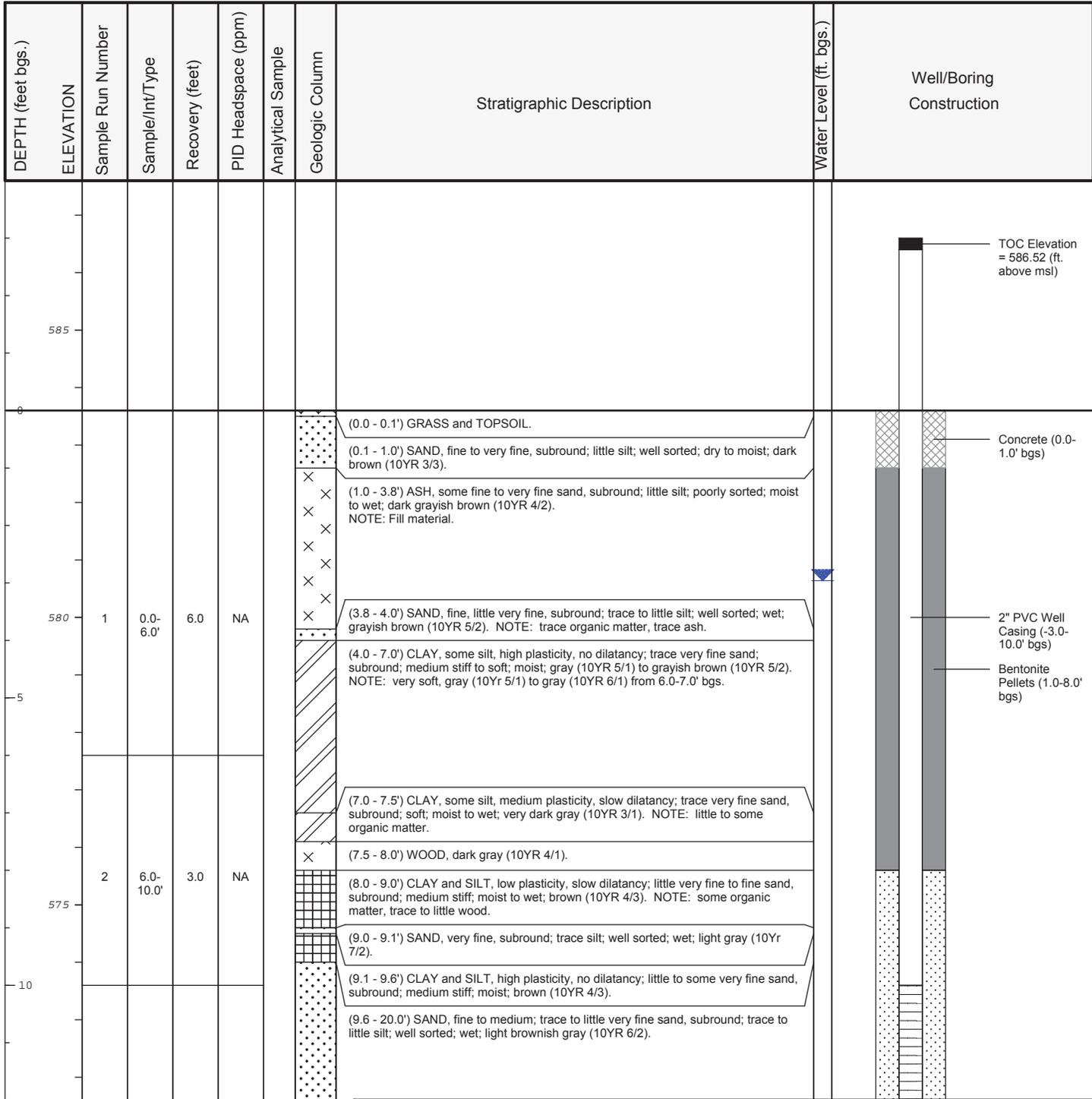


# APPENDIX A

## Soil Boring and Monitoring Well Construction Logs



<b>Date Start:</b> 10/12/15 <b>Date Finish:</b> 10/12/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Hand Auger/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 3.8 <b>Water Level Finish (ft. btoc.):</b> 5.96	<b>Northing:</b> 645763.32 <b>Easting:</b> 12624262.15 <b>Casing Elevation:</b> 586.52  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 583.6  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15001  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Cloudy, Windy
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**Remarks:** bgs = below ground surface  
btoc = below top of casing

Hand Auger to 6.0' bgs.  
Groundwater encountered at 3.8' bgs during drilling.  
Water level at development was 5.96' btoc.  
No odor or staining observed.  
Groundwater elevation measured on November 30, 2015 was 580.84 feet



<b>Date Start:</b> 10/12/15 <b>Date Finish:</b> 10/12/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Hand Auger/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 3.8 <b>Water Level Finish (ft. btoc.):</b> 5.96	<b>Northing:</b> 645763.32 <b>Easting:</b> 12624262.15 <b>Casing Elevation:</b> 586.52  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 583.6  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15001  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Cloudy, Windy
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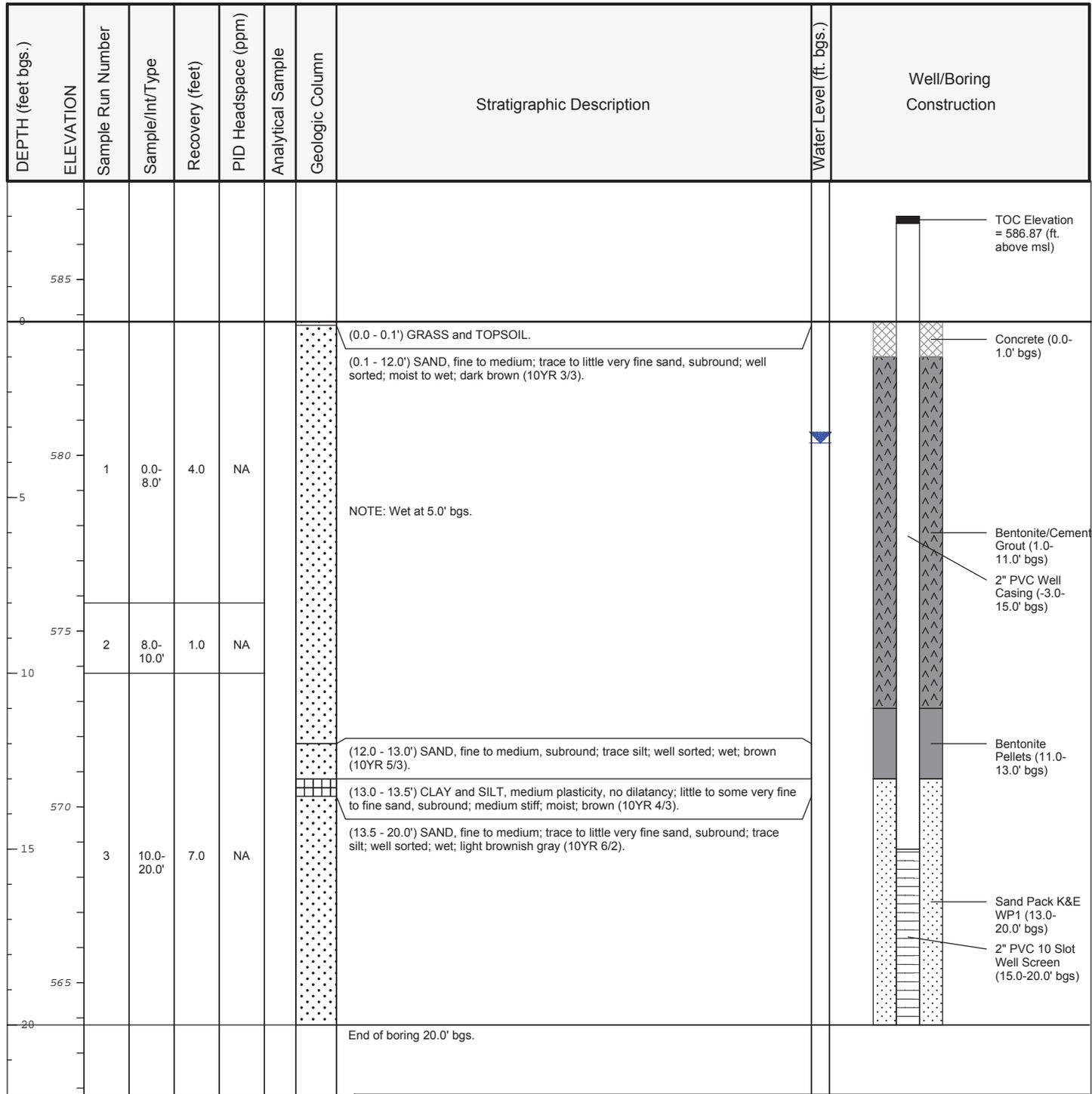
DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
15		3	10.0-20.0'	9.0	NA					<p>Sand Pack K&amp;E WP1 (10.0-20.0' bgs) 2" PVC 10 Slot Well Screen (10.0-20.0' bgs)</p>
20								NOTE: organic matter, roots, from 18.8 to 18.9' bgs.		
25								End of boring 20.0' bgs.		

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Hand Auger to 6.0' bgs. Groundwater encountered at 3.8' bgs during drilling. Water level at development was 5.96' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 580.84 feet
--	---

**Date Start:** 10/12/15  
**Date Finish:** 10/12/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** John Pitsch  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 5.0  
**Water Level Finish (ft. btoc.):** 6.45

**Northing:** 645701.73  
**Easting:** 12624512.86  
**Casing Elevation:** 586.87  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 583.8  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15002  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Cloudy, Windy



**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 5.0' bgs during drilling.  
 Water level at development was 6.45' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.86 feet



**Date Start:** 10/12/15  
**Date Finish:** 10/12/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** John Pitsch  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 11.0  
**Water Level Finish (ft. btoc.):** 6.77

**Northing:** 645555.93  
**Easting:** 12624726.22  
**Casing Elevation:** 587.12  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 584.1  
**Descriptions By:** A. Westhuis

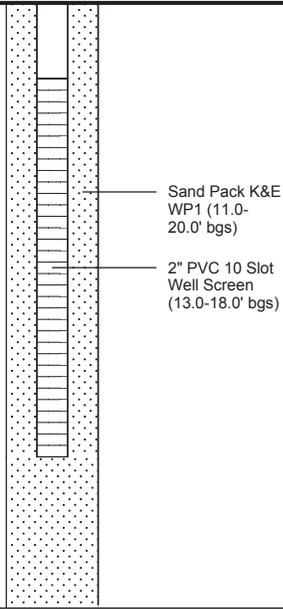
**Well/Boring ID:** BCC MW-15003  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Cloudy, Windy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
585										
0								(0.0 - 0.1') GRASS and TOPSOIL.		TOC Elevation = 587.12 (ft. above msl)
580		1	0.0-8.0'	3.5	NA			(0.1 - 10.0') SAND, fine to medium; trace to little very fine sand, subround; well sorted; moist to wet; dark brown (10YR 3/3).		Concrete (0.0-1.0' bgs)
575		2	8.0-10.0'	1.0	NA					Bentonite/Cement Grout (1.0-9.0' bgs) 2" PVC Well Casing (-3.0-13.0' bgs)
10								(10.0 - 11.0') CLAY and SILT, medium plasticity, no dilatancy; little to some very fine to fine sand, subround; medium stiff; moist; brown (10YR 4/3). NOTE: little to some organic matter; roots, wood.		Bentonite Pellets (9.0-11.0' bgs)
								(11.0 - 18.0') SAND, fine to medium; trace to little very fine sand, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/2).		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 11.0' bgs during drilling.  
 Water level at development was 6.77' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.84 feet



<b>Date Start:</b> 10/12/15 <b>Date Finish:</b> 10/12/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> John Pitsch <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 11.0 <b>Water Level Finish (ft. btoc.):</b> 6.77	<b>Northing:</b> 645555.93 <b>Easting:</b> 12624726.22 <b>Casing Elevation:</b> 587.12  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 584.1  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15003  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Cloudy, Windy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
15	570	3	10.0-20.0'	9.0	NA					
	565							(18.0 - 20.0') SAND, very fine to fine, subround; little to trace silt; well sorted; wet; grayish brown (10YR 5/2) to gray (10YR 6/1).  NOTE: Organic matter; roots, leaves, wood from 18.0 to 18.3' bgs and 19.0 to 19.1' bgs.		
20								End of boring 20.0' bgs.		
25	560									

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 8.0' bgs. Groundwater encountered at 11.0' bgs during drilling. Water level at development was 6.77' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 580.84 feet
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**Date Start:** 10/13/15  
**Date Finish:** 10/13/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 7.0  
**Water Level Finish (ft. btoc.):** 10.27

**Northing:** 645491.68  
**Easting:** 12624824.48  
**Casing Elevation:** 590.57  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 587.7  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15004  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 50 F Cloudy, Windy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
590										TOC Elevation = 590.57 (ft. above msl)
0								(0.0 - 0.1') GRASS and TOPSOIL.		Concrete (0.0-1.0' bgs)
585		1	0.0-8.0'	3.5	NA			(0.1 - 10.0') SAND, fine; little very fine sand, subround; trace granules, subround; trace silt; well sorted; dry to moist; light yellowish brown (10YR 6/4).		2" PVC Well Casing (-3.0-5.0' bgs)
5								NOTE: Wet at 7.0' bgs.		Bentonite Pellets (1.0-4.0' bgs)
580								(10.0 - 14.0') SAND, fine; little medium, subround; trace to little silt; well sorted; wet; grayish brown (10YR 5/2).		Sand Pack K&E WP1 (4.0-20.0' bgs)
10								NOTE: Trace organic material; wood at 13.5' bgs.		2" PVC 10 Slot Well Screen (5.0-15.0' bgs)
575		2	8.0-20.0'	10.0	NA			(14.0 - 17.0') SAND, medium; little coarse sand, subround; trace granules, subround; little silt; well sorted; wet; grayish brown (10YR 5/2).		
15								NOTE: Organic matter, wood; dark brown (10YR 3/3) from 16.5 to 17.0' bgs.		
570								(17.0 - 20.0') SAND, very fine to fine, subround; little silt; well sorted; wet; grayish brown (10YR 5/2).		
20								End of boring 20.0' bgs.		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 7.0' bgs during drilling.  
 Water level at development was 10.27' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.82 feet



**Date Start:** 10/13/15  
**Date Finish:** 10/13/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 6.0  
**Water Level Finish (ft. btoc.):** 7.61

**Northing:** 645166.74  
**Easting:** 12624783.15  
**Casing Elevation:** 587.77  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 584.8  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15005  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 50 F Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	585							(0.0 - 0.1') GRASS and TOPSOIL.		TOC Elevation = 587.77 (ft. above msl)
5	580	1	0.0-6.0'	6.0	NA		(0.1 - 10.0') SAND, fine; little very fine sand, subround; trace granules, subround; little to trace silt; well sorted; moist to wet; pale brown (10YR 6/3).			Concrete (0.0-1.0' bgs) 2" PVC Well Casing (-3.0-5.0' bgs) Bentonite Pellets (1.0-4.0' bgs)
10	575	2	6.0-10.0'	4.0	NA		NOTE: Wet at 6.0' bgs.			
15	570	3	10.0-20.0'	8.0	NA		(10.0 - 10.5') SAND, fine, subround; little silt; well sorted; wet; very dark gray (10YR 3/1). NOTE: trace organic matter, large wood fragments. (10.5 - 20.0') SAND, fine to medium; trace coarse sand, subround; little to trace silt; well sorted; wet; grayish brown (10YR 5/2).			Sand Pack K&E WP1 (4.0-20.0' bgs) 2" PVC 10 Slot Well Screen (5.0-15.0' bgs)
20	565						End of boring 20.0' bgs.			

