Appendix F

PRB Data

Appendix F-1a: Kinetics Experiment Analytical Data
Appendix F-1b: Continuously Stirred Batch Reactor Experiment Analytical Data
Appendix F-1c: Field Parameters
Appendix F-2: Laboratory Bench Testing Data Report
Appendix F-3: Bench Testing Photo Log
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Appendix F-5: Peerless Metal 8/50 Zero Valent Iron Product Specifications

Appendix F-1a

Kinetics Experiment Analytical Data

Appendix F-1a
Kinetics Experiment Analytical Data
D.E. Karn Generating Facility
Consumers Energy

			Location	**Karn-MW-10**	**Kin-01**	**Kin-03**	**Kin-05**	**Kin-09**	**Kin-12**	**Kin-Control-12**
			Date	**7/24/2020**	**7/29/2020**	**7/29/2020**	**7/29/2020**	**7/29/2020**	**7/29/2020**	**7/29/2020**
			Sample Type	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Parameter	Units	Chronic-Based Mixing Zone GSI Criteria[1]	Acute-Based Mixing Zone GSI Criteria[1]							
Effective Date		12/23/2015	12/23/2015							
Exceedance Key		Underline	No Exceed							
Arsenic (USEPA 6010C)	ug/l	100	680	450	< 1 U	1	1	1	< 1 U	316

Footnotes

N Sample Type: Normal

U The analyte was analyzed for, but was not detected.

[1] Criteria shown are mixing zone-based groundwater surface water interface (GSI) criteria that were developed for the D.E. Karn Generating Facility by the Michigan Department of Environment, Great Lakes, and Energy in December 2015

Appendix F-1b

Continuously Stirred Batch Reactor Experiment Analytical Data

Appendix F-1b
CSBR Experiment Analytical Data
D.E. Karn Generating Facility
Consumers Energy

			Location	**Karn-MW-10**	**Kin-CSBR-Initial**	**Karn-CSBR-05-01**	**Karn-CSBR-10-01**	**Karn-CSBR-05-02**	**Karn-CSBR-10-02**	**Karn-CSBR-05-03**	**Karn-CSBR-10-03**	**Karn-CSBR-05-04**	**Karn-CSBR-10-04**	**Karn-CSBR-05-05**	**Karn-CSBR-10-05**	**Karn-CSBR-05-06**	**Karn-CSBR-10-06**	**Karn-CSBR-05-07**	**Karn-CSBR-10-07**	**Karn-CSBR-05-08**	**Karn-CSBR-10-08**
			Date	**7/24/2020**	**7/31/2020**	**7/31/2020**	**7/31/2020**	**8/01/2020**	**8/01/2020**	**8/01/2020**	**8/01/2020**	**8/02/2020**	**8/02/2020**	**8/02/2020**	**8/02/2020**	**8/03/2020**	**8/03/2020**	**8/03/2020**	**8/03/2020**	**8/04/2020**	**8/04/2020**
			Sample Type	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Parameter	Units	Chronic-Based Mixing Zone GSI Criteria[1]	Acute-Based Mixing Zone GSI Criteria[1]																		
Effective Date		12/23/2015	12/23/2015																		
Exceedance Key		Underline	No Exceed																		
General Parameters																					
Dimethylarsinic acid	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	< 1 U	--	--	--	--	< 1 U	--	--	--	--	--	--
Monomethylarsonic acid	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	< 1 U	--	--	--	--	< 1 U	--	--	--	--	--	--
Dissolved Metals																					
Arsenic (USEPA 7010)	ug/l	100	680	447	385	4	2	23	4	8	3	20	11	49	15	155	53	94	41	104	41
Arsenic (USEPA 6010C)	ug/l	100	680	450	320	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic III	ug/l	100	680	395	< 1 U	--	--	--	--	< 1 U	--	--	--	--	< 1 U	--	--	--	--	--	--
Arsenic V	ug/l	100	680	45	298	--	--	--	--	8	--	--	--	--	13	--	--	--	--	--	--
Arsenic, other as species	ug/l	100	680	8	1	--	--	--	--	< 1 U	--	--	--	--	< 1 U	--	--	--	--	--	--
Barium	ug/l	N/A	N/A	120	120	--	--	--	--	50	--	--	--	--	55	--	--	--	--	--	--
Cadmium	ug/l	N/A	N/A	< 0.1 U	< 0.1 U	--	--	--	--	< 0.1 U	--	--	--	--	< 0.1 U	--	--	--	--	--	--
Chromium	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	2	--	--	--	--	< 1 U	--	--	--	--	--	--
Iron	ug/l	N/A	N/A	18	22	--	--	--	--	14	--	--	--	--	12	--	--	--	--	--	--
Lead	ug/l	N/A	N/A	11	49	--	--	--	--	9	--	--	--	--	10	--	--	--	--	--	--
Manganese	ug/l	N/A	N/A	170	180	--	--	--	--	8	--	--	--	--	6	--	--	--	--	--	--
Mercury	ug/l	N/A	N/A	< 0.08 U	< 0.08 U	--	--	--	--	< 0.08 U	--	--	--	--	< 0.08 U	--	--	--	--	--	--
Selenium	ug/l	55	120	19	< 1 U	--	--	--	--	< 1 U	--	--	--	--	< 1 U	--	--	--	--	--	--

Footnotes

N Sample Type: Normal

FD Sample Type: Field Duplicate

U The analyte was analyzed for, but was not detected.