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 6.0' bgs.  
 Groundwater encountered at 6.0' bgs during drilling.  
 Water level at development was 7.61' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.54 feet



<b>Date Start:</b> 10/13/15 <b>Date Finish:</b> 10/13/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 5.0 <b>Water Level Finish (ft. btoc.):</b> 7.45	<b>Northing:</b> 645291.65 <b>Easting:</b> 12624610.52 <b>Casing Elevation:</b> 587.81  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 584.9  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15006  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 50 F Cloudy
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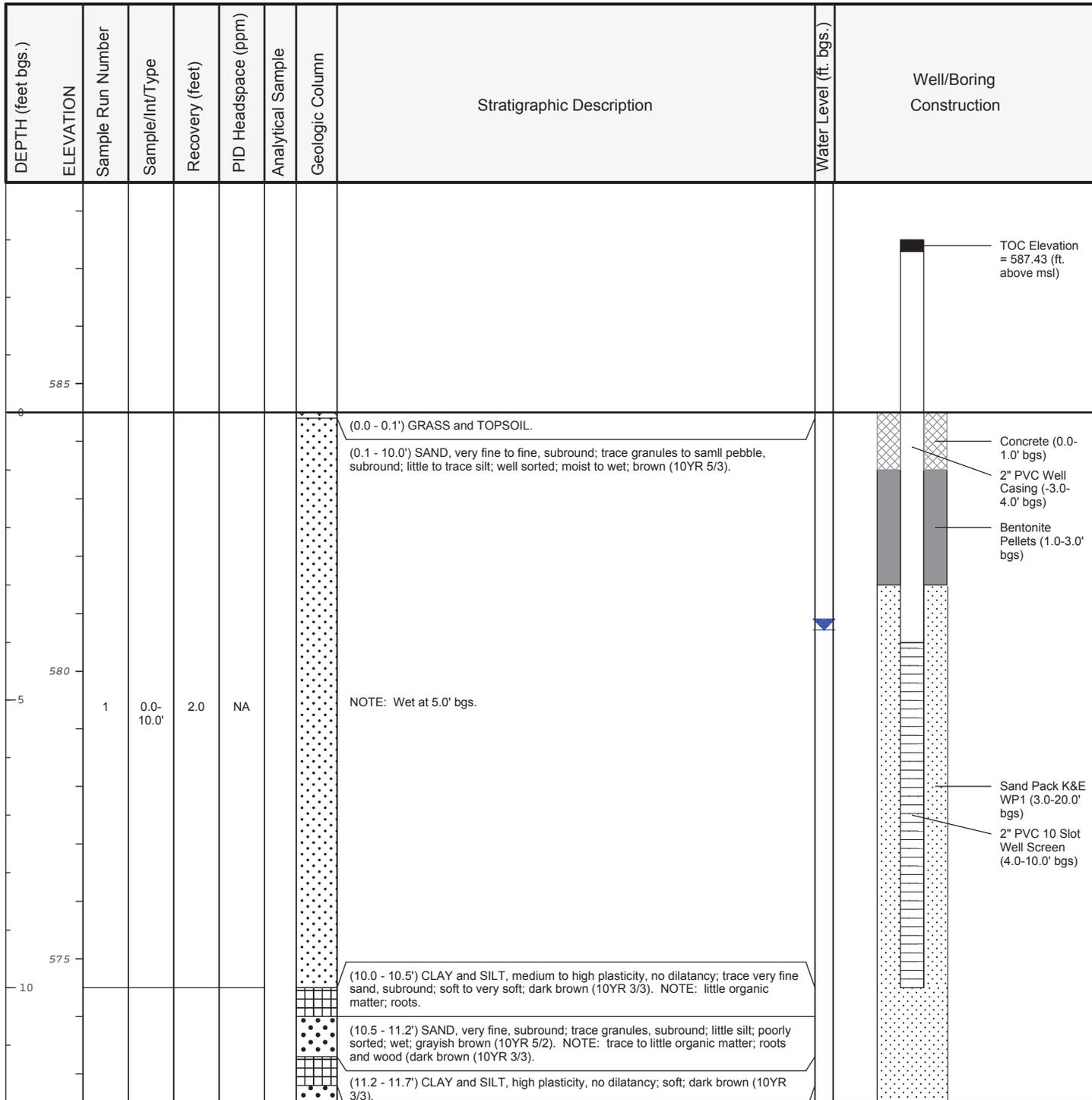
DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	585							(0.0 - 0.1') LANDSCAPING STONE.		TOC Elevation = 587.81 (ft. above msl)
5	580	1	0.0-10.0'	4.0	NA		(0.1 - 9.0') SAND, fine, subround; trace granules, subround; trace silt; well sorted; moist to wet; light yellowish brown (10YR 6/4).	NOTE: Wet at 5.0' bgs.		Concrete (0.0-1.0' bgs) 2" PVC Well Casing (-3.0-5.0' bgs) Bentonite Pellets (1.0-4.0' bgs)
10	575						(9.0 - 20.0') SAND, fine to medium, subround; trace granules, subround; well sorted; wet; light brownish gray (10YR 6/2).			Sand Pack K&E WP1 (4.0-20.0' bgs) 2" PVC 10 Slot Well Screen (5.0-15.0' bgs)
15	570	2	10.0-20.0'	8.0	NA					
20	565							End of boring 20.0' bgs.		

**Remarks:** bgs = below ground surface  
btoc = below top of casing

Air Knife to 6.0' bgs.  
Groundwater encountered at 5.0' bgs during drilling.  
Water level at development was 7.45' btoc.  
No odor or staining observed.  
Groundwater elevation measured on November 30, 2015 was 581.14 feet



<b>Date Start:</b> 10/14/15 <b>Date Finish:</b> 10/14/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 5.0 <b>Water Level Finish (ft. btoc.):</b> 6.78	<b>Northing:</b> 645409.39 <b>Easting:</b> 12624188.85 <b>Casing Elevation:</b> 587.43  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 584.5  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15007  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 50 F Cloudy
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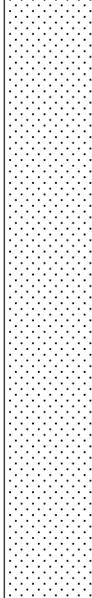


**Remarks:** bgs = below ground surface  
btoc = below top of casing

Air Knife to 9.0' bgs.  
Groundwater encountered at 5.0' bgs during drilling.  
Water level at development was 6.78' btoc.  
No odor or staining observed.  
Groundwater elevation measured on November 30, 2015 was 581.13 feet



<b>Date Start:</b> 10/14/15 <b>Date Finish:</b> 10/14/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 5.0 <b>Water Level Finish (ft. btoc.):</b> 6.78	<b>Northing:</b> 645409.39 <b>Easting:</b> 12624188.85 <b>Casing Elevation:</b> 587.43  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 584.5  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15007  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 50 F Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
15	570	2	10.0-20.0'	8.0	NA			<p>(11.7 - 12.5') SAND, very fine to fine, subround; little silt; poorly sorted; wet; pale brown (10YR 6/3).</p> <p>NOTE: Organic rich matter roots and wood; dark brown (10YR 3/3) from 12.0 to 12.5' bgs.</p> <p>(12.5 - 20.0') SAND, fine to medium; little very fine sand, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/2).</p> <p>NOTE: Organic matter wood; dark brown (10YR 3/3) from 19.5 to 20.0' bgs.</p>		
20	565							End of boring 20.0' bgs.		
25	560									

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 9.0' bgs. Groundwater encountered at 5.0' bgs during drilling. Water level at development was 6.78' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 581.13 feet
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**Date Start:** 10/14/15  
**Date Finish:** 10/14/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 4.5  
**Water Level Finish (ft. btoc.):** 7.11

**Northing:** 645340.01  
**Easting:** 12623510.47  
**Casing Elevation:** 587.76  
**Borehole Depth (ft. bgs.):** 20.0  
**Surface Elevation:** 584.8  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15008  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	585							(0.0 - 0.1') LANDSCAPING STONE.		TOC Elevation = 587.76 (ft. above msl)
0 - 9.5							(0.1 - 9.5') SAND, fine to very fine, subround; trace granules to small pebble, subround; little silt; well sorted; moist to wet; brown (10YR 5/3).	NOTE: Wet at 4.5' bgs.		Concrete (0.0-1.0' bgs) 2" PVC Well Casing (-3.0-4.0' bgs) Bentonite Pellets (1.0-3.0' bgs)
5	580	1	0.0-10.0'	3.0	NA				4.5	Sand Pack K&E WP1 (3.0-20.0' bgs) 2" PVC 10 Slot Well Screen (4.0-9.0' bgs)
10	575							(9.5 - 12.0') SAND, fine, little medium sand, subround; little to trace silt; well sorted; wet; grayish brown (10YR 5/2).		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 4.5' bgs during drilling.  
 Water level at development was 7.11' btoc.  
 No staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.99 feet



<b>Date Start:</b> 10/14/15 <b>Date Finish:</b> 10/14/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 4.5 <b>Water Level Finish (ft. btoc.):</b> 7.11	<b>Northing:</b> 645340.01 <b>Easting:</b> 12623510.47 <b>Casing Elevation:</b> 587.76  <b>Borehole Depth (ft. bgs.):</b> 20.0 <b>Surface Elevation:</b> 584.8  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15008  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Partly Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
15	570	2	10.0-20.0'	9.0	NA			<p>(12.0 - 13.0') SAND, fine, little medium sand, subround; little to some silt; poorly sorted; wet; dark grayish brown (10YR 4/2). NOTE: wood fragments; very dark gray (10YR 3/1), slight odor at 12.0' bgs.</p> <p>(13.0 - 13.5') CLAY and SILT, low plasticity, no dilatancy; little to trace very fine to fine sand, subround; soft; dark brown (10YR 3/3). NOTE: little organic matter, roots.</p> <p>(13.5 - 15.5') SAND, fine, subround; some silt; poorly sorted; wet; brown (10YR 4/3). NOTE: trace organics.</p> <p>(15.5 - 20.0') SAND, fine to medium; trace silt; well sorted; wet; grayish brown (10YR 5/2).</p>		
20	565							End of boring 20.0' bgs.		
25	560									

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 8.0' bgs. Groundwater encountered at 4.5' bgs during drilling. Water level at development was 7.11' btoc. No staining observed. Groundwater elevation measured on November 30, 2015 was 580.99 feet
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**Date Start:** 10/14/15  
**Date Finish:** 10/14/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 0.5  
**Water Level Finish (ft. btoc.):** 7.51

**Northing:** 645606.92  
**Easting:** 12623622.98  
**Casing Elevation:** 589.27  
  
**Borehole Depth (ft. bgs.):** 24.0  
**Surface Elevation:** 586.3  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15009  
**Client:** Consumers Energy  
  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
590										TOC Elevation = 589.27 (ft. above msl)
0								(0.0 - 8.0') NO RECOVERY, soils not logged, air knife soil cuttings disposed in CE approved area.		Concrete (0.0-1.0' bgs)
585		1	0.0-8.0'	0.0	NA			NOTE: Wet at 4.5' bgs.	7.51	2" PVC Well Casing (-3.0-14.0' bgs) Bentonite/Cement Grout (1.0-11.0' bgs)
580		2	8.0-10.0'	2.0	NA	X X X X X		(8.0 - 10.0') ASH, rapid dilatancy; wet; soft; very dark gray (10YR 3/1). NOTE: Fill material. Little to trace organic matter; roots and wood fragments.		
10								(10.0 - 12.0') CLAY and SILT, low plasticity, no dilatancy; some to little very fine to fine sand, subround; soft; dark brown (10YR 3/3).		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 0.5' bgs during drilling.  
 Water level at development was 7.51' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 581.88 feet



**Date Start:** 10/14/15  
**Date Finish:** 10/14/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 0.5  
**Water Level Finish (ft. btoc.):** 7.51

**Northing:** 645606.92  
**Easting:** 12623622.98  
**Casing Elevation:** 589.27  
**Borehole Depth (ft. bgs.):** 24.0  
**Surface Elevation:** 586.3  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15009  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
575		3	10.0-15.0'	4.0	NA			(12.0 - 17.2') SAND, fine, subround; little silt; well sorted; wet; brown (10YR 4/3). NOTE: Some clay, low plasticity, no dilatancy; soft; dark brown (10YR 3/3).		Bentonite Pellets (11.0-13.0' bgs)
15										
570		4	15.0-20.0'	5.0	NA			NOTE: Some organic rich matter, roots and wood; wet; very dark brown (10YR 2/2) from 17.0 to 17.2' bgs.  (17.2 - 24.0') CLAY and SILT, low plasticity, no dilatancy; little to trace very fine to fine sand, subround; soft; dark brown (10YR 3/3). NOTE: little organic matter, roots.		Sand Pack K&E WP1 (13.0-24.0' bgs) 2" PVC 10 Slot Well Screen (14.0-24.0' bgs)
20										
565		5	20.0-24.0'	4.0	NA					
25								End of boring 24.0' bgs.		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 0.5' bgs during drilling.  
 Water level at development was 7.51' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 581.88 feet





**Date Start:** 10/14/15  
**Date Finish:** 10/15/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 0.3  
**Water Level Finish (ft. btoc.):** 6.93

**Northing:** 645690.69  
**Easting:** 12623979.47  
**Casing Elevation:** 588.11  
**Borehole Depth (ft. bgs.):** 24.0  
**Surface Elevation:** 585.2  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15010  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
15	570	2	10.0-20.0'	8.0	NA			NOTE: Little silt and organic matter near 17.0' bgs.		<p>           Sand Pack K&amp;E WP1 (11.0-22.0' bgs)            2" PVC 10 Slot Well Screen (12.0-22.0' bgs)         </p>
20	565	3	20.0-24.0'	4.0	NA					
25	560							End of boring 24.0' bgs.		



**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 0.3' bgs during drilling.  
 Water level at development was 6.93' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 581.42 feet



<b>Date Start:</b> 10/15/15 <b>Date Finish:</b> 10/15/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 6.5 <b>Water Level Finish (ft. btoc.):</b> 13.03	<b>Northing:</b> 64578029 <b>Easting:</b> 12623765.87 <b>Casing Elevation:</b> 595.22  <b>Borehole Depth (ft. bgs.):</b> 32.0 <b>Surface Elevation:</b> 592.3  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15011  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Partly Cloudy
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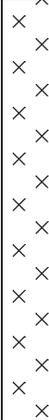
DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
575							X X X X	(18.0 - 19.0') CLAY and SILT, medium to high plasticity, no dilatancy; medium stiff to soft; moist; dark brown (10YR 3/3). NOTE: organic rich, some wood and roots; slight odor.		
20							X	(19.0 - 26.0') SAND, fine, subround; some to little silt; well sorted; wet; light brownish gray (10YR 6/2).		Bentonite Pellets (18.0-20.0' bgs)
570		3	20.0-32.0'	9.0	NA		.	(26.0 - 27.0') SAND, fine, little medium sand, subround; little silt; poorly sorted; wet; dark grayish brown (10YR 4/2). NOTE: organic rich, some roots and wood.		Sand Pack K&E WP1 (20.0-32.0' bgs)
25							.	(27.0 - 32.0') SAND, fine, little very fine sand, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/2).		2" PVC 10 Slot Well Screen (21.0-31.0' bgs)
565							.			
30							.			
560							.	End of boring 32.0' bgs.		
35							.			