[1] Criteria shown are mixing zone-based groundwater surface water interface (GSI) criteria that were developed for the D.E. Karn Generating Facility by the Michigan Department of Environment, Great Lakes, and Energy in December 2015

Appendix F-1b
CSBR Experiment Analytical Data
D.E. Karn Generating Facility
Consumers Energy

			Location	Karn-CSBR-05-09	Karn-CSBR-10-09	Karn-CSBR-05-10	Karn-CSBR-10-10	Karn-CSBR-05-11	Karn-CSBR-10-11	Karn-CSBR-05-12	Karn-CSBR-10-12	Karn-CSBR-05-13	Karn-CSBR-10-13	Karn-CSBR-05-14		Karn-CSBR-10-14
			Date	8/04/2020	8/04/2020	8/05/2020	8/05/2020	8/05/2020	8/05/2020	8/06/2020	8/06/2020	8/06/2020	8/06/2020	8/07/2020		8/07/2020
			Sample Type	N	N	N	N	N	N	N	N	N	N	N	FD	N
Parameter	Units	Chronic-Based Mixing Zone GSI Criteria[1]	Acute-Based Mixing Zone GSI Criteria[1]													
Effective Date		12/23/2015	12/23/2015													
Exceedance Key		Underline	No Exceed													
General Parameters																
Dimethylarsinic acid	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	--	--	--	--	< 1 U	< 1 U	< 1 U
Monomethylarsonic acid	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	--	--	--	--	< 1 U	< 1 U	< 1 U
Dissolved Metals																
Arsenic (USEPA 7010)	ug/l	100	680	98	65	70	97	99	77	178	47	206	68	215	201	113
Arsenic (USEPA 6010C)	ug/l	100	680	--	--	--	--	--	--	--	--	--	--	210	210	--
Arsenic III	ug/l	100	680	< 1 U	2	--	--	--	--	--	--	--	--	2	2	1
Arsenic V	ug/l	100	680	77	62	--	--	--	--	--	--	--	--	184	182	112
Arsenic, other as species	ug/l	100	680	< 1 U	< 1 U	--	--	--	--	--	--	--	--	< 1 U	< 1 U	< 1 U
Barium	ug/l	N/A	N/A	56	61	--	--	--	--	--	--	--	--	76	78	76
Cadmium	ug/l	N/A	N/A	< 0.1 U	< 0.1 U	--	--	--	--	--	--	--	--	< 0.1 U	< 0.1 U	< 0.1 U
Chromium	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	--	--	--	--	< 1 U	< 1 U	< 1 U
Iron	ug/l	N/A	N/A	12	11	--	--	--	--	--	--	--	--	12	13	31
Lead	ug/l	N/A	N/A	< 1 U	< 1 U	--	--	--	--	--	--	--	--	< 1 U	< 1 U	< 1 U
Manganese	ug/l	N/A	N/A	4	4	--	--	--	--	--	--	--	--	3	3	4
Mercury	ug/l	N/A	N/A	< 0.08 U	< 0.08 U	--	--	--	--	--	--	--	--	< 0.08 U	< 0.08 U	< 0.08 U
Selenium	ug/l	55	120	< 1 U	< 1 U	--	--	--	--	--	--	--	--	< 1 U	< 1 U	< 1 U

Footnotes

N Sample Type: Normal

FD Sample Type: Field Duplicate

U The analyte was analyzed for, but was not detected.

[1] Criteria shown are mixing zone-based groundwater surface water i

Data Footnotes and Qualifiers

Barr Standard Footnotes and Qualifiers

--	Not analyzed/Not available.
N	Sample Type: Normal
FD	Sample Type: Field Duplicate
U	The analyte was analyzed for, but was not detected.

Appendix F-1c

Field Parameters

Appendix F-1c
CSBR Experiment Field Parameters
D.E. Karn Generating Facility
Consumers Energy

Batch	Zero Valent Iron Mass (g)	pH (s.u.)	Oxidation Reduction Potential (mV)	Dissolved Oxygen (mg/L)	Conductivity (µS/cm)	Temperature (°C)
1	5	7.82	150.7	14.48*	650	8.7
	10	8.10	144.8	14.46*	627	--
2	5	8.13	200.4	13.91*	808	21.7
	10	8.06	192.3	15.17*	762	21.7
3	5	8.14	86.6	14.22*	763	22.9
	10	8.15	98.6	13.83*	747	22.3
4	5	8.06	175.8	12.88*	726	21.3
	10	8.11	160.7	13.71*	733	21.3
5	5	8.30	163.6	13.01*	699	22.6
	10	8.71	164.3	13.04*	732	22.7
6	5	8.31	170.7	13.38*	738	21.9
	10	8.32	168.8	13.98*	691	21.7
7	5	7.27	170.1	4.22	625	23.7
	10	7.42	144.5	3.52	653	23.8
8	5	8.23	113.3	4.15	652	22.4
	10	7.98	106.2	3.98	647	22.5
9	5	7.96	67.4	3.37	658	24.0
	10	7.90	69.0	3.42	663	23.7
10	5	8.06	164.3	4.20	1212	21.1
	10	8.13	213.4	4.13	1327	21.1
11	5	8.06	183.6	5.17	704	23.3
	10	8.08	221.5	4.48	787	23.1
12	5	7.91	147.1	4.57	678	22.6
	10	7.95	133.3	4.07	649	22.4
13	5	7.32	134.7	4.10	699	23.5
	10	7.84	121.0	3.86	683	24.1
14	5	8.11	124.0	4.26	704	22.9
	10	8.12	112.1	4.52	682	22.9

*Value believed erroneous due to faulty dissolved oxygen sensor

Appendix F-2

Laboratory Bench Testing Data Report

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Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Data Transmittal Cover Page

Project Name: **Barr Engineering**
ATS Project Number: **B008-ARS**
ATS Report Number(s): **Inorg_Analysis_SRF_0727201, 0731201, 0804201, & 0807201**
Client PO Number:

Project Description: This data report contains the results of 37 samples received by ATS between July 27, 2020 and August 7,2020, to be analyzed for various parameters.

We certify that the sample analyses for this report have been conducted in accordance with guidelines provided in the referenced standard test method, and are consistent with detailed procedures described in a written Standard Operating Procedure specific to the ATS Laboratories, as required by USEPA. Laboratory data sheets, SOPs, and QA/QC information are available for inspection and audit at the laboratory upon request. Unless specifically noted on the data report, all applicable sample preservation and holding time requirements have been met.

Recipient: Mr. Andrew Dykstra
Email: adykstra@barr.com
FAX Number:

No. of Pages (including cover pg.): 63

From: Mark DeLong
Senior Scientist
Email: Mark.DeLong@annarbortechnicalservices.com
FAX Number: 734-995-3731

Additional Message: Copy Dana Pasi at dpasi@barr.com

Date: 8/27/20
Signed: Mark DeLong

IF YOU DO NOT RECEIVE ALL PAGES OF THIS TRANSMITTAL, PLEASE CALL 734-995-0995.