	<p><b>Remarks:</b> bgs = below ground surface btoc = below top of casing</p> <p>Air Knife to 9.0' bgs. Groundwater encountered at 6.5' bgs during drilling. Water level at development was 13.03' btoc. No staining observed. Groundwater elevation measured on November 30, 2015 was 582.13 feet</p>
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**Date Start:** 10/15/15  
**Date Finish:** 10/15/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 8.0  
**Water Level Finish (ft. btoc.):** 13.79

**Northing:** 645889.92  
**Easting:** 12623545.99  
**Casing Elevation:** 597.39  
  
**Borehole Depth (ft. bgs.):** 35.0  
**Surface Elevation:** 594.5  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15012  
**Client:** Consumers Energy  
  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
595										TOC Elevation = 597.39 (ft. above msl)
0								(0.0 - 0.1') GRASS, ROOTS and ASH.		Concrete (0.0-1.0' bgs)
5	590	1	0.0-10.0'	3.0	NA		 (0.1 - 9.0') SAND, fine, subround, and ASH; little silt; poorly sorted; wet; soft; dark grayish brown (10YR 4/2).  NOTE: Wet at 8.0' bgs.			
10	585						 (9.0 - 18.0') ASH, little fine sand, subround; non-plastic, rapid dilatancy; poorly sorted; wet; soft; gray (10YR 5/1). NOTE: Fill material.  NOTE: Laminated from 13.0-15.0' bgs.	8.0		2" PVC Well Casing (-3.0-21.0' bgs) Bentonite/Cement Grout (1.0-18.0' bgs)
15	580	2	10.0-20.0'	9.0	NA					

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 9.0' bgs.  
 Groundwater encountered at 8.0' bgs during drilling.  
 Water level at development was 13.79' btoc.  
 No staining observed.  
 Groundwater elevation measured on November 30, 2015 was 583.46 feet





**Date Start:** 10/15/15  
**Date Finish:** 10/16/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 9.5  
**Water Level Finish (ft. btoc.):** 16.38

**Northing:** 645716.41  
**Easting:** 12623389.21  
**Casing Elevation:** 598.5  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 595.9  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15013  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	595	1	0.0-10.0'	5.0	NA			(0.0 - 0.1') GRASS, ROOTS and ASH. (0.1 - 9.5') SAND, fine, subround, and ASH; poorly sorted; moist; yellowish brown (10YR 5/6) to dark yellowish brown (10YR 3/6).		
5	590							NOTE: Wet at 9.5' bgs. (9.5 - 10.5') ASH, little fine sand, subround; non-plastic, rapid dilatancy; poorly sorted; wet; soft; gray (10YR 5/1) to dark gray (10YR 4/1). NOTE: Fill material. (10.5 - 13.5') SAND, fine to medium, and ASH; trace coarse sand, subround; poorly sorted; moist to wet; dark yellowish brown (10YR 4/4) to brown (10YR 4/3).		
10	585							(13.5 - 28.0') ASH; little fine sand, subround; non-plastic, rapid dilatancy; poorly sorted; wet; very soft; gray (10YR 5/1) to grayish brown (10YR 5/2).		
15	580	2	10.0-20.0'	9.0	NA					
20	575									

**Remarks:** bgs = below ground surface  
 Air Knife to 9.0' bgs.  
 Groundwater encountered at 9.5' bgs during drilling.  
 Water level at development was 16.38' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 582.33 feet above mean sea level.



**Date Start:** 10/15/15  
**Date Finish:** 10/16/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 9.5  
**Water Level Finish (ft. btoc.):** 16.38

**Northing:** 645716.41  
**Easting:** 12623389.21  
**Casing Elevation:** 598.5  
  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 595.9  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15013  
**Client:** Consumers Energy  
  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headpace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	570	3	20.0-25.0'	4.0	NA		X X X X X X X X X			
30	565		25.0-30.0	5.0	NA		X	(28.0 - 36.0') SAND, fine, trace medium sand, subround; trace silt; well sorted; wet; light gray (10YR 7/2) to very pale brown (10YR 7/3).		Bentonite Pellets (27.0-29.0' bgs)
35	560		30.0-35.0	5.0	NA			(36.0 - 36.5') SAND, fine, subround; trace silt and organics; light gray (10YR 7/1) to dark yellowish brown (10YR 4/4). NOTE: some leaves and small sticks.		Sand Pack K&E WP1 (29.0-40.0' bgs)
40	555		35.0-40.0	4.0	NA			(36.5 - 37.5') CLAY and SILT, low plasticity to non-plastic, no dilatancy; moist; medium stiff; dark brown (10YR 3/3). NOTE: some organics, leaves, roots and wood.		2" PVC 10 Slot Well Screen (30.0-40.0' bgs)
								(37.5 - 40.0') SAND, fine, subround; trace silt; well sorted; wet; light gray (10YR 7/2).		
45	550							End of boring 40.0' bgs.		

**Remarks:** bgs = below ground surface  
  
 Air Knife to 9.0' bgs.  
 Groundwater encountered at 9.5' bgs during drilling.  
 Water level at development was 16.38' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 582.33 feet above mean sea level.



**Date Start:** 10/16/15  
**Date Finish:** 10/16/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 14.0  
**Water Level Finish (ft. btoc.):** 15.50

**Northing:** 645925.93  
**Easting:** 12623318.73  
**Casing Elevation:** 599.04  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 596.2  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15014  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
600										
0								(0.0 - 0.1') GRASS, ROOTS and ASH.		TOC Elevation = 599.04 (ft. above msl)
5	595	1	0.0-10.0'	3.0	NA			(0.1 - 14.0') SAND, fine to medium, subround, and ASH; poorly sorted; soft; moist to wet; brown (10YR 5/3) to dark grayish brown (10YR 4/2). NOTE: Fill material.		Concrete (0.0-1.0' bgs)
10	590									
15	585							(14.0 - 14.5') ASH, little fine sand, subround; non-plastic, rapid dilatancy; poorly sorted; wet; soft; very dark grayish brown (10YR 5/2) to dark gray (10YR 4/1). NOTE: Fill material. Little to trace organics; roots.		2" PVC Well Casing (-3.0-23.0' bgs)
15	580	2	10.0-20.0'	9.0	NA			(14.5 - 17.5') ASH, non-plastic, rapid dilatancy; poorly sorted; wet; soft; dark gray (10YR 4/1). NOTE: Fill material.	14.0	Bentonite/Cement Grout (1.0-20.0' bgs)
20								(17.5 - 20.0') ASH, non-plastic, rapid dilatancy; poorly sorted; wet; soft; grayish brown (10YR 5/2) to dark gray (10YR 4/1). NOTE: Fill material, laminated.		
20	575							(20.0 - 27.0') SAND, fine, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/2). NOTE: Organic rich matter, roots, leaves; dark brown (10YR 3/3) from 20.0 to 20.5' bgs.		Bentonite Pellets (20.0-22.0' bgs)

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 9.25' bgs.  
 Groundwater encountered at 14.0' bgs during drilling.  
 Water level at development was 15.50' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 583.19 feet



<b>Date Start:</b> 10/16/15 <b>Date Finish:</b> 10/16/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 14.0 <b>Water Level Finish (ft. btoc.):</b> 15.50	<b>Northing:</b> 645925.93 <b>Easting:</b> 12623318.73 <b>Casing Elevation:</b> 599.04  <b>Borehole Depth (ft. bgs.):</b> 40.0 <b>Surface Elevation:</b> 596.2  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15014  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Partly Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	570	3	20.0-30.0'	8.0	NA					<p>Sand Pack K&amp;E WP1 (22.0-40.0' bgs) 2" PVC 10 Slot Well Screen (23.0-31.0' bgs)</p>
30	565						(27.0 - 31.0') SAND, fine, subround; some silt; little clay; poorly sorted; wet; light brownish gray (10YR 6/2). NOTE: little to some organics, roots and wood from 27.0 to 27.1' bgs and at 30.0' bgs.			
35	560	4	30.0-40.0	9.0	NA		(31.0 - 34.0') SAND and SILT; trace clay; non-plastic, rapid dilatancy; wet; poorly sorted; soft; dark grayish brown (10YR 4/2). NOTE: rich organic layer; some roots and wood.			
							(34.0 - 36.0') SAND, fine, subround; little silt; well sorted; wet; light brownish gray (10YR 6/2).			
							(36.0 - 37.5') SAND, fine, and ORGANICS; poorly sorted; wet; dark brown (10YR 3/3) to light gray (10YR 7/2).			
							(37.5 - 39.0') SAND, fine, subround; well sorted; wet; light brownish gray (10YR 6/2).			
40	555						(39.0 - 40.0') CLAY and SILT, low plasticity to non-plastic, no dilatancy; moist; medium stiff; dark brown (10YR 3/3).			
45	550						End of boring 40.0' bgs.			

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 9.25' bgs. Groundwater encountered at 14.0' bgs during drilling. Water level at development was 15.50' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 583.19 feet
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**Date Start:** 10/16/15  
**Date Finish:** 10/19/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 8.5  
**Water Level Finish (ft. btoc.):** 12.16

**Northing:** 646138.93  
**Easting:** 12623024.09  
**Casing Elevation:** 596.75  
**Borehole Depth (ft. bgs.):** 30.0  
**Surface Elevation:** 593.9  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15015  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
595										
0								(0.0 - 8.5') SAND, fine to medium, and ASH, subangular; poorly sorted; moist; dark grayish brown (4/2). NOTE: Fill material.		TOC Elevation = 596.75 (ft. above msl) Concrete (0.0-1.0' bgs)
5		1	0.0-10.0'	2.0	NA					
585								(8.5 - 14.0') ASH, non-plastic, rapid dilatancy; wet; soft; very dark grayish brown (10YR 3/2). NOTE: Fill material.		2" PVC Well Casing (-3.0-20.0' bgs) Bentonite/Cement Grout (1.0-17.0' bgs)
10										
580										

NOTE: Wood fragments at 14.0' bgs.

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.5' bgs.  
 Groundwater encountered at 8.5' bgs during drilling.  
 Water level at development was 12.16' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.81 feet



<b>Date Start:</b> 10/16/15 <b>Date Finish:</b> 10/19/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 8.5 <b>Water Level Finish (ft. btoc.):</b> 12.16	<b>Northing:</b> 646138.93 <b>Easting:</b> 12623024.09 <b>Casing Elevation:</b> 596.75  <b>Borehole Depth (ft. bgs.):</b> 30.0 <b>Surface Elevation:</b> 593.9  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15015  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Partly Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
15		2	10.0-20.0'	9.0	NA		(14.0 - 17.0') SAND, fine, subround; well sorted; wet; light brownish gray (10YR 6/4). NOTE: light yellowish brown (10YR 6/4) from 14.0-16.0' bgs; pale brown (10YR 6/3) from 16.-17.0' bgs.			
575						X X X X	(17.0 - 19.0') FILL material, wood fragments; brown (10YR 4/3) to very dark brown (10YR 2/2).			Bentonite Pellets (17.0-19.0' bgs)
20							(19.0 - 29.0') SAND, fine, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/4).			
570										
25		3	20.0-30.0'	10.0	NA			NOTE: Little clay and silt at 27.0' bgs.		
565							(29.0 - 29.5') CLAY and SILT, low to medium plasticity, no dilatancy; little fine sand, subround; moist; medium stiff; brown (10YR 4/3). NOTE: organic rich, wood near 29.5' bgs.			
30							(29.5 - 30.0') SAND, fine, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/4).			Sand Pack K&E WP1 (19.0-30.0' bgs) 2" PVC 10 Slot Well Screen (20.0-30.0' bgs)
							End of boring 30.0' bgs.			

 <small>Design &amp; Consultancy for natural and built assets</small>	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 8.5' bgs. Groundwater encountered at 8.5' bgs during drilling. Water level at development was 12.16' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 580.81 feet
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**Date Start:** 10/19/15  
**Date Finish:** 10/19/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 8.5  
**Water Level Finish (ft. btoc.):** 8.65

**Northing:** 646227.56  
**Easting:** 12622459.26  
**Casing Elevation:** 589.05  
**Borehole Depth (ft. bgs.):** 45.0  
**Surface Elevation:** 586.2  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15016  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
590										TOC Elevation = 589.05 (ft. above msl)
8								(0.0 - 15.0') SAND, fine to medium, and ASH; little coarse, subround; poorly sorted; moist to wet; dark grayish brown (10YR 4/2). NOTE: Fill material, trace coal fragments.		Concrete (0.0-1.0' bgs)
5		1	0.0-10.0'	3.0	NA			NOTE: Wet at 9.0' bgs.	8.5	
580										
10										
575										
15		2	10.0-20.0'	10.0	NA			(15.0 - 17.0') SAND, fine, subround; little silt; well sorted; wet; light brownish gray (10YR 6/4).		2" PVC Well Casing (-3.0-35.0' bgs)
570								(17.0 - 19.0') FILL material, wood fragments; some fine sand, subround; brown (10YR 4/3) to very dark brown (10YR 2/2).		Bentonite/Cement Grout (1.0-32.0' bgs)
20								(19.0 - 25.0') SAND, fine, subround; some clay; some to trace silt, non-plastic, no dilatancy; medium stiff; well sorted; wet; light brownish gray (10YR 6/4).		
565								NOTE: organic rich matter, leaves, sticks, wood; moist; dark brown (10YR 3/3) from 21.0 to 25.0' bgs.		

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.5' bgs.  
 Groundwater encountered at 8.5' bgs during drilling.  
 Water level at development was 8.65' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.08 feet

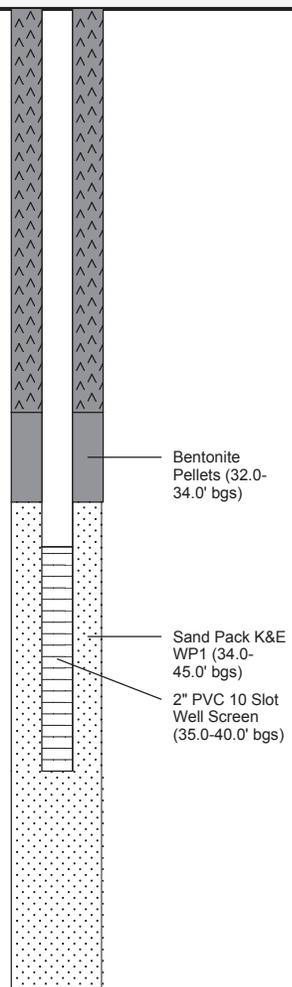


**Date Start:** 10/19/15  
**Date Finish:** 10/19/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 8.5  
**Water Level Finish (ft. btoc.):** 8.65

**Northing:** 646227.56  
**Easting:** 12622459.26  
**Casing Elevation:** 589.05  
**Borehole Depth (ft. bgs.):** 45.0  
**Surface Elevation:** 586.2  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15016  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	560	3	20.0-30.0'	10.0	NA			(25.0 - 27.0') SAND, fine, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/4).		
								(27.0 - 28.5') CLAY and SILT, low plasticity to non-plastic, no dilatancy; little fine sand, subround; moist; soft; dark brown (10YR 3/3). NOTE: organic rich, trace roots.		
								(28.5 - 28.8') SAND, fine, subround; trace silt; well sorted; wet; light brownish gray (10YR 6/4).		
								(28.8 - 35.0') CLAY and SILT, low plasticity to non-plastic, no dilatancy; little fine sand, subround; moist; soft; dark brown (10YR 3/3). NOTE: Organic rich; trace roots from 28.8 to 30.0' bgs.		
								NOTE: Trace shell fragments at 34.0' bgs.		
35	550	4	30.0-40.0'	9.0	NA			(35.0 - 37.0') SAND, fine, subround; little silt; well sorted; wet; yellowish brown (10YR 5/4).		
								(37.0 - 40.5') SAND, fine, subround; trace silt; well sorted; wet; pale brown (10YR 6/3).		
								NOTE: Trace small pebble, subround at 39.0' bgs.		
40	545	5	40.0-45.0'	5.0	NA			(40.5 - 45.0') CLAY, high plasticity, no dilatancy; trace silt; moist; medium stiff to soft; gray (10YR 7/1).		
45	540							End of boring 45.0' bgs.		