LABORATORY OPERATIONS
SAMPLE DELIVERY GROUP (SDG) CASE NARRATIVE

ATS Project Number: B008-ARS
Report Date: 8/14/20 PRELIMINARY
Updated: 8/27/20 FINAL
ATS SDGs: 0727201, 0731201, 0804201 & 0807201

Case Narrative Summary

This case narrative applies to the following 37 samples that were received at Ann Arbor Technical Services, Inc. (ATS) between July 27 and August 7, 2020, and associated matrix-specific QA/QC:

Samples

Client Sample Identification	Laboratory Identification	Laboratory Sample ID	Matrix
Karn-MW-10 7/24/20	ATS / BAL	0727201-1 / 2033017-10	Water
Kin-01 7/29/20	ATS	0731201-1	Water
Kin-03 7/29/20	ATS	0731201-2	Water
Kin-05 7/29/20	ATS	0731201-3	Water
Kin-09 7/29/20	ATS	0731201-4	Water
Kin-12 7/29/20	ATS	0731201-5	Water
Kin-Control-12 7/29/20	ATS	0731201-6	Water
Karn-CSBR-Initial 7/31/20	ATS / BAL	0731201-7 / 2033017-06	Water
Karn-CSBR-05-01 7/31/20	ATS	0804201-1	Water
Karn-CSBR-10-01 7/31/20	ATS	0804201-2	Water
Karn-CSBR-05-02 8/1/20	ATS	0804201-3	Water
Karn-CSBR-10-02 8/1/20	ATS	0804201-4	Water
Karn-CSBR-05-03 8/1/20	ATS / BAL	0804201-5 / 2033017-07	Water
Karn-CSBR-10-03 8/1/20	ATS	0804201-6	Water
Karn-CSBR-05-04 8/2/20	ATS	0804201-7	Water
Karn-CSBR-10-04 8/2/20	ATS	0804201-8	Water
Karn-CSBR-05-05 8/2/20	ATS	0804201-9	Water
Karn-CSBR-10-05 8/2/20	ATS / BAL	0804201-10 / 2033017-08	Water
Karn-CSBR-05-06 8/3/20	ATS	0804201-11	Water
Karn-CSBR-10-06 8/3/20	ATS	0804201-12	Water
Karn-CSBR-05-07 8/3/20	ATS	0804201-13	Water
Karn-CSBR-10-07 8/3/20	ATS	0804201-14	Water
Karn-CSBR-05-08 8/4/20	ATS	0804201-15	Water
Karn-CSBR-10-08 8/4/20	ATS	0804201-16	Water

Karn-CSBR-05-09 8/4/20	ATS / BAL	0807201-1 / 2033017-04	Water
Karn-CSBR-10-09 8/4/20	ATS / BAL	0807201-2 / 2033017-05	Water
Karn-CSBR-05-10 8/5/20	ATS	0807201-3	Water
Karn-CSBR-10-10 8/5/20	ATS	0807201-4	Water
Karn-CSBR-10-11 8/5/20	ATS	0807201-5	Water
Karn-CSBR-05-11 8/5/20	ATS	0807201-6	Water
Karn-CSBR-05-12 8/6/20	ATS	0807201-7	Water
Karn-CSBR-10-12 8/6/20	ATS	0807201-8	Water
Karn-CSBR-05-13 8/6/20	ATS	0807201-9	Water
Karn-CSBR-10-13 8/6/20	ATS	0807201-10	Water
Karn-CSBR-05-14 8/7/20	ATS / BAL	0807201-11 / 2033017-02	Water
Karn-CSBR-10-14 8/7/20	ATS / BAL	0807201-12 / 2033017-01	Water
DUP 8/7/20	ATS / BAL	0807201-13 / 2033017-11	Water

Upon receipt, samples were scheduled for the following analyses:

• Soluble Arsenic by USEPA 7010	• 37 + 5 Matrix Spikes + 5 Matrix Spike Duplicates
• Soluble Metals by USEPA 6010C (select samples)	• 9 + 1 Matrix Spike + 1 Matrix Spike Duplicate
• Soluble Mercury by USEPA 7470A (select samples)	• 9 + 1 Matrix Spike + 1 Matrix Spike Duplicate
• Arsenic Speciation by ATS IC/ICP-MS (select samples)	• 11 + 2 Matrix Spikes + 2 Matrix Spike Duplicate

A subsample was prepared by ATS and shipped under chain of custody to Brook Applied Labs for analysis by ATS IC/ICP-MS.

Sample Receipt and Chain of Custody Records

Samples were delivered directly to ATS by a client representative. Samples were received on ice, with proper chain of custody records included. Sample condition and anomalies, if any, are presented in the "Sample Receipt" section of this report. All samples were prepared and analyzed within the holding times cited in the corresponding analytical methods with the following exceptions:

- **None**

Data Review and Approval

All data contained in this report have been generated in accordance with guidelines provided in the referenced standard test methods, and are consistent with detailed procedures described in a written standard operating procedure (SOP) specific to the laboratories, as required by USEPA. All data are peer and management reviewed to ensure compliance with the above referenced SOP's and project specifications. In addition, all data conform to the laboratory's Quality Assurance / Quality Control Manuals.

Data Qualifications, Specifications, and Technical Narration

The following are qualifier descriptions that may be used throughout this SDG and are presented with their associated samples in each SDG section as appropriate.

- "E" – exceeds the calibration range of the method
- "D" – result taken from sample dilution
- "J" – concentration reported between the laboratory / instrument determined method detection limit (MDL) and the practical quantitation limit (PQL)
- "B" – analyte concentration in method blank exceeds reporting limit
- "U" – analyte not detected above MDL
- "*" – indicates analyte has exceeded batch or sample specific QA/QC control limits
- "M" – indicates matrix interference

A single QA/QC batch is defined as no more than 20 samples excluding method blanks (MB, LRB), fortified blanks (BS, LFB, LCS), matrix spikes (MS, SPK), and duplicates whether spiked or native (MSD, SPK DUP, DUP, LR).

Data Deliverables

All data deliverables are generated to comply with the USEPA. This data package constitutes a Level II package; other data report packages (Level I, Level IV DVP, EPA R5 EDD) are available upon request. There were no hardcopy data summary sheets generated for this project.

Sample Preparation

All samples were filtered by ATS upon receipt using a 0.45 micron membrane filter after allowing them to stabilize for approximately 24 hours at 4°C, per client request. Following filtration, samples were preserved with either nitric acid or sodium EDTA (ethylenediaminetetraacetic acid), as appropriate for the methods. The following anomalies were noted:

Anomalies Noted:
- **None**

Sample Analysis

Soluble Arsenic Analysis: Samples were analyzed in accordance with USEPA method 7010 (Determination of Metals and Trace Elements in Water and Wastes by Graphite Furnace Atomic Absorption Spectrophotometry). An initial calibration with at least five levels was used for quantitation. Concentrations were reported to the lowest calibration standard. Samples were reported as mg/L.

Soluble Metals Scan Analysis: Select samples were analyzed in accordance with USEPA method 6010C (Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry). An initial calibration with at least five levels was used to quantitate individual metals. Concentrations were reported to the lowest calibration standard. Samples were reported as mg/L.

Soluble Mercury Analysis: Select samples were analyzed in accordance with USEPA method 7470A (Determination of Mercury in Liquid Wastes by Cold Vapor-Atomic Emission Spectrometry). An initial calibration with at least five levels was used for quantitation. Concentrations were reported to the method detection limit (MDL). Samples were reported as mg/L.

Arsenic Speciation Analysis: Select samples were analyzed in accordance with ATS method IC/ICP-MS 200.8 (Determination of Arsenic Species by Ion Chromatography / Inductively Coupled Plasma-Atomic Mass Spectrometry). An initial calibration with at least five levels for each species was used for quantitation. Concentrations were reported to a project specific reporting limit (RL). Samples were reported as mg/L.

Anomalies Noted:

- **For purposes of this study, sample dilution factor was not applied to the reporting limit noted on the data report.**

Analytical QA/QC Summary

Calibration Verification *(Applicable to all analyses)*

Method calibration and instrument suitability was verified through the analysis of a mid-level calibration verification standard at a frequency of every 10 samples. All verification standards met method criteria with the following exceptions:

Lab Sample ID	Method	Constituent	Percent Recovery	Acceptance Limits
CCV-5	USEPA 6010	Iron	89.5	90-110%

Instrument Blanks *(Applicable to all analyses)*

Low system background was demonstrated through the analysis of instrument blanks at a frequency of approximately every 10 samples. All instrument blanks met the acceptance criteria with the following exceptions:

- **None**

Interference Checks *(Applicable to ICP/AES analyses only)*

The lack of spectral interferences was verified through the analysis of interference check standards daily. All interference standards met the acceptance criteria with the following exceptions:

- **None**

Laboratory Reagent Blanks *(Applicable to all analyses)*

A laboratory reagent blank (LRB) was analyzed as part of each QA/QC batch. The LRB's met the acceptance criteria with the following exceptions:

- **None**

Laboratory Fortified Blanks and Matrix Spikes *(Applicable to all analyses)*

A laboratory fortified blank (LFB) / laboratory control sample (LCS) was analyzed with each QA/QC batch. For arsenic speciation, the LCS/LFB's contained appropriate concentrations of arsenite (As III) species, arsenate (As V) species, dimethylarsinic acid (DMA) species, and monomethylarsonic acid (MMA) species. All LCS/LFB's met the acceptance criteria with the following exceptions:

- **None**

A matrix spike (MS) and matrix spike duplicate (MSD) was analyzed with each QA/QC batch. For arsenic speciation, the LCS/LFB's contained appropriate concentrations of arsenite (As III) species, arsenate (As V) species, dimethylarsinic acid (DMA) species, and monomethylarsonic acid (MMA) species. All MS/MDS's met the acceptance criteria with the following exceptions:

- **Two matrix spikes and spike duplicates for arsenate were not reportable due to inadequate spiking levels relative to native sample concentrations.**

Matrix Replicates *(Applicable to all analyses)*

A minimum of one replicate analysis was analyzed with each QA/QC batch. All replicates met the acceptance criteria with the following exceptions:

- **None**

Sample Dilutions

Samples containing compounds at concentrations above the initial calibration curve were diluted and reanalyzed for those compounds. The following samples and analytes were diluted:

- **EPA 7010**

0727201-1
0731201-6
0731201-7
0804201-3
0804201-9
0804201-11
0804201-12
0804201-13
0804201-14
0804201-15
0804201-16
0807201-1
0807201-2
0807201-3
0807201-4
0807201-5
0807201-6
0807201-7
0807201-8
0807201-9
0807201-10
0807201-11
0807201-12
0807201-13

Mark DeLong

______________________________________ / August 27, 2020

Mark T. DeLong (Quality Assurance Coordinator)

Philip B.

______________________________________ / August 27, 2020

Philip B. Simon (Laboratory Director)

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Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0727201

Sample Identification: Karn-MW-10

Laboratory Sample ID: 0727201-1

Sample Date:	7/24/20
Sample Time:	10:40 AM
Sampled By:	Client
Laboratory Receipt Date:	7/27/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.447	0.001	8/13/20	12:23	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.45	0.001	8/11/20	17:04	DMS
Soluble Barium	USEPA 6010C	mg/L	0.12	0.001	8/11/20	17:04	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	17:04	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	17:04	DMS
Soluble Iron	USEPA 6010C	mg/L	0.018	0.001	8/11/20	17:04	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.17	0.001	8/11/20	17:04	DMS
Soluble Lead	USEPA 6010C	mg/L	0.011	0.001	8/11/20	17:04	DMS
Soluble Selenium	USEPA 6010C	mg/L	0.019	0.001	8/11/20	17:04	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	17:56	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.045	0.001	8/15/20	12:53	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	0.395	0.001	8/15/20	12:53	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:53	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:53	BAL
Other As Species	IC/ICP-MS	mg/L	0.008	0.001	8/15/20	12:53	BAL

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-01

Laboratory Sample ID: 0731201-1

Sample Date:	7/29/20
Sample Time:	11:10 AM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	<0.001	0.001	8/21/20	12:02	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-03

Laboratory Sample ID: 0731201-2

Sample Date:	7/29/20
Sample Time:	1:10 PM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.001	0.001	8/21/20	12:08	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-05

Laboratory Sample ID: 0731201-3

Sample Date:	7/29/20
Sample Time:	3:10 PM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.001	0.001	8/21/20	12:14	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-09

Laboratory Sample ID: 0731201-4

Sample Date:	7/29/20
Sample Time:	7:10 PM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.001	0.001	8/12/20	15:08	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.