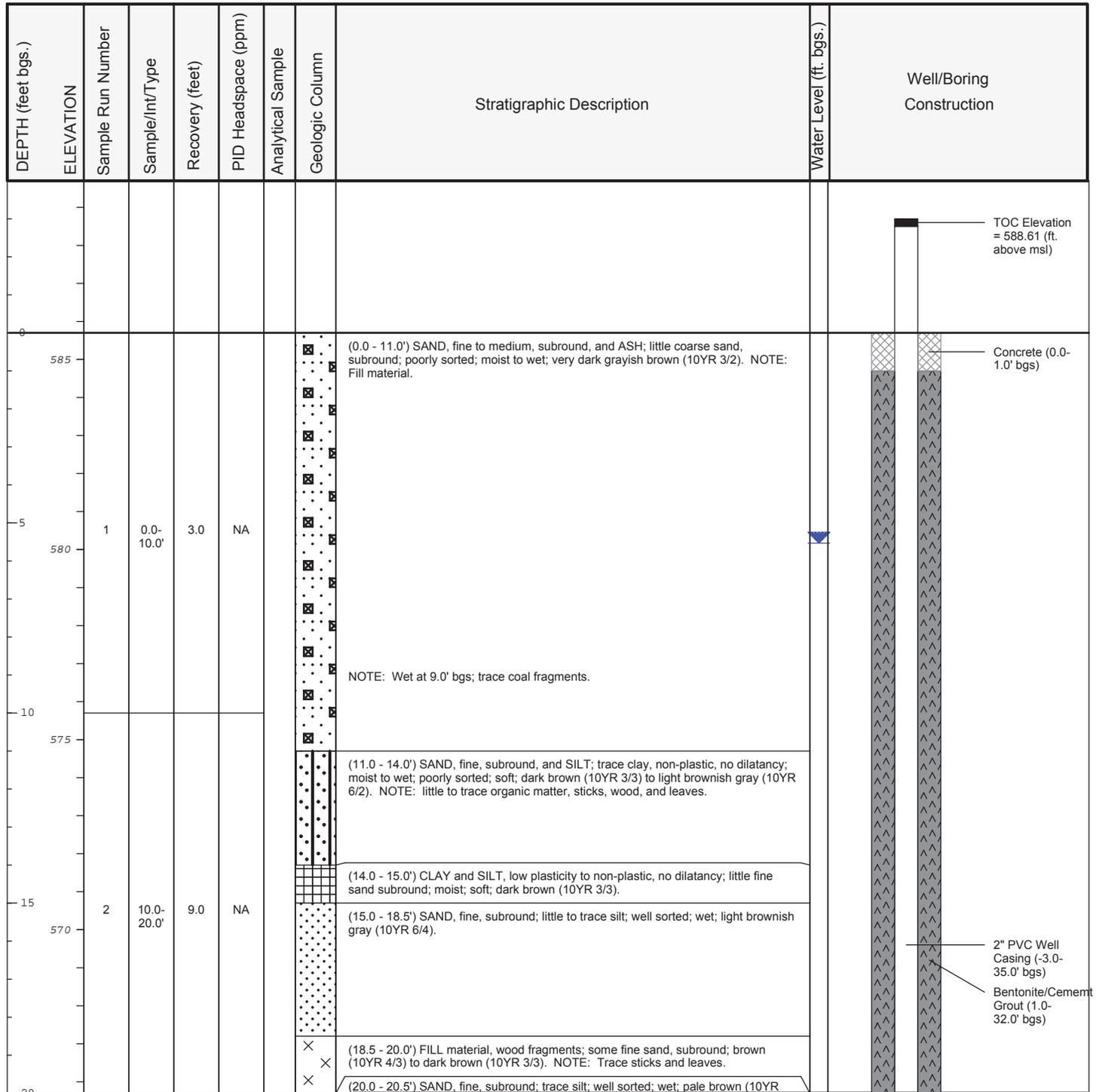
**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.5' bgs.  
 Groundwater encountered at 8.5' bgs during drilling.  
 Water level at development was 8.65' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.08 feet



**Date Start:** 10/19/15  
**Date Finish:** 10/20/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 8.0  
**Water Level Finish (ft. btoc.):** 8.53

**Northing:** 646354.69  
**Easting:** 12622085.55  
**Casing Elevation:** 588.61  
**Borehole Depth (ft. bgs.):** 40.0  
**Surface Elevation:** 585.7  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15017  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy, Windy



**Remarks:** bgs = below ground surface  
  
 Air Knife to 8.0' bgs.  
 Groundwater encountered at 8.0' bgs during drilling.  
 Water level at development was 8.53' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 579.99 feet above mean sea level.



<b>Date Start:</b> 10/19/15 <b>Date Finish:</b> 10/20/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 8.0 <b>Water Level Finish (ft. btoc.):</b> 8.53	<b>Northing:</b> 646354.69 <b>Easting:</b> 12622085.55 <b>Casing Elevation:</b> 588.61  <b>Borehole Depth (ft. bgs.):</b> 40.0 <b>Surface Elevation:</b> 585.7  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15017  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Partly Cloudy, Windy
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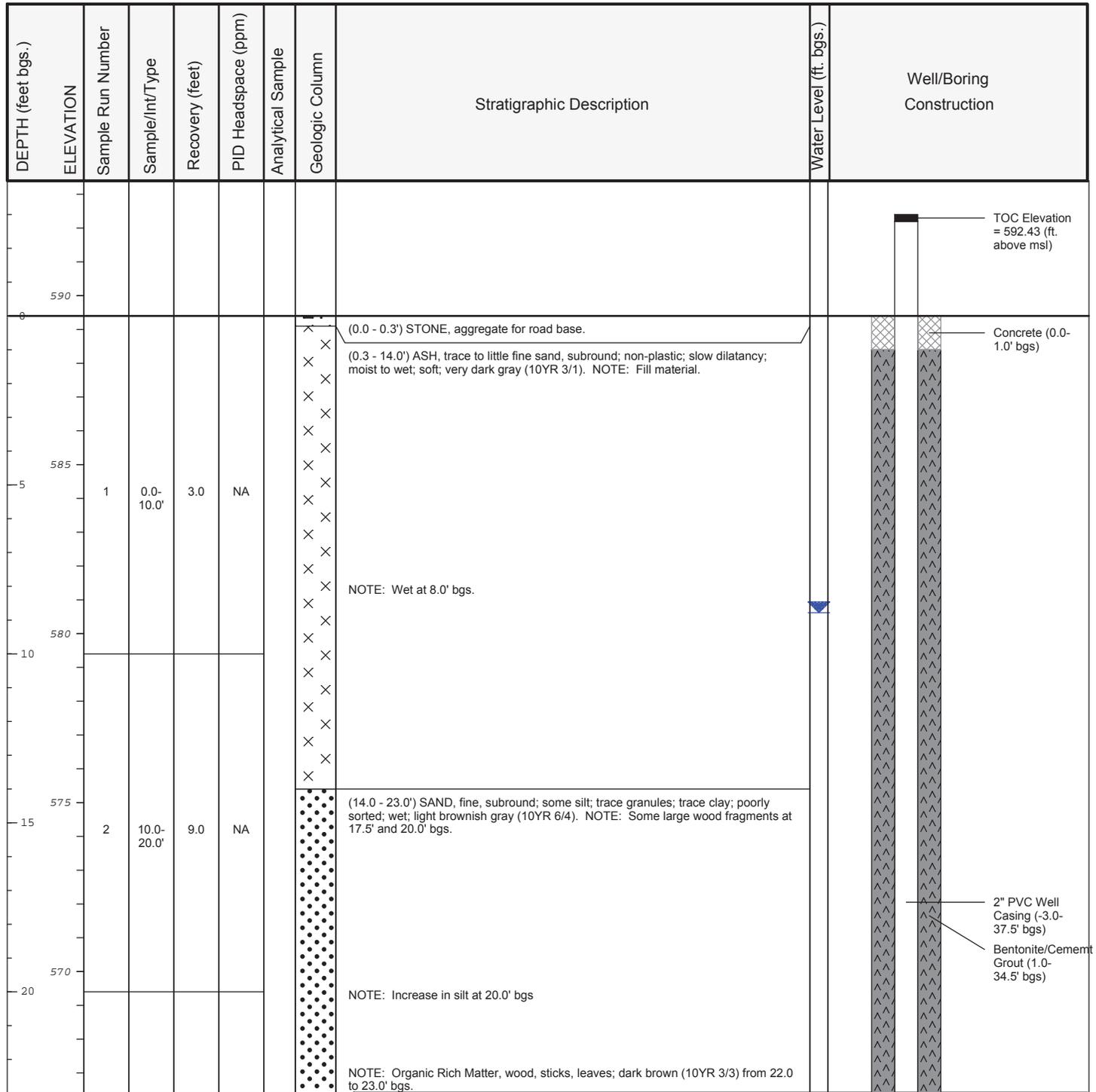
DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
565								6/3). (20.5 - 21.5') SAND, fine, subround; trace silt; trace wood; poorly sorted; wet; pale brown (10YR 6/3) to dark brown (10YR 3/3). NOTE: Organic rich matter, wood, sticks; dark brown (10YR 3/3) from 21.0 to 21.5' bgs. (21.5 - 22.0') SAND, fine subround; trace silt; well sorted; wet; pale brown (10YR 6/3). (22.0 - 23.5') CLAY and SILT, non-plastic, no dilatancy; little fine sand, subround; moist; soft; brown (10YR 3/3). (23.5 - 33.0') CLAY and SILT, non-plastic, no dilatancy; some fine sand, subround; moist; soft; brown (10YR 3/3).		
25		3	20.0-30.0'	9.0	NA					
560								NOTE: Some wood and sticks; trace shell fragments at 33.0' bgs. (33.0 - 35.0') SAND, fine, subround; trace silt; well sorted; wet; yellow (10YR 7/6).		
30								(35.0 - 40.0') SAND, fine, subround; trace silt; well sorted; wet; pale brown (10YR 6/3).		
555		4	30.0-40.0'	9.0	NA					
35										
550										
40								End of boring 40.0' bgs.		
545										

	<b>Remarks:</b> bgs = below ground surface  Air Knife to 8.0' bgs. Groundwater encountered at 8.0' bgs during drilling. Water level at development was 8.53' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 579.99 feet above mean sea level.
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**Date Start:** 10/20/15  
**Date Finish:** 10/20/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 8.0  
**Water Level Finish (ft. btoc.):** 11.78

**Northing:** 646789.54  
**Easting:** 12622179.74  
**Casing Elevation:** 592.43  
**Borehole Depth (ft. bgs.):** 45.0  
**Surface Elevation:** 589.4  
**Descriptions By:** A. Westhuis

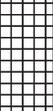
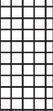
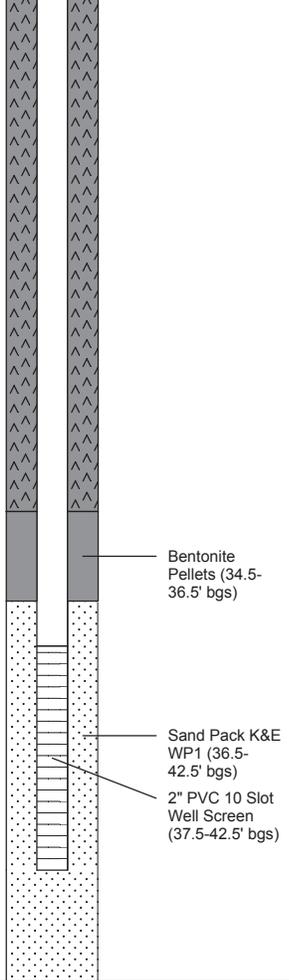
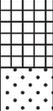
**Well/Boring ID:** BCC MW-15018  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Cloudy



**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 8.5' bgs.  
 Groundwater encountered at 8.0' bgs during drilling.  
 Water level at development was 11.78' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.08 feet