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Michigan Laboratory ID: 9604
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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-12

Laboratory Sample ID: 0731201-5

Sample Date:	7/29/20
Sample Time:	10:10 PM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	<0.001	0.001	8/12/20	15:15	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-Control-12

Laboratory Sample ID: 0731201-6

Sample Date:	7/29/20
Sample Time:	10:15 PM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.316	0.001	8/13/20	12:30	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0731201

Sample Identification: Kin-CSBR-Initial

Laboratory Sample ID: 0731201-7

Sample Date:	7/31/20
Sample Time:	6:00 AM
Sampled By:	Client
Laboratory Receipt Date:	7/31/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.385	0.001	8/12/20	15:27	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.32	0.001	8/11/20	17:32	DMS
Soluble Barium	USEPA 6010C	mg/L	0.12	0.001	8/11/20	17:32	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	17:32	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	17:32	DMS
Soluble Iron	USEPA 6010C	mg/L	0.022	0.001	8/11/20	17:32	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.18	0.001	8/11/20	17:32	DMS
Soluble Lead	USEPA 6010C	mg/L	0.049	0.001	8/11/20	17:32	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	17:32	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	18:09	JEB

Arsenic Speciation

Arsenate (As V)	IC/ICP-MS	mg/L	0.298	0.001	8/15/20	13:08	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	13:08	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	13:08	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	13:08	BAL
Other As Species	IC/ICP-MS	mg/L	0.001	0.001	8/15/20	13:08	BAL

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
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Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-01

Laboratory Sample ID: 0804201-1

Sample Date:	7/31/20
Sample Time:	6:35 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.004	0.001	8/21/20	12:21	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-01

Laboratory Sample ID: 0804201-2

Sample Date:	7/31/20
Sample Time:	6:30 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.002	0.001	8/21/20	12:27	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-02

Laboratory Sample ID: 0804201-3

Sample Date:	8/1/20
Sample Time:	6:30 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.023	0.001	8/21/20	12:33	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.

290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-02

Laboratory Sample ID: 0804201-4

Sample Date:	8/1/20
Sample Time:	6:35 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.004	0.001	8/13/20	10:35	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.

290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-03

Laboratory Sample ID: 0804201-5

Sample Date:	8/1/20
Sample Time:	6:35 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.008	0.001	8/13/20	10:42	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.012	0.001	8/11/20	18:15	DMS
Soluble Barium	USEPA 6010C	mg/L	0.050	0.001	8/11/20	18:15	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	18:15	DMS
Soluble Chromium	USEPA 6010C	mg/L	0.002	0.001	8/11/20	18:15	DMS
Soluble Iron	USEPA 6010C	mg/L	0.014	0.001	8/11/20	18:15	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.008	0.001	8/11/20	18:15	DMS
Soluble Lead	USEPA 6010C	mg/L	0.009	0.001	8/11/20	18:15	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001			DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	18:28	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.008	0.001	8/15/20	12:22	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:22	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:22	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:22	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:22	BAL

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-03

Laboratory Sample ID: 0804201-6

Sample Date:	8/1/20
Sample Time:	6:45 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.003	0.001	8/21/20	13:31	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-04

Laboratory Sample ID: 0804201-7

Sample Date:	8/2/20
Sample Time:	6:47 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.020	0.001	8/21/20	12:58	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-04

Laboratory Sample ID: 0804201-8

Sample Date:	8/2/20
Sample Time:	6:52 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.011	0.001	8/21/20	13:12	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-05

Laboratory Sample ID: 0804201-9

Sample Date:	8/2/20
Sample Time:	6:40 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.049	0.001	8/13/20	11:20	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

290 South Wagner Road
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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-05

Laboratory Sample ID: 0804201-10

Sample Date: 8/2/20
Sample Time: 6:45 PM
Sampled By: Client
Laboratory Receipt Date: 8/4/20
Sample Matrix: Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.015	0.001	8/13/20	11:27	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.022	0.001	8/11/20	18:42	DMS
Soluble Barium	USEPA 6010C	mg/L	0.055	0.001	8/11/20	18:42	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	18:42	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	18:42	DMS
Soluble Iron	USEPA 6010C	mg/L	0.012	0.001	8/11/20	18:42	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.006	0.001	8/11/20	18:42	DMS
Soluble Lead	USEPA 6010C	mg/L	0.010	0.001	8/11/20	18:42	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	18:42	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	18:34	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.013	0.001	8/15/20	12:38	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:38	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:38	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:38	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	12:38	BAL

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-06

Laboratory Sample ID: 0804201-11

Sample Date:	8/3/20
Sample Time:	6:35 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.155	0.001	8/13/20	11:45	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-06

Laboratory Sample ID: 0804201-12

Sample Date:	8/3/20
Sample Time:	6:40 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.053	0.001	8/13/20	11:52	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-07

Laboratory Sample ID: 0804201-13

Sample Date:	8/3/20
Sample Time:	6:45 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.094	0.001	8/13/20	11:58	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-07

Laboratory Sample ID: 0804201-14

Sample Date:	8/3/20
Sample Time:	6:50 PM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.041	0.001	8/13/20	12:04	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

ANN ARBOR TECHNICAL SERVICES, INC.
290 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-05-08

Laboratory Sample ID: 0804201-15

Sample Date:	8/4/20
Sample Time:	6:45 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.104	0.001	8/13/20	12:11	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0804201

Sample Identification: Karn-CSBR-10-08

Laboratory Sample ID: 0804201-16

Sample Date:	8/4/20
Sample Time:	6:50 AM
Sampled By:	Client
Laboratory Receipt Date:	8/4/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.041	0.001	8/13/20	12:17	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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290 South Wagner Road
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Tel. 734/995-0995 Fax. 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-05-09

Laboratory Sample ID: 0807201-1

Sample Date:	8/4/20
Sample Time:	6:37 PM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.098	0.001	8/12/20	13:21	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.093	0.001	8/11/20	19:25	DMS
Soluble Barium	USEPA 6010C	mg/L	0.056	0.001	8/11/20	19:25	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	19:25	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	19:25	DMS
Soluble Iron	USEPA 6010C	mg/L	0.012	0.001	8/11/20	19:25	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.004	0.001	8/11/20	19:25	DMS
Soluble Lead	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	19:25	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	19:25	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	18:41	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.077	0.001	8/15/20	10:05	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:05	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:05	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:05	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:05	BAL

Comments

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Dilution factor not applied to reporting limit.

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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-10-09

Laboratory Sample ID: 0807201-2

Sample Date:	8/4/20
Sample Time:	6:42 PM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.065	0.001	8/12/20	13:40	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.080	0.001	8/11/20	19:37	DMS
Soluble Barium	USEPA 6010C	mg/L	0.061	0.001	8/11/20	19:37	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	19:37	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	19:37	DMS
Soluble Iron	USEPA 6010C	mg/L	0.011	0.001	8/11/20	19:37	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.004	0.001	8/11/20	19:37	DMS
Soluble Lead	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	19:37	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	19:37	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	18:47	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.062	0.001	8/15/20	10:20	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	0.002	0.001	8/15/20	10:20	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:20	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:20	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	10:20	BAL

Comments

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-05-10

Laboratory Sample ID: 0807201-3

Sample Date:	8/5/20
Sample Time:	6:40 AM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.070	0.001	8/12/20	13:46	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-10-10

Laboratory Sample ID: 0807201-4

Sample Date:	8/5/20
Sample Time:	6:46 AM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.097	0.001	8/12/20	13:53	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Wisconsin Laboratory ID: 998321720

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-10-11

Laboratory Sample ID: 0807201-5

Sample Date:	8/5/20
Sample Time:	6:43 PM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.077	0.001	8/12/20	13:59	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-05-11

Laboratory Sample ID: 0807201-6

Sample Date:	8/5/20
Sample Time:	6:47 PM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.099	0.001	8/12/20	14:05	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-05-12

Laboratory Sample ID: 0807201-7

Sample Date:	8/6/20
Sample Time:	6:44 AM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.178	0.001	8/12/20	14:12	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
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ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-10-12

Laboratory Sample ID: 0807201-8

Sample Date:	8/6/20
Sample Time:	6:49 AM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.047	0.001	8/12/20	14:18	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-05-13

Laboratory Sample ID: 0807201-9

Sample Date:	8/6/20
Sample Time:	6:36 PM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.206	0.001	8/12/20	14:24	JEB

Comments

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-10-13

Laboratory Sample ID: 0807201-10

Sample Date:	8/6/20
Sample Time:	6:41 PM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.068	0.001	8/12/20	14:31	JEB

Comments

All methods reference USEPA unless otherwise specified.
Dilution factor not applied to reporting limit.

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-05-14

Laboratory Sample ID: 0807201-11

Sample Date:	8/7/20
Sample Time:	6:30 AM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.215	0.001	8/12/20	16:06	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.21	0.001	8/11/20	20:28	DMS
Soluble Barium	USEPA 6010C	mg/L	0.076	0.001	8/11/20	20:28	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	20:28	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:28	DMS
Soluble Iron	USEPA 6010C	mg/L	0.012	0.001	8/11/20	20:28	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.003	0.001	8/11/20	20:28	DMS
Soluble Lead	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:28	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:28	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	18:53	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.184	0.001	8/15/20	9:50	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	0.002	0.001	8/15/20	9:50	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	9:50	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	9:50	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	9:50	BAL

Comments

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: Karn-CSBR-10-14

Laboratory Sample ID: 0807201-12

Sample Date:	8/7/20
Sample Time:	6:35 AM
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.113	0.001	8/13/20	12:36	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.13	0.001	8/11/20	20:32	DMS
Soluble Barium	USEPA 6010C	mg/L	0.076	0.001	8/11/20	20:32	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	20:32	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:32	DMS
Soluble Iron	USEPA 6010C	mg/L	0.031	0.001	8/11/20	20:32	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.004	0.001	8/11/20	20:32	DMS
Soluble Lead	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:32	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:32	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	19:00	JEB

Arsenic Speciation

Arsenate (As V)	IC/ICP-MS	mg/L	0.112	0.001	8/15/20	9:34	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	0.001	0.001	8/15/20	9:34	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	9:34	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	9:34	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	9:34	BAL

Comments

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Dilution factor not applied to reporting limit.

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Metals Analysis
Data Summary Sheet

For: Mr. Andrew D. Dykstra
Barr Engineering Co.
3005 Boardwalk Dr
Ann Arbor, MI 48108

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20
ATS SRF: 0807201

Sample Identification: DUP

Laboratory Sample ID: 0807201-13

Sample Date:	8/7/20
Sample Time:	--
Sampled By:	Client
Laboratory Receipt Date:	8/7/20
Sample Matrix:	Wastewater

Parameter	Method	Units	Result	Reporting Limit	Analysis Date	Analysis Time	Analyst
Soluble Arsenic	USEPA 7010	mg/L	0.201	0.001	8/12/20	16:31	JEB
Soluble Arsenic	USEPA 6010C	mg/L	0.21	0.001	8/11/20	20:43	DMS
Soluble Barium	USEPA 6010C	mg/L	0.078	0.001	8/11/20	20:43	DMS
Soluble Cadmium	USEPA 6010C	mg/L	<0.0001	0.0001	8/11/20	20:43	DMS
Soluble Chromium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:43	DMS
Soluble Iron	USEPA 6010C	mg/L	0.013	0.001	8/11/20	20:43	DMS
Soluble Manganese	USEPA 6010C	mg/L	0.003	0.001	8/11/20	20:43	DMS
Soluble Lead	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:43	DMS
Soluble Selenium	USEPA 6010C	mg/L	<0.001	0.001	8/11/20	20:43	DMS
Soluble Mercury	USEPA 7470A	mg/L	<0.00008	0.00008	8/11/20	19:06	JEB
Arsenic Speciation							
Arsenate (As V)	IC/ICP-MS	mg/L	0.182	0.001	8/15/20	13:08	BAL
Arsenite (As III)	IC/ICP-MS	mg/L	0.002	0.001	8/15/20	13:08	BAL
DMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	13:08	BAL
MMA	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	13:08	BAL
Other As Species	IC/ICP-MS	mg/L	<0.001	0.001	8/15/20	13:08	BAL