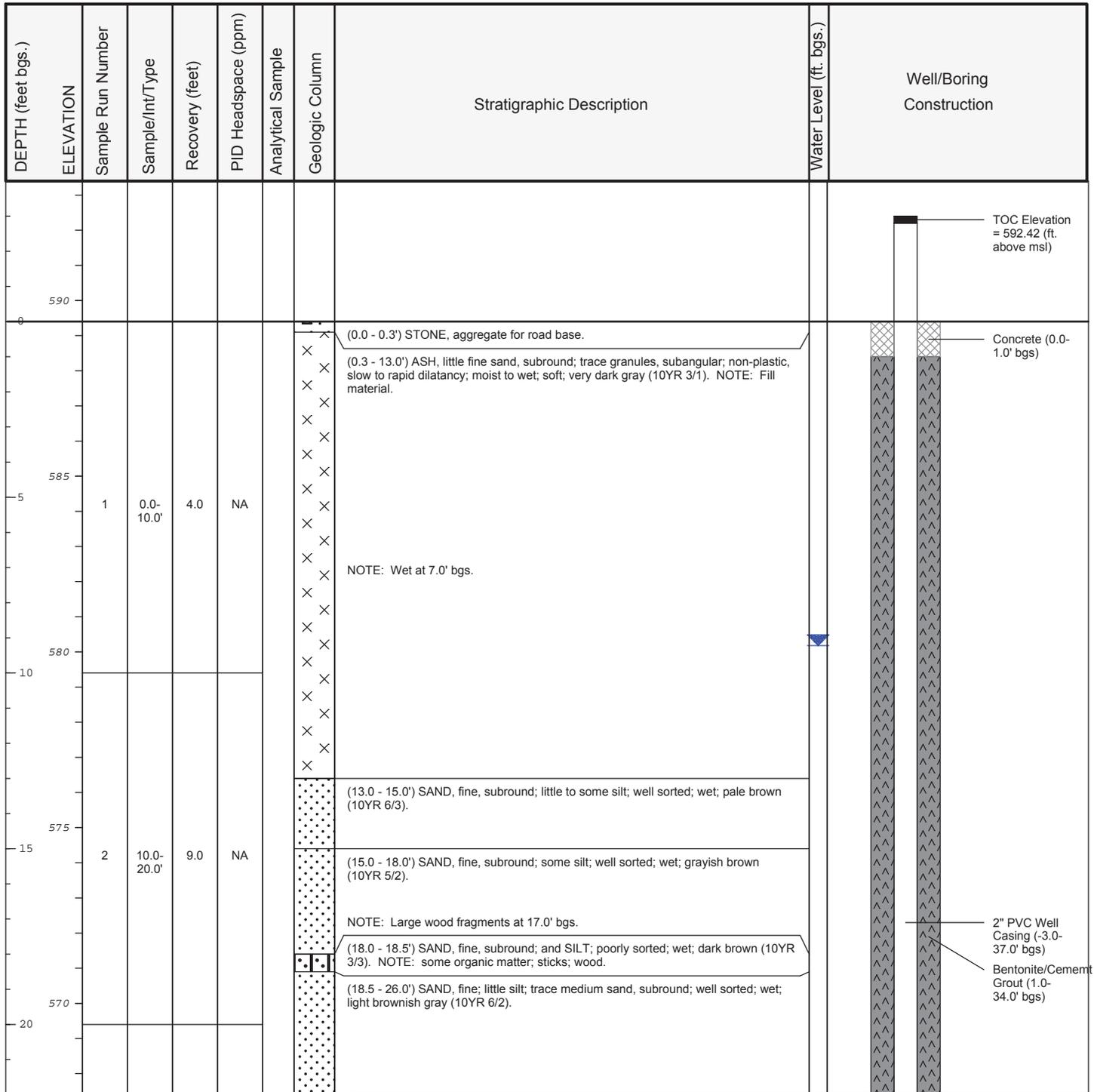


<b>Date Start:</b> 10/20/15 <b>Date Finish:</b> 10/20/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 8.0 <b>Water Level Finish (ft. btoc.):</b> 11.78	<b>Northing:</b> 646789.54 <b>Easting:</b> 12622179.74 <b>Casing Elevation:</b> 592.43  <b>Borehole Depth (ft. bgs.):</b> 45.0 <b>Surface Elevation:</b> 589.4  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15018  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	565	3	20.0-30.0'	10.0	NA		 <p>(23.0 - 25.5') SAND, fine, subround; some silt; poorly sorted; wet; light brownish gray (10YR 6/4). NOTE: wood debris from 24.0 to 24.3' bgs.</p> <p>NOTE: Organic rich matter, wood, sticks, leaves; dark brown (10YR 3/3) from 25.0 to 25.5' bgs.</p>  <p>(25.5 - 27.5') SAND, fine, subround; little to some silt; well sorted; wet; light brownish gray (10YR 6/4). NOTE: wood debris, sticks, brown (10YR 3/3) from 26.0 to 26.3' bgs.</p>  <p>(27.5 - 28.0') CLAY and SILT, low plasticity to non-plastic, no dilatancy; little fine sand, subround; moist; soft; dark brown (10YR 3/3).</p>  <p>(28.0 - 30.0') SAND, fine, subround, and SILT; wet; poorly sorted; soft; light brownish gray (10YR 6/4) to dark brown (10YR 3/3). NOTE: little wood debris, organic rich near 29.0' bgs.</p>  <p>(30.0 - 37.0') CLAY and SILT, low plasticity to non-plastic, no dilatancy; trace fine sand, subround; moist; medium stiff to soft; dark brown (10YR 3/3) to very dark brown (10YR 2/2). NOTE: organic rich, large sticks at 31.0' bgs; white shell fragments from 35.0 to 37.0' bgs.</p>		 <p>Bentonite Pellets (34.5-36.5' bgs)</p> <p>Sand Pack K&amp;E WP1 (36.5-42.5' bgs)</p> <p>2" PVC 10 Slot Well Screen (37.5-42.5' bgs)</p>	
35	555	4	30.0-40.0'	10.0	NA		 <p>(37.0 - 42.5') SAND, fine, subround; well sorted; wet; very pale brown (10YR 7/3).</p>			
40	550	5	40.0-45.0'	5.0	NA		 <p>(42.5 - 45.0') CLAY, high plasticity, no dilatancy; trace silt; moist; medium stiff to soft; gray (10YR 7/1).</p>			
45	545						End of boring 45.0' bgs.			
50	540									

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 8.5' bgs. Groundwater encountered at 8.0' bgs during drilling. Water level at development was 11.78' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 580.08 feet
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<b>Date Start:</b> 10/20/15 <b>Date Finish:</b> 10/20/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 7.0 <b>Water Level Finish (ft. btoc.):</b> 12.22	<b>Northing:</b> 647103.13 <b>Easting:</b> 12622369.93 <b>Casing Elevation:</b> 592.42  <b>Borehole Depth (ft. bgs.):</b> 45.0 <b>Surface Elevation:</b> 589.4  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15019  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Cloudy
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**Remarks:** bgs = below ground surface  
btoc = below top of casing

Air Knife to 8.5' bgs.  
Groundwater encountered at 7.0' bgs during drilling.  
Water level at development was 12.22' btoc.  
No odor or staining observed.  
Groundwater elevation measured on November 30, 2015 was 580.11 feet



<b>Date Start:</b> 10/20/15 <b>Date Finish:</b> 10/20/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 7.0 <b>Water Level Finish (ft. btoc.):</b> 12.22	<b>Northing:</b> 647103.13 <b>Easting:</b> 12622369.93 <b>Casing Elevation:</b> 592.42  <b>Borehole Depth (ft. bgs.):</b> 45.0 <b>Surface Elevation:</b> 589.4  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15019  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	565	3	20.0-30.0'	9.0	NA			(26.0 - 27.0') CLAY and SILT, non-plastic, no dilatancy; little fine sand, subround; moist; soft; dark brown (10YR 3/3). (27.0 - 27.5') SAND, fine, subround; little silt; well sorted; wet; light brownish gray (10YR 6/2). NOTE: some organic debris, sticks. (27.5 - 29.0') SAND, fine, subround; and SILT; trace clay, non-plastic, slow dilatancy; poorly sorted; wet; brown (10YR 4/3) to dark brown (10YR 3/3). (29.0 - 30.0') SAND, fine, subround; some silt; trace clay; poorly sorted; wet; light brownish gray (10YR 6/2). NOTE: some roots, sticks and wood. (30.0 - 31.5') CLAY and SILT, low plasticity, no dilatancy; little to trace fine sand, subround; moist; soft to medium stiff; dark brown (10YR 3/3). NOTE: organic rich. (31.5 - 32.5') SAND, fine, subround, and SILT; poorly sorted; wet; grayish brown (10YR 5/2). (32.5 - 37.0') CLAY and SILT, low plasticity, no dilatancy; little fine sand, subround; moist; medium stiff; dark brown (10YR 3/3). NOTE: ganic rich; trace white shell fragments at 32.5 to 36.5' bgs.		
35	555	4	30.0-40.0'	9.0	NA			(37.0 - 42.0') SAND, fine, subround; trace silt; well sorted; wet; pale brown (10YR 6/3).		
40	550	5	40.0-45.0'	5.0	NA			(42.0 - 45.0') CLAY, high plasticity, no dilatancy; trace silt; moist; medium stiff; gray (10YR 7/1).		
45	545							End of boring 45.0' bgs.		

**Remarks:** bgs = below ground surface  
btoc = below top of casing

Air Knife to 8.5' bgs.  
Groundwater encountered at 7.0' bgs during drilling.  
Water level at development was 12.22' btoc.  
No odor or staining observed.  
Groundwater elevation measured on November 30, 2015 was 580.11 feet



**Date Start:** 10/21/15  
**Date Finish:** 10/21/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 7.0  
**Water Level Finish (ft. btoc.):** 12.19

**Northing:** 647436.97  
**Easting:** 12622626.85  
**Casing Elevation:** 592.23  
**Borehole Depth (ft. bgs.):** 45.0  
**Surface Elevation:** 589.5  
**Descriptions By:** A. Westhuis

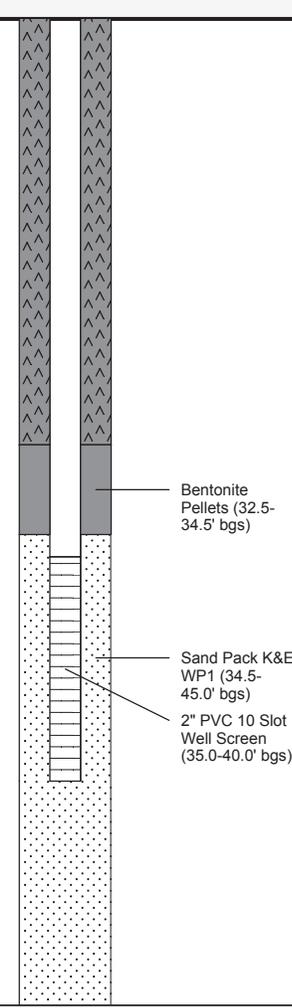
**Well/Boring ID:** BCC MW-15020  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
0	590									TOC Elevation = 592.23 (ft. above msl) Concrete (0.0-1.0' bgs)
5	585	1	0.0-10.0'	0.0	NA			(0.0 - 10.0') NO RECOVERY; most soil cuttings from air knife were not placed back into the hole.		
10	580								▼	
15	575	2	10.0-20.0'	5.0	NA		(10.0 - 18.0') SAND, fine, subround; some ash; little medium sand; trace granules to small pebble, subangular; moist to wet; poorly sorted; very dark grayish brown (10YR 3/2). NOTE: little large stones; road base fill material.			
20	570						(18.0 - 20.0') ASH, trace fine sand, subround; non-plastic, rapid dilatancy; wet; soft; very dark gray (10YR 4/1). NOTE: Fill material.			2" PVC Well Casing (-3.0-35.0' bgs) Bentonite/Cement Grout (1.0-32.5' bgs)
							(20.0 - 31.0') SAND fine, subround; little silt; well sorted; wet; light brownish gray (10YR 6/2).			

**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
 Air Knife to 8.5' bgs.  
 Groundwater encountered at 7.0' bgs during drilling.  
 Water level at development was 12.19' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.14 feet



<b>Date Start:</b> 10/21/15 <b>Date Finish:</b> 10/21/15 <b>Drilling Company:</b> Mateco Drilling <b>Driller's Name:</b> Dan Mourer <b>Drilling Method:</b> Air Knife/Sonic <b>Sampling Method:</b> Continuous <b>Rig Type:</b> Sonic <b>Water Level Start (ft. bgs.):</b> 7.0 <b>Water Level Finish (ft. btoc.):</b> 12.19	<b>Northing:</b> 647436.97 <b>Easting:</b> 12622626.85 <b>Casing Elevation:</b> 592.23  <b>Borehole Depth (ft. bgs.):</b> 45.0 <b>Surface Elevation:</b> 589.5  <b>Descriptions By:</b> A. Westhuis	<b>Well/Boring ID:</b> BCC MW-15020  <b>Client:</b> Consumers Energy  <b>Location:</b> BC Cobb Facility 151 N Causeway St. Muskegon, MI  <b>Weather Conditions:</b> 60 F Partly Cloudy
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DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	565	3	20.0-30.0'	5.0	NA					
30	560							(31.0 - 32.5') CLAY and SILT, medium plasticity, no dilatancy; trace fine sand, subround; moist; medium stiff; dark brown (10YR 3/3). NOTE: trace white shell fragments.		
35	555	4	30.0-40.0'	10.0	NA			(32.5 - 34.0') SAND, fine, subround; some to little silt; well sorted; wet; brown (10YR 5/3). (34.0 - 35.0') CLAY and SILT, low plasticity to non-plastic; some fine sand, subround; wet; soft to very soft; brown (10YR 4/3). (35.0 - 40.0') SAND, fine, subround; trace silt; well sorted; wet; light gray (10YR 7/2). NOTE: large cobble at 35.0' bgs.		
40	550							(40.0 - 45.0') CLAY, high plasticity, no dilatancy; trace silt; moist; medium stiff to soft; gray (10YR 5/1).		
45	545	5	40.0-45.0'	4.0	NA			End of boring 45.0' bgs.		
50	540									

	<b>Remarks:</b> bgs = below ground surface btoc = below top of casing  Air Knife to 8.5' bgs. Groundwater encountered at 7.0' bgs during drilling. Water level at development was 12.19' btoc. No odor or staining observed. Groundwater elevation measured on November 30, 2015 was 580.14 feet
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**Date Start:** 10/21/15  
**Date Finish:** 10/21/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 5.0  
**Water Level Finish (ft. btoc.):** 14.00

**Northing:** 646654.84  
**Easting:** 12623310.03  
**Casing Elevation:** 593.73  
  
**Borehole Depth (ft. bgs.):** 50.0  
**Surface Elevation:** 590.7  
  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15021  
**Client:** Consumers Energy  
  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
  
**Weather Conditions:** 60 F Partly Cloudy

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
565		3	20.0-30.0'	10.0	NA			(23.5 - 25.0') SAND, fine, subround; little silt; well sorted; wet; light gray (10YR 7/2).		
								(25.0 - 27.0') SAND, fine, subround, and SILT; poorly sorted; moist to wet; brown (10YR 4/3) to dark gray (10YR 4/1). NOTE: some organic debris, sticks, wood, leaves.		
								(27.0 - 28.5') SAND, fine, subround; little to some silt; well sorted; wet; light gray (10YR 7/2).		
30								(28.5 - 29.5') CLAY and SILT, non-plastic, no dilatancy; little fine sand, subround; medium stiff; moist; dark brown (10YR 3/3). NOTE: some organic debris, wood from 29.0 to 29.5' bgs.		
560								(29.5 - 32.5') SAND, fine, subround, and SILT; poorly sorted; moist; dark brown (10YR 3/3). NOTE: wood, sticks and leaves from 29.5 to 30.0' and 32.0 to 32.5' bgs.		
								(32.5 - 35.0') SAND, fine, subround; little silt; well sorted; wet; pale brown (10YR 6/3).		
35		4	30.0-40.0'	10.0	NA			(34.5 - 35.0') NOTE: Organics, wood, sticks.		
555								(35.0 - 39.5') CLAY, medium to high plasticity, no dilatancy; little to some silt; medium stiff; very dark brown (10YR 2/2).  NOTE: White shell fragments at 37.5' and 38.0' bgs.		
40								(39.5 - 42.5') SAND, fine, subround; trace silt; well sorted; wet; light gray (10YR 7/2).		
550								(42.5 - 50.0') CLAY, high plasticity, no dilatancy; trace silt; moist; medium stiff; gray (10YR 5/1).		
45		5	40.0-50.0'	10.0	NA					
545										
50								End of boring 50.0' bgs.		
540										

**Remarks:** bgs = below ground surface

Air Knife to 8.0' bgs.  
 Groundwater encountered at 5.0' bgs during drilling.  
 Water level at development was 14.00' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 580.1 feet above mean sea level.