Comments

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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0812201

Parameter: Arsenic (USEPA 7010)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS 0807201-1 Matrix Spike	0.30 mg/L	0.30 mg/L	0.30 mg/L	1.0
#B008-ARS 0731201-7 Matrix Spike	1.2 mg/L	1.3 mg/L	1.3 mg/L	0.2

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank 8/12/20	<0.001 mg/L	0.010 mg/L	0.011 mg/L	109.7
#B008-ARS				
0807201-1 Matrix Spike	0.10 mg/L	0.20 mg/L	0.30 mg/L	100.7
0807201-1 Matrix Spike Duplicate	0.10 mg/L	0.20 mg/L	0.30 mg/L	99.2
#B008-ARS				
0731201-7 Matrix Spike	0.38 mg/L	0.80 mg/L	1.2 mg/L	109.4
0731201-7 Matrix Spike Duplicate	0.38 mg/L	0.80 mg/L	1.3 mg/L	109.6

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0813201

Parameter: Arsenic (USEPA 7010)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
0804201-5 Matrix Spike	0.029 mg/L	0.028 mg/L	0.028 mg/L	3.8
#B008-ARS				
0807201-12 Matrix Spike	0.30 mg/L	0.30 mg/L	0.30 mg/L	3.1

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank 8/13/20	<0.001 mg/L	0.010 mg/L	0.010 mg/L	101.4
#B008-ARS				
0804201-5 Matrix Spike	0.009 mg/L	0.020 mg/L	0.029 mg/L	101.0
0804201-5 Matrix Spike Duplicate	0.009 mg/L	0.020 mg/L	0.028 mg/L	95.7
#B008-ARS				
0807201-12 Matrix Spike	0.11 mg/L	0.20 mg/L	0.30 mg/L	91.5
0807201-12 Matrix Spike Duplicate	0.11 mg/L	0.20 mg/L	0.30 mg/L	96.3

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0821201
Parameter: Arsenic (USEPA 7010)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
0804201-3 Matrix Spike	0.066 mg/L	0.067 mg/L	0.066 mg/L	1.7

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank 8/21/20	<0.001 mg/L	0.010 mg/L	0.009 mg/L	86.7
#B008-ARS				
0804201-3 Matrix Spike	0.011 mg/L	0.050 mg/L	0.066 mg/L	109.1
0804201-3 Matrix Spike Duplicate	0.011 mg/L	0.050 mg/L	0.067 mg/L	111.3

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201

Parameter: Mercury (USEPA 7470A)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
0731201-7 Matrix Spike	0.0041 mg/L	0.0042 mg/L	0.0042 mg/L	1.4

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank 8/11/20	<0.00008 mg/L	0.0020 mg/L	0.0022 mg/L	109.0
#B008-ARS				
0731201-7 Matrix Spike	<0.00008 mg/L	0.0040 mg/L	0.0041 mg/L	103.5
0731201-7 Matrix Spike Duplicate	<0.00008 mg/L	0.0040 mg/L	0.0042 mg/L	105.0

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.0008 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201

Parameter: Arsenic (USEPA 6010C)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
0731201-7 Matrix Spike	4.3 mg/L	4.3 mg/L	4.3 mg/L	1.6

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.001 mg/L	1.0 mg/L	1.1 mg/L	106.7
#B008-ARS				
0731201-7 Matrix Spike	0.32 mg/L	4.0 mg/L	4.3 mg/L	98.6
0731201-7 Matrix Spike Duplicate	0.32 mg/L	4.0 mg/L	4.3 mg/L	100.3

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201
Parameter: Barium (USEPA 6010C)

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
0731201-7 Matrix Spike	4.0 mg/L	4.1 mg/L	4.0 mg/L	2.5

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.001 mg/L	1.0 mg/L	1.0 mg/L	95.7
#B008-ARS				
0731201-7 Matrix Spike	0.12 mg/L	4.0 mg/L	4.0 mg/L	96.1
0731201-7 Matrix Spike Duplicate	0.12 mg/L	4.0 mg/L	4.1 mg/L	98.7

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201
Parameter: Cadmium (USEPA 6010C)

ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS 0731201-7 Matrix Spike	3.7 mg/L	3.8 mg/L	3.8 mg/L	2.7

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.0001 mg/L	1.0 mg/L	1.1 mg/L	108.3
#B008-ARS				
0731201-7 Matrix Spike	<0.0001 mg/L	4.0 mg/L	3.7 mg/L	93.6
0731201-7 Matrix Spike Duplicate	<0.0001 mg/L	4.0 mg/L	3.8 mg/L	96.2

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS Laboratory Reagent Blank	<0.0001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201
Parameter: Chromium (USEPA 6010C)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS 0731201-7 Matrix Spike	3.8 mg/L	3.9 mg/L	3.8 mg/L	1.9

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.001 mg/L	1.0 mg/L	1.1 mg/L	106.2
#B008-ARS				
0731201-7 Matrix Spike	<0.001 mg/L	4.0 mg/L	3.8 mg/L	94.6
0731201-7 Matrix Spike Duplicate	<0.001 mg/L	4.0 mg/L	3.9 mg/L	96.4

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201
Parameter: Iron (USEPA 6010C)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
0731201-7 Matrix Spike	33 mg/L	34 mg/L	34 mg/L	1.2

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.001 mg/L	1.0 mg/L	1.0 mg/L	96.4
#B008-ARS				
0731201-7 Matrix Spike	0.022 mg/L	40 mg/L	33 mg/L	83.3
0731201-7 Matrix Spike Duplicate	0.022 mg/L	40 mg/L	34 mg/L	84.3

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201

Parameter: Manganese (USEPA 6010C)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS 0731201-7 Matrix Spike	3.9 mg/L	4.0 mg/L	3.9 mg/L	1.9

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.001 mg/L	1.0 mg/L	1.0 mg/L	104.8
#B008-ARS				
0731201-7 Matrix Spike	0.18 mg/L	4.0 mg/L	3.9 mg/L	93.0
0731201-7 Matrix Spike Duplicate	0.18 mg/L	4.0 mg/L	4.0 mg/L	94.9