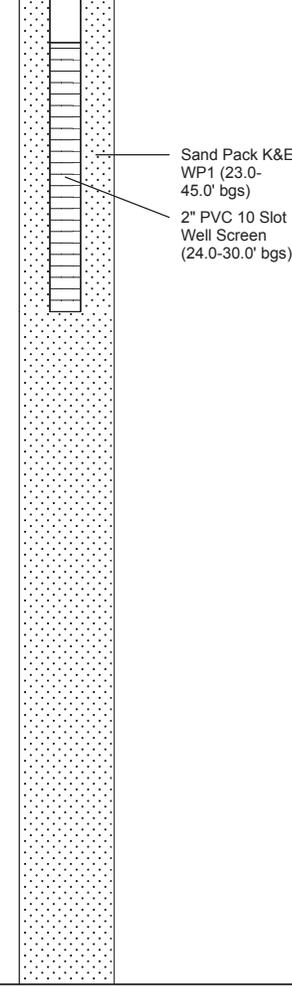




**Date Start:** 10/23/15  
**Date Finish:** 10/23/15  
**Drilling Company:** Mateco Drilling  
**Driller's Name:** Dan Mourer  
**Drilling Method:** Air Knife/Sonic  
**Sampling Method:** Continuous  
**Rig Type:** Sonic  
**Water Level Start (ft. bgs.):** 7.0  
**Water Level Finish (ft. btoc.):** 12.28

**Northing:** 646263.16  
**Easting:** 12623634.96  
**Casing Elevation:** 595.82  
**Borehole Depth (ft. bgs.):** 45.0  
**Surface Elevation:** 592.6  
**Descriptions By:** A. Westhuis

**Well/Boring ID:** BCC MW-15022  
**Client:** Consumers Energy  
**Location:** BC Cobb Facility  
 151 N Causeway St.  
 Muskegon, MI  
**Weather Conditions:** 40 F Sunny

DEPTH (feet bgs.)	ELEVATION	Sample Run Number	Sample/Int/Type	Recovery (feet)	PID Headspace (ppm)	Analytical Sample	Geologic Column	Stratigraphic Description	Water Level (ft. bgs.)	Well/Boring Construction
25	570	3	20.0-30.0'	8.0	NA					 <p>           Sand Pack K&amp;E WP1 (23.0-45.0' bgs)            2" PVC 10 Slot Well Screen (24.0-30.0' bgs)         </p>
30	565						(30.0 - 33.0') SAND, fine, subround, and SILT, non-plastic, no dilatancy to slow dilatancy; moist to wet; poorly sorted; light brownish gray (10YR 6/2) to grayish brown (10YR 5/2). NOTE: little to some organic debris.			
35	560	4	30.0-40.0'	9.0	NA		(33.0 - 37.0') SILT, non-plastic, no dilatancy; some fine sand, subround; little clay; poorly sorted; moist to wet; grayish brown (10YR 5/2) to dark brown (10YR 3/3).  NOTE: Organic rich debris, sitcks and wood from 36.0 to 37.0' bgs.			
40	555						(37.0 - 40.5') SAND, fine, subround; little silt; well sorted; wet; light brownish gray (10YR 6/2).			
45	550	5	40.0-45.0'	5.0	NA		(40.5 - 43.0') CLAY and SILT, non-plastic, no dilatancy; some to little fine sand, subround; poorly sorted; moist; dark brown (10YR 3/3). NOTE: white shell fragments at 41.0' bgs; organic rich.  (43.0 - 44.0') SAND, fine, subround; well sorted; light grayish brown (10YR 6/2).  (44.0 - 45.0') CLAY and SILT, non-plastic to low plasticity, no dilatancy; little to trace fine sand, subround; moist; dark gray (10YR 3/3).			
45	550						End of boring 45.0' bgs.			



**Remarks:** bgs = below ground surface  
 btoc = below top of casing  
  
 Air Knife to 9.0' bgs.  
 Groundwater encountered at 7.0' bgs during drilling.  
 Water level at development was 12.28' btoc.  
 No odor or staining observed.  
 Groundwater elevation measured on November 30, 2015 was 583.42 feet



# SOIL DESCRIPTION

Udden-Wenworth Scale Modified ARCADIS, 2008			
Size Class	Millimeters	Inches	Standard Sieve #
Boulder	256 – 4096	10.09+	
Large cobble	128 - 256	5.04 -10.08	
Small cobble	64 - 128	2.52 – 5.04	
Very large pebble	32 – 64	0.16 - 2.52	
Large pebble	16 – 32	0.63 – 1.26	
Medium pebble	8 – 16	0.31 – 0.63	
Small pebble	4 – 8	0.16 – 0.31	No. 5 +
Granule	2 – 4	0.08 – 0.16	No.5 – No.10
Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
Fine sand	1/8 -¼	0.005 – 0.1	No.60 - No.120
Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
Clay (subgroups not included)	1/2048 – 1/256	.00002 – 0.0002	

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

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

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet (Saturated)	Visible free water, soil is usually below the water table.

## Fine-grained soil – Consistency

Description	Criteria
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated one inch by thumb.
Medium stiff	N-value 9-15 or indented about ¼ inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

## Coarse-grained soil – Density

Description	Criteria
Very loose	N-value 1- 4
Loose	N-value 5-10
Medium dense	N-value 11-30
Dense	N-value 31- 50
Very dense	N-value >50

# APPENDIX B

## Photographic Log



# APPENDIX C

## Hydraulic Test Logs



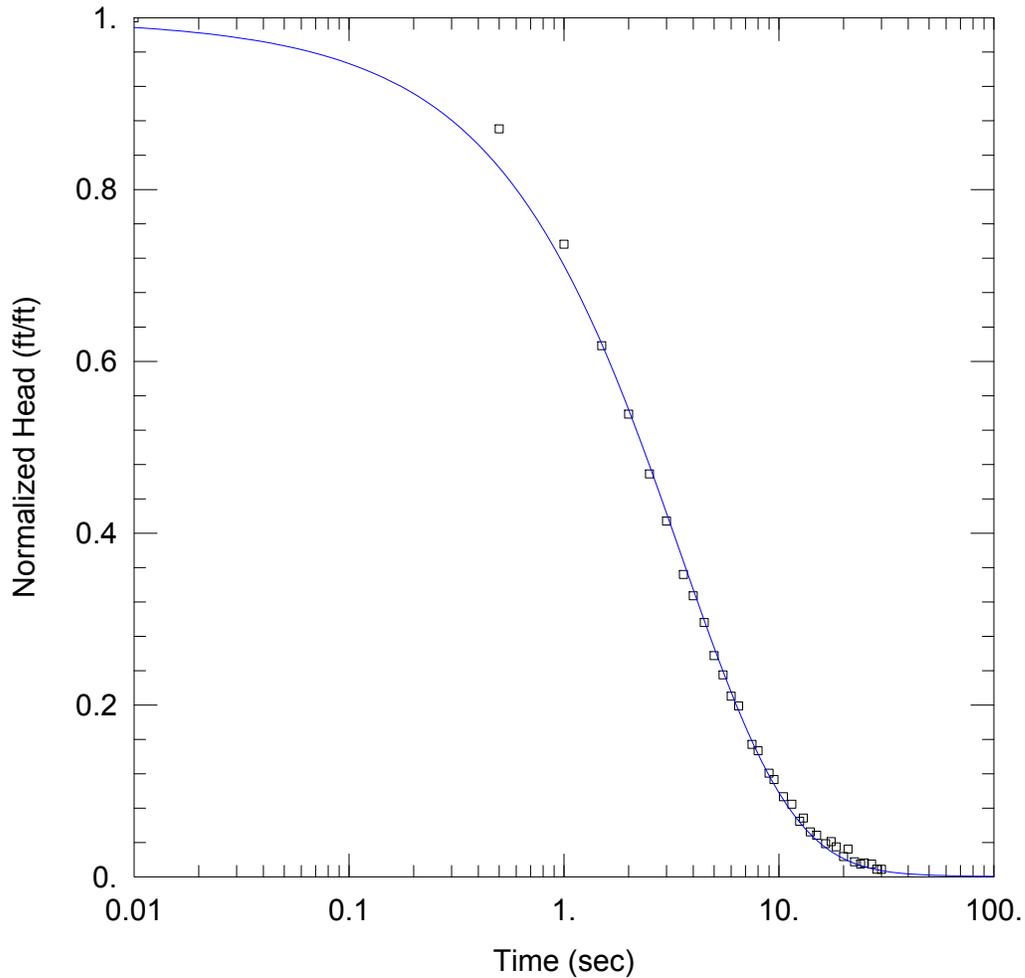
# Slug Test Analysis Result for BCC MW-15017 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 45. ft/day      Ss = 5.5E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 35.4 ft

## WELL DATA (BCC-MW-15017)

Initial Displacement: 0.804 ft  
Static Water Column Height: 33.9 ft  
Total Well Penetration Depth: 33.9 ft  
Screen Length: 5. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft



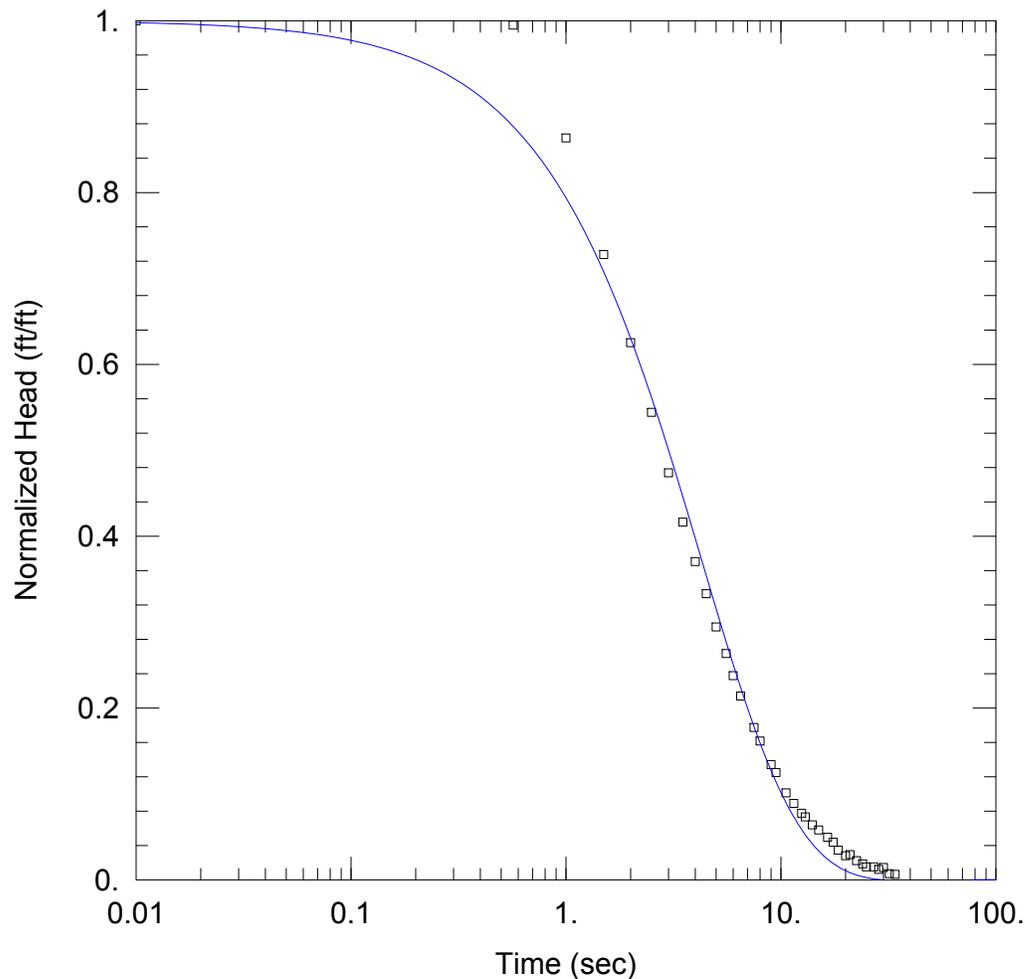
# Slug Test Analysis Result for BCC MW-15017 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 38. ft/day      Ss = 1.0E-10 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 35.4 ft

## WELL DATA (BCC-MW-15017)

Initial Displacement: 1.393 ft  
Static Water Column Height: 33.9 ft  
Total Well Penetration Depth: 33.9 ft  
Screen Length: 5. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

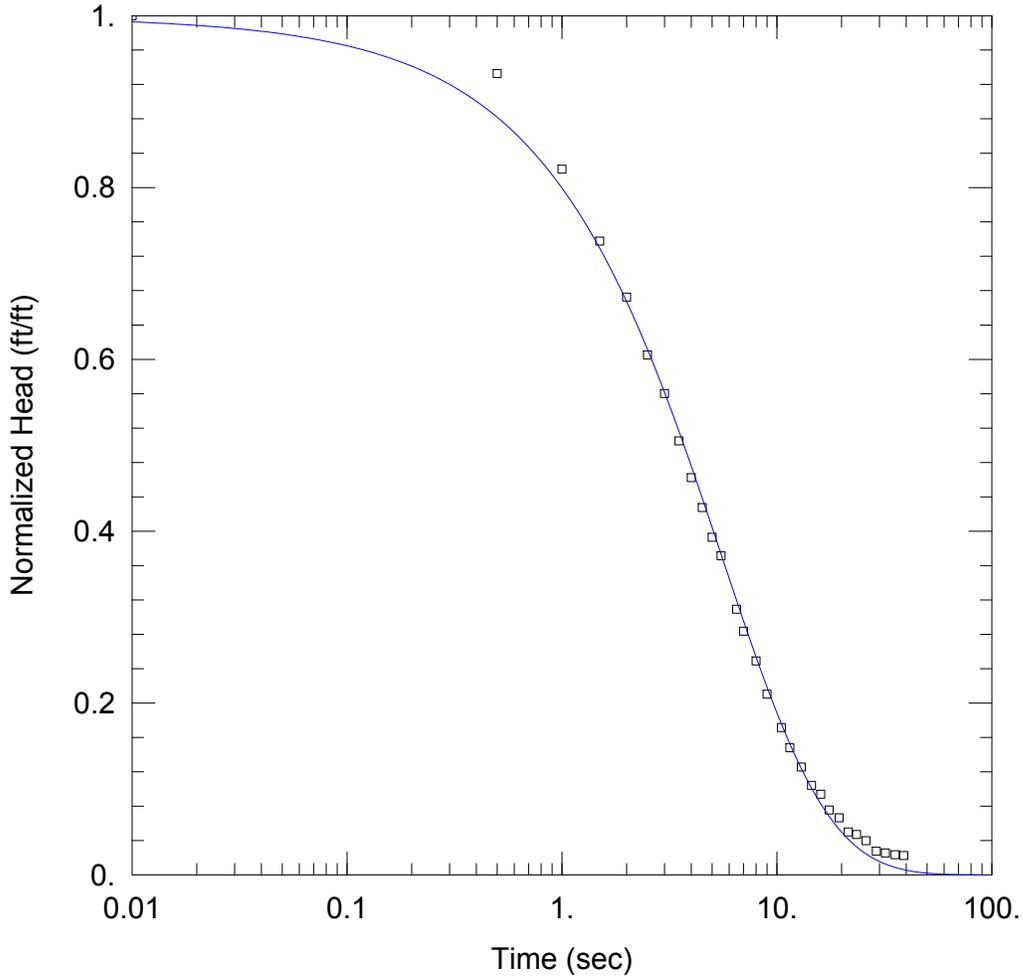
# Slug Test Analysis Result for BCC-MW-15020 - Test 1

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 30. ft/day      Ss = 2.3E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 30.42 ft

## WELL DATA (BCC-MW-15020)

Initial Displacement: 0.98 ft  
Static Water Column Height: 30.42 ft  
Total Well Penetration Depth: 30.42 ft  
Screen Length: 5. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft



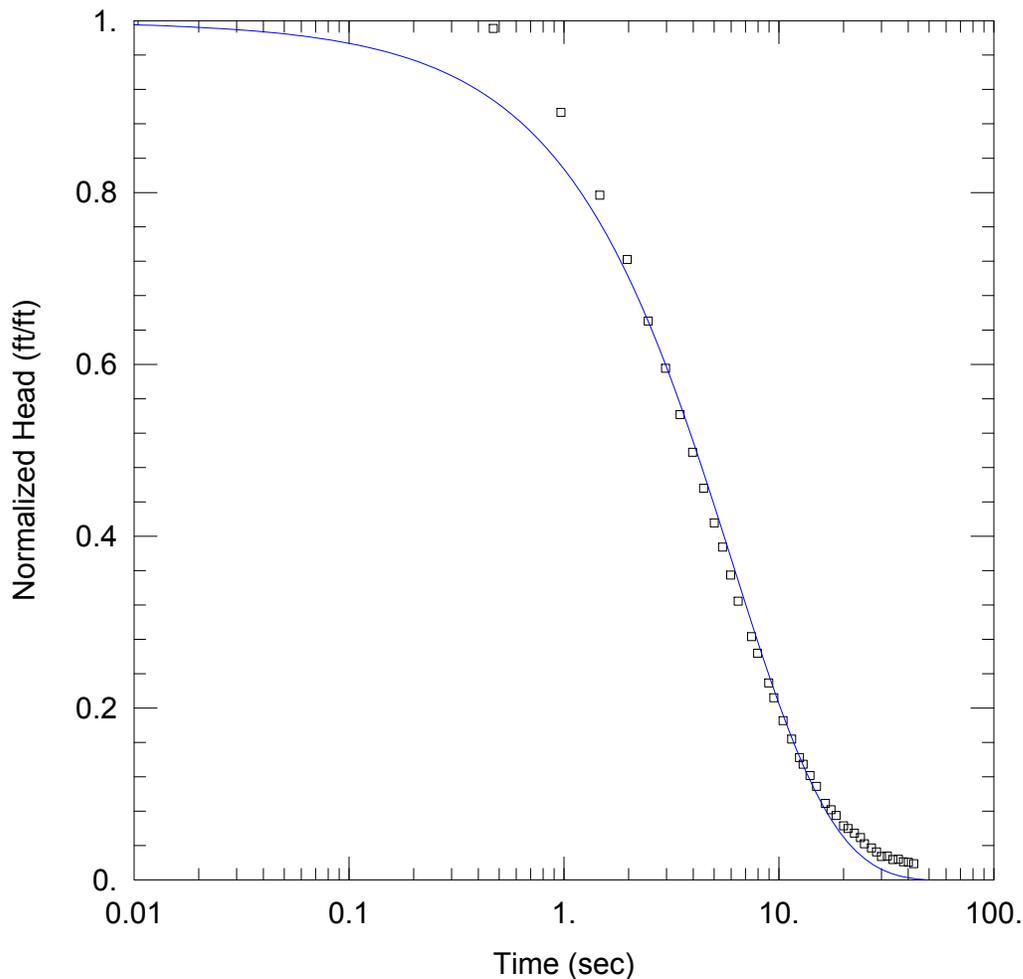
# Slug Test Analysis Result for BCC MW-15020 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 35. ft/day      Ss = 8.4E-6 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 30.42 ft

## WELL DATA (BCC-MW-15020)

Initial Displacement: 1.911 ft  
Static Water Column Height: 30.42 ft  
Total Well Penetration Depth: 30.42 ft  
Screen Length: 5. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

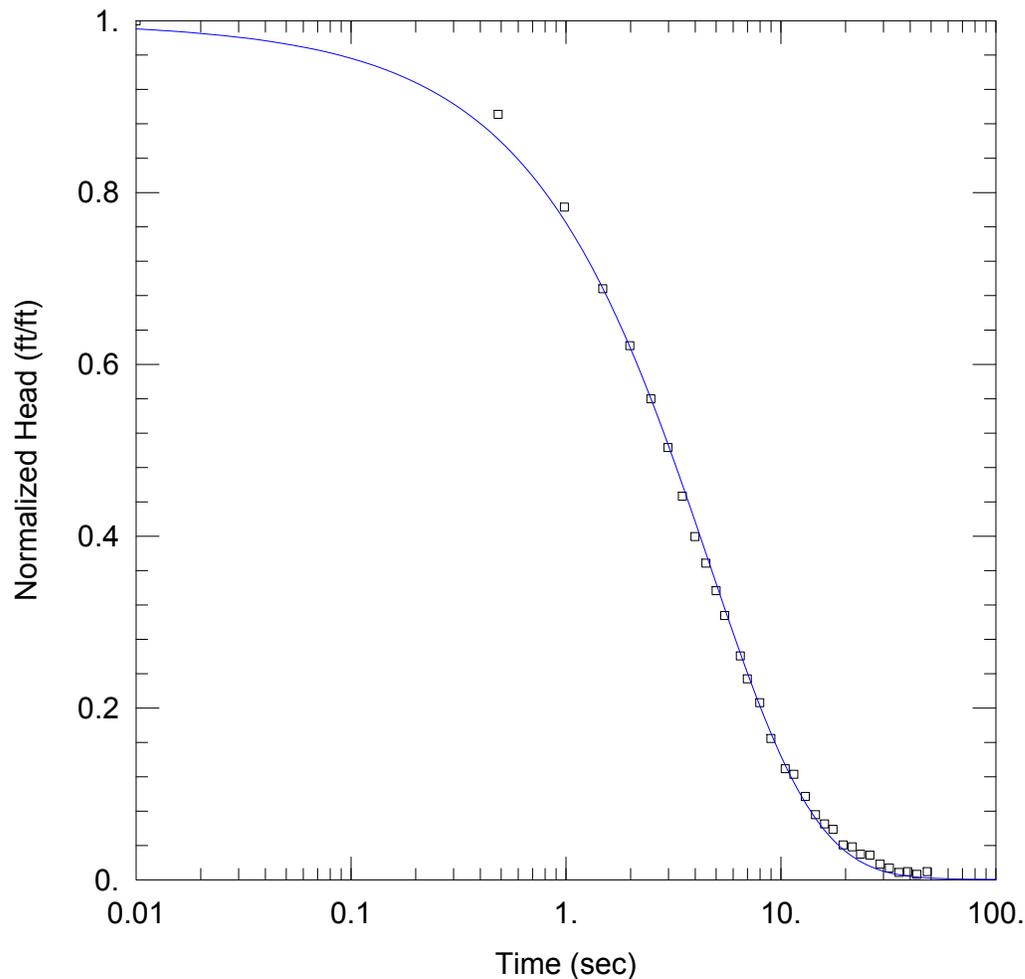
# Slug Test Analysis Result for BCC MW-15021 - Test 1

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 62. ft/day      Ss = 0.0001 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 31.84 ft

## WELL DATA (BCC-MW-15021)

Initial Displacement: 0.936 ft  
Static Water Column Height: 31.84 ft  
Total Well Penetration Depth: 31.84 ft  
Screen Length: 3. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

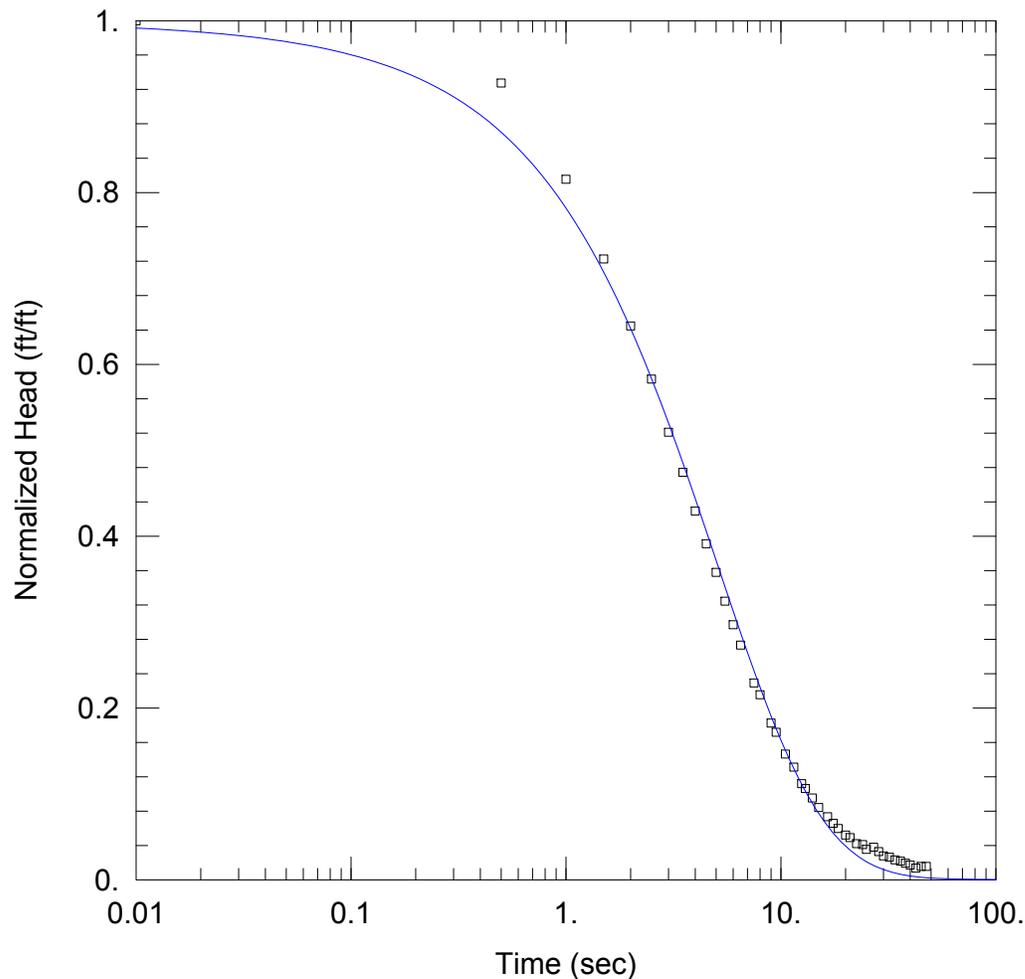
# Slug Test Analysis Result for BCC MW-15021 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 55. ft/day      Ss = 7.9E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 31.84 ft

## WELL DATA (BCC-MW-15021)

Initial Displacement: 1.973 ft  
Static Water Column Height: 31.84 ft  
Total Well Penetration Depth: 31.84 ft  
Screen Length: 3. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

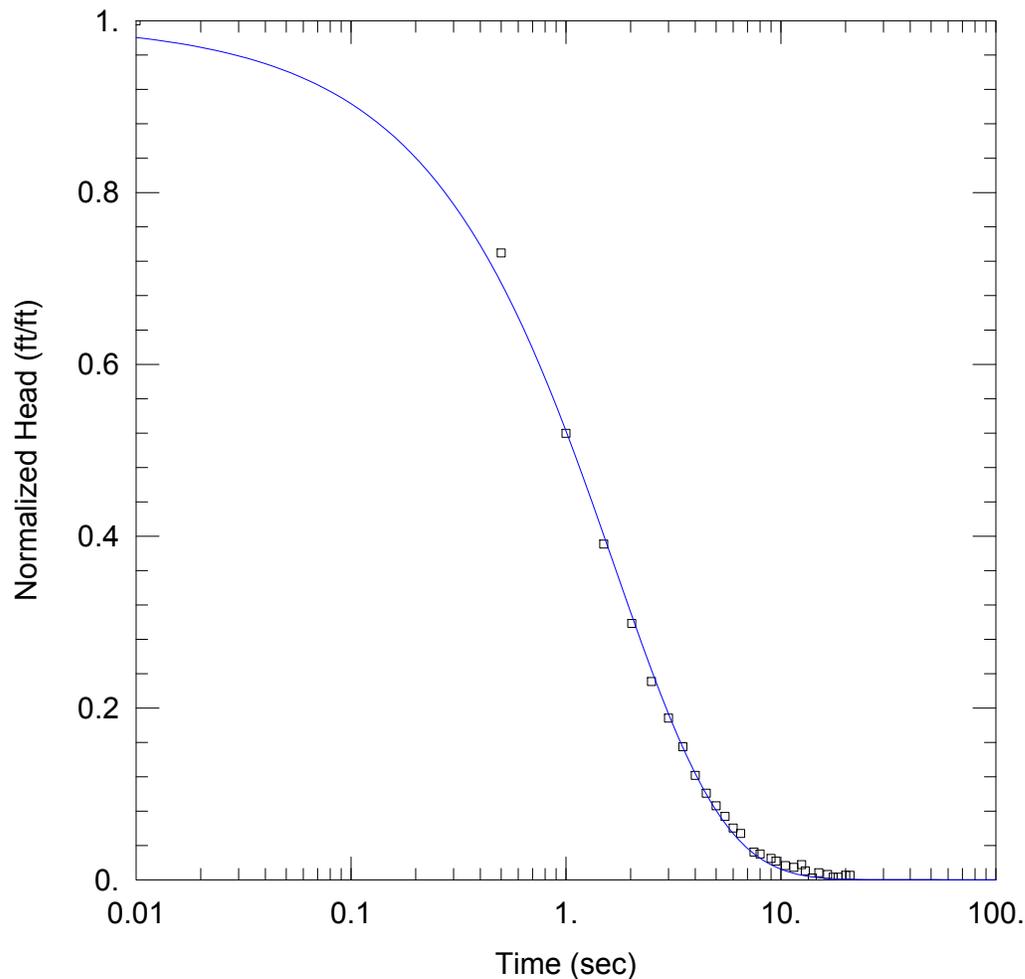
# Slug Test Analysis Result for BCC MW-15001 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 62. ft/day      Ss = 3.1E-5 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 41.09 ft

## WELL DATA (BCC-MW-15001)

Initial Displacement: 0.962 ft  
Static Water Column Height: 17.09 ft  
Total Well Penetration Depth: 17.09 ft  
Screen Length: 10. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

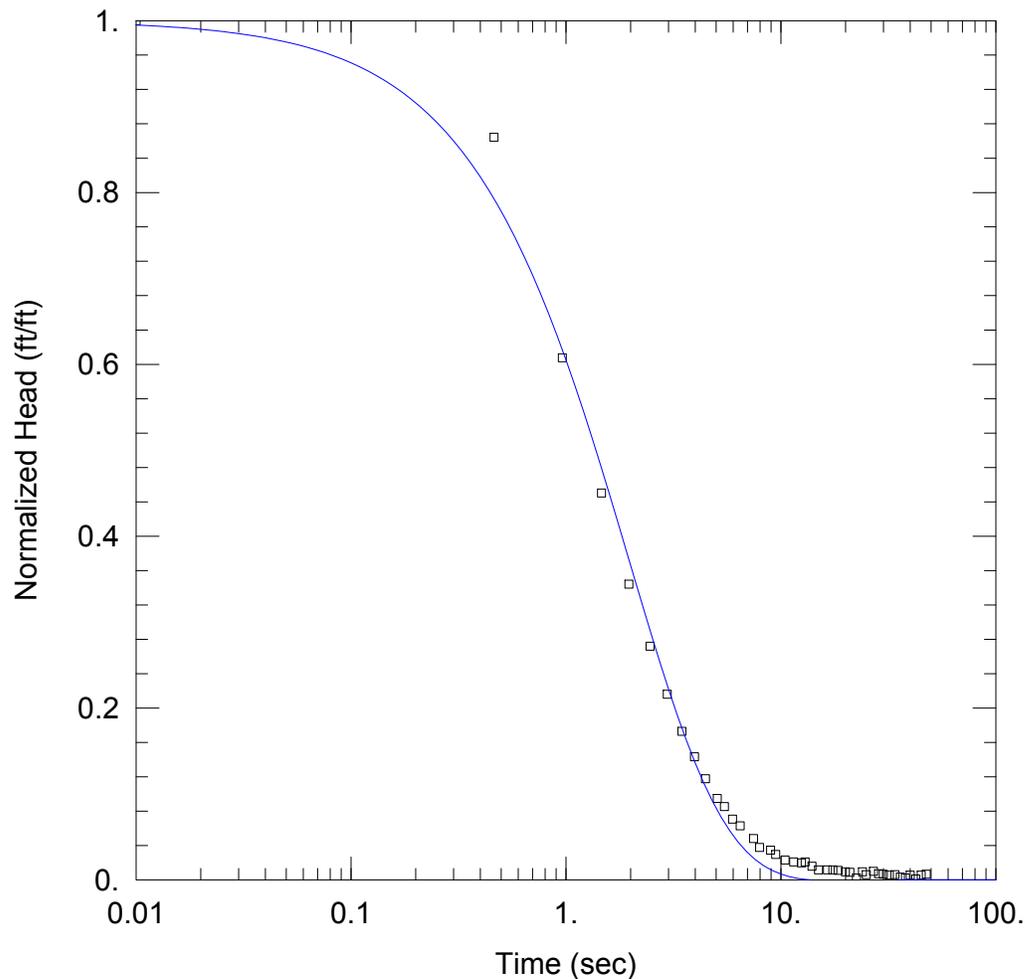
# Slug Test Analysis Result for BCC MW-15001 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 56. ft/day      Ss = 1.0E-10 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 41.09 ft

## WELL DATA (BCC-MW-15001)

Initial Displacement: 1.828 ft  
Static Water Column Height: 17.09 ft  
Total Well Penetration Depth: 17.09 ft  
Screen Length: 10. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

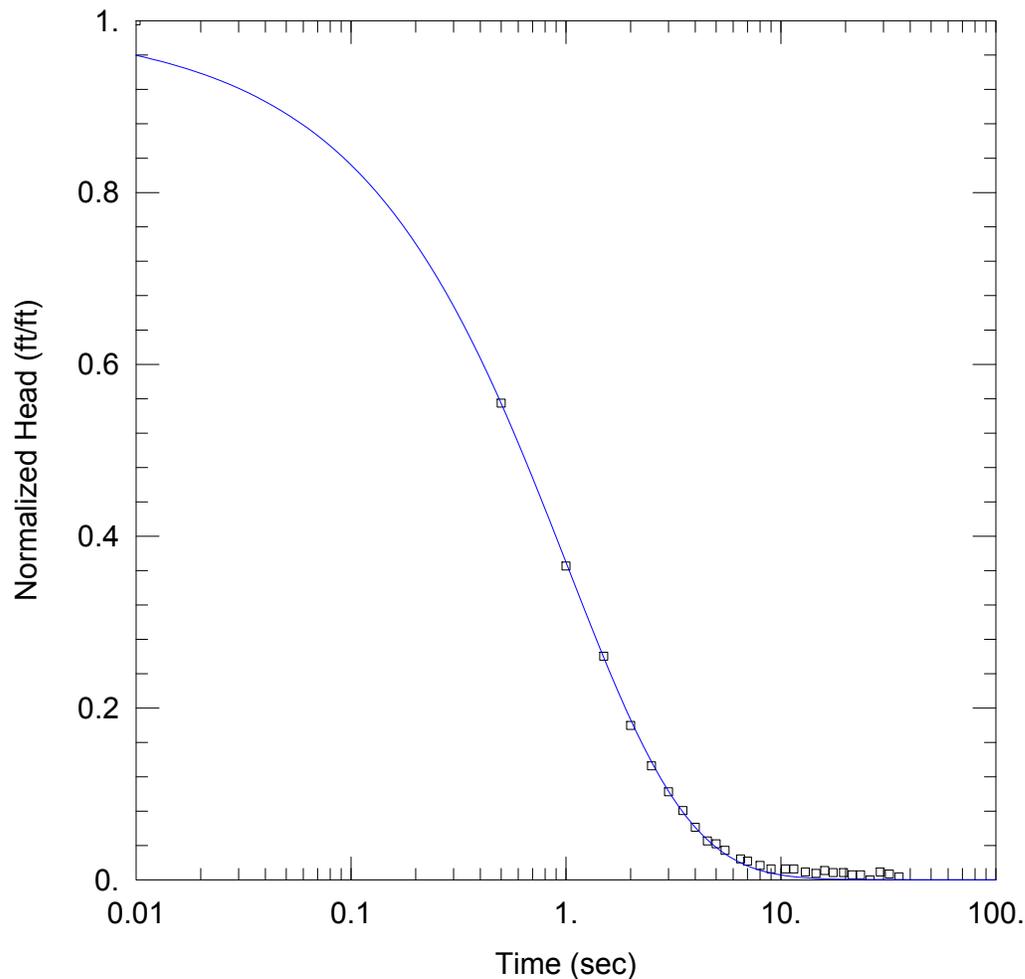
# Slug Test Analysis Result for BCC MW-15005 - Test 1

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 90. ft/day      Ss = 0.00016 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 39.51 ft

## WELL DATA (BCC-MW-15005)

Initial Displacement: 1.191 ft  
Static Water Column Height: 10.51 ft  
Total Well Penetration Depth: 10.51 ft  
Screen Length: 10. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

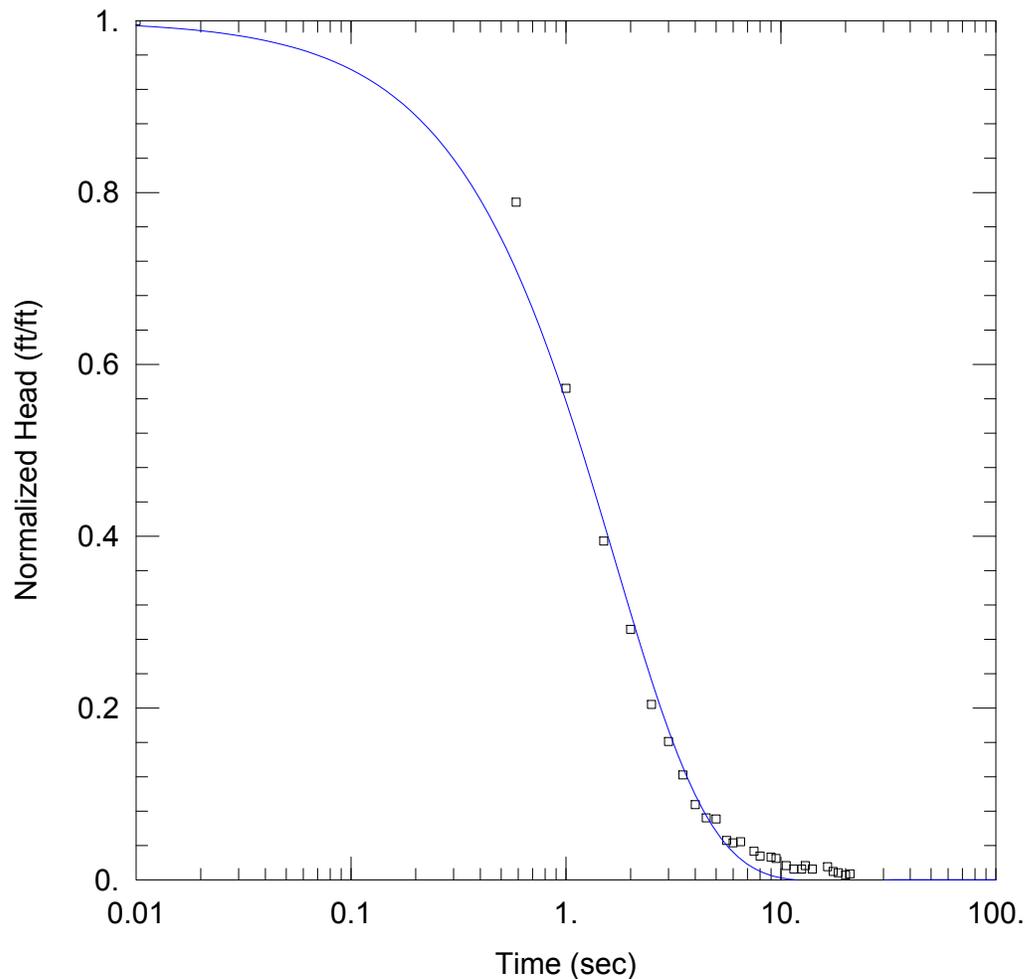
# Slug Test Analysis Result for BCC MW-15005 - Test 2

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: KGS Model

Kr = 107. ft/day      Ss = 1.0E-10 ft<sup>-1</sup>  
Kz/Kr = 1.

## AQUIFER DATA

Saturated Thickness: 39.51 ft

## WELL DATA (BCC-MW-15005)

Initial Displacement: 0.72 ft  
Static Water Column Height: 10.51 ft  
Total Well Penetration Depth: 10.51 ft  
Screen Length: 10. ft  
Casing Radius: 0.083 ft  
Well Radius: 0.33 ft

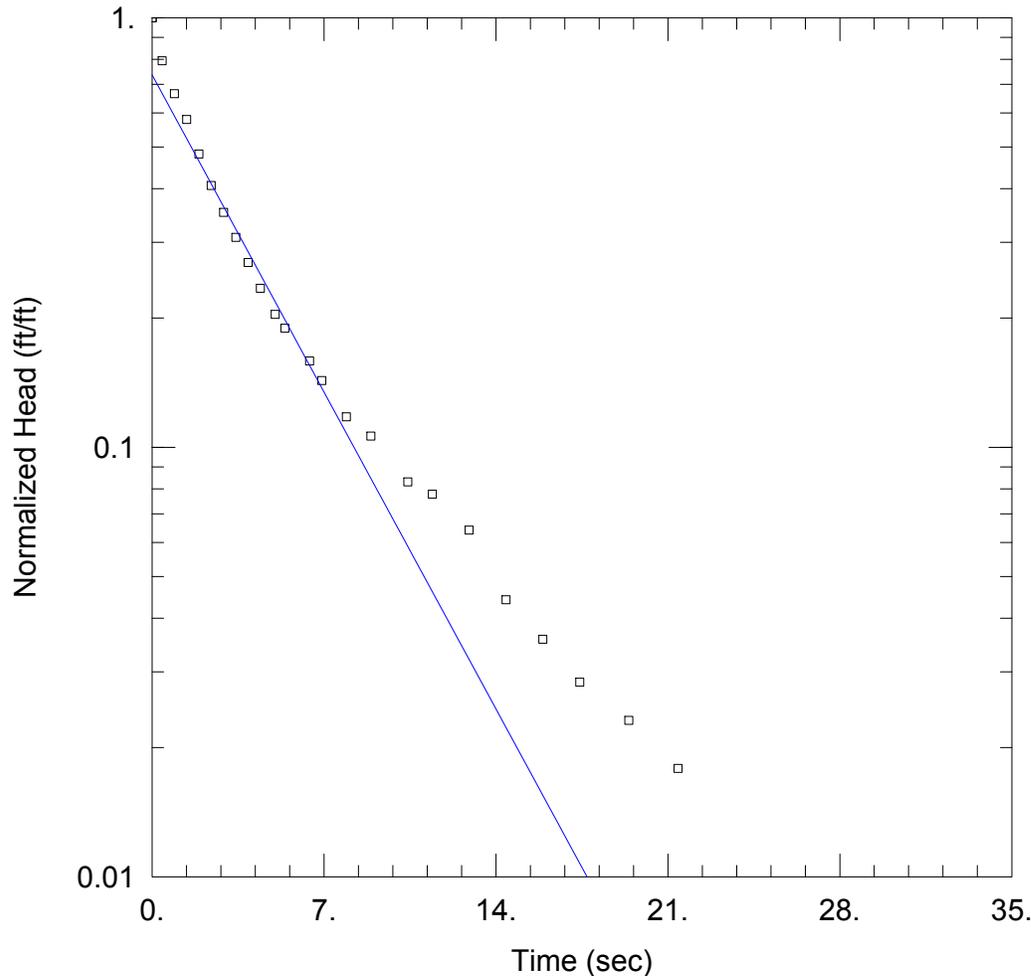
# Slug Test Analysis Result for BCC MW-15008 - Test 1

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
 Solution Method: Bouwer-Rice  
 K = 71 ft/day                      y0 = 0.7 ft

## AQUIFER DATA

Saturated Thickness: 4.75 ft

## WELL DATA (BCC-MW-15008)

Initial Displacement: 0.951 ft  
 Static Water Column Height: 4.75 ft  
 Total Well Penetration Depth: 4.75 ft  
 Screen Length: 4.75 ft  
 Casing Radius: 0.083 ft  
 Well Radius: 0.333 ft



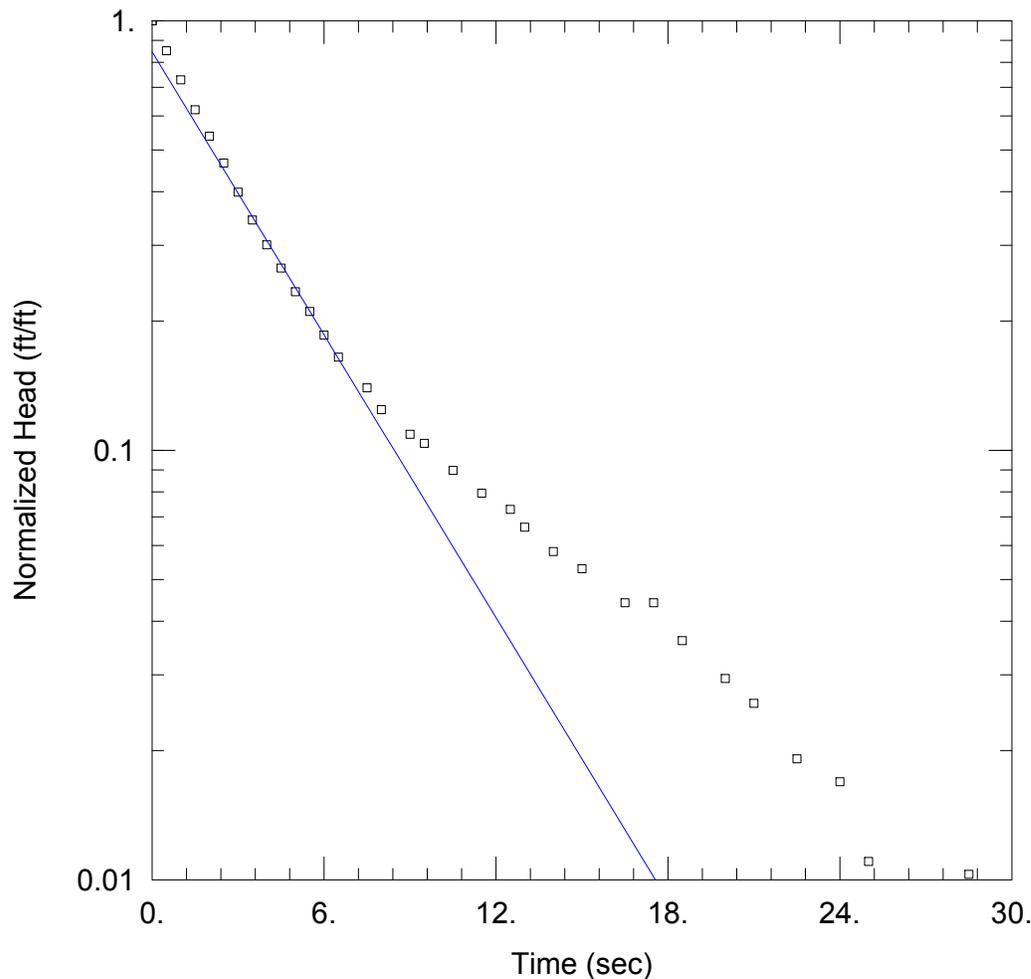
# Slug Test Analysis Result for BCC MW-15008 - Test 3

Prepared By:  
**Arcadis**

Prepared For:  
**Consumer Energy**

Project:

Location:  
**Muskegon, MI**



## SOLUTION

Aquifer Model: Unconfined  
Solution Method: Bouwer-Rice  
K = 45. ft/day                      y0 = 1.15 ft

## AQUIFER DATA

Saturated Thickness: 4.75 ft

## WELL DATA (BCC-MW-15008)

Initial Displacement: 1.359 ft  
Static Water Column Height: 4.75 ft  
Total Well Penetration Depth: 4.75 ft  
Screen Length: 4.75 ft  
Casing Radius: 0.083 ft  
Well Radius: 0.333 ft

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A decorative graphic consisting of three thin orange lines. One line is horizontal, extending across the width of the page. Two other lines are diagonal, starting from the bottom left and extending towards the top right, intersecting the horizontal line.