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201
Parameter: Lead (USEPA 6010C)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS 0731201-7 Matrix Spike	3.8 mg/L	3.9 mg/L	3.8 mg/L	2.0

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS Laboratory Fortified Blank	<0.001 mg/L	1.0 mg/L	1 mg/L	103.9
#B008-ARS				
0731201-7 Matrix Spike	0.049 mg/L	4.0 mg/L	3.8 mg/L	93.1
0731201-7 Matrix Spike Duplicate	0.049 mg/L	4.0 mg/L	3.9 mg/L	95.0

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: QCINORG0811201

Parameter: Selenium (USEPA 6010C)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS 0731201-7 Matrix Spike	4.1 mg/L	4.2 mg/L	4.1 mg/L	1.4

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank	<0.001 mg/L	5.0 mg/L	5.4 mg/L	107.5
#B008-ARS				
0731201-7 Matrix Spike	<0.001 mg/L	4.0 mg/L	4.1 mg/L	102.9
0731201-7 Matrix Spike Duplicate	<0.001 mg/L	4.0 mg/L	4.2 mg/L	104.3

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

Control Limits:

Recoveries
- Laboratory Fortified Blank (85 - 115 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<20%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: B202271
Parameter: Arsenate (As V) (ATS Custom IC/ICP-MS)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
Karn CSBR-Initial MS	0.302 mg/L	0.302 mg/L	0.302 mg/L	<0.1
Karn CSBR-Initial MS Matrix Spike	0.354 mg/L	0.352 mg/L	0.353 mg/L	0.6
Karn CSBR-Initial MSD	0.303 mg/L	0.297 mg/L	0.300 mg/L	2.0
Karn CSBR-Initial MSD Matrix Spike	0.351 mg/L	0.352 mg/L	0.352 mg/L	0.2

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank (B202271-BS1)	<0.001 mg/L	0.005 mg/L	0.005 mg/L	98.0
#B008-ARS				
Karn CSBR-Initial MS Matrix Spike	0.302 mg/L	0.051 mg/L	NR	-
Karn CSBR-Initial MS Matrix Spike Duplicate	0.302 mg/L	0.051 mg/L	NR	-
Karn CSBR-Initial MSD Matrix Spike	0.300 mg/L	0.051 mg/L	NR	-
Karn CSBR-Initial MSD Matrix Spike Duplicate	0.300 mg/L	0.051 mg/L	NR	-

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

NR - Not Reportable due to inadequate spiking levels relative to native sample concentrations.

Control Limits:

Recoveries
- Laboratory Fortified Blank (75 - 125 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<25%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: B202271

Parameter: Arsenite (As III) (ATS Custom IC/ICP-MS)

ATS Project: Barr Engineering Co. #B008-ARS

Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
Karn CSBR-Initial MS	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	nc
Karn CSBR-Initial MS Matrix Spike	0.055 mg/L	0.054 mg/L	0.054 mg/L	0.9
Karn CSBR-Initial MSD	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	nc
Karn CSBR-Initial MSD Matrix Spike	0.054 mg/L	0.055 mg/L	0.055 mg/L	0.6

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank (B202271-BS1)	<0.001 mg/L	0.005 mg/L	0.005 mg/L	101.0
#B008-ARS				
Karn CSBR-Initial MS Matrix Spike	<0.001 mg/L	0.055 mg/L	0.055 mg/L	100.0
Karn CSBR-Initial MS Matrix Spike Duplicate	<0.001 mg/L	0.055 mg/L	0.054 mg/L	99.0
Karn CSBR-Initial MSD Matrix Spike	<0.001 mg/L	0.055 mg/L	0.054 mg/L	99.0
Karn CSBR-Initial MSD Matrix Spike Duplicate	<0.001 mg/L	0.055 mg/L	0.055 mg/L	99.0

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

nc - not calcuable.

Control Limits:

Recoveries
- Laboratory Fortified Blank (75 - 125 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<25%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: B202271
Parameter: DMA (ATS Custom IC/ICP-MS)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
Karn CSBR-Initial MS	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	nc
Karn CSBR-Initial MS Matrix Spike	0.054 mg/L	0.054 mg/L	0.054 mg/L	<0.1
Karn CSBR-Initial MSD	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	nc
Karn CSBR-Initial MSD Matrix Spike	0.053 mg/L	0.054 mg/L	0.054 mg/L	0.8

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank (B202271-BS1)	<0.001 mg/L	0.005 mg/L	0.005 mg/L	104.0
#B008-ARS				
Karn CSBR-Initial MS Matrix Spike	<0.001 mg/L	0.055 mg/L	0.054 mg/L	102.0
Karn CSBR-Initial MS Matrix Spike Duplicate	<0.001 mg/L	0.055 mg/L	0.054 mg/L	102.0
Karn CSBR-Initial MSD Matrix Spike	<0.001 mg/L	0.055 mg/L	0.053 mg/L	102.0
Karn CSBR-Initial MSD Matrix Spike Duplicate	<0.001 mg/L	0.055 mg/L	0.054 mg/L	102.0

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

NC - not calculated

Control Limits:

Recoveries
- Laboratory Fortified Blank (75 - 125 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<25%)

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Quality Assurance / Quality Control Data Summary

QC Batch Number: B202271
Parameter: MMA (ATS Custom IC/ICP-MS)
ATS Project: Barr Engineering Co. #B008-ARS
Report Date: 8/21/20 PRELIMINARY; Updated 8/25/20

Results of QA Samples run concurrently with project samples

REPLICATE ANALYSIS

Sample	Replicate #1	Replicate #2	Mean	Relative Range (percent)
#B008-ARS				
Karn CSBR-Initial MS	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	nc
Karn CSBR-Initial MS Matrix Spike	0.053 mg/L	0.054 mg/L	0.054 mg/L	1.1
Karn CSBR-Initial MSD	<0.001 mg/L	<0.001 mg/L	<0.001 mg/L	nc
Karn CSBR-Initial MSD Matrix Spike	0.054 mg/L	0.055 mg/L	0.054 mg/L	1.4

SPIKES and/or QC CHECK SAMPLES

Sample/Analyte	Known Concentration	Spike Concentration	Analyzed Concentration	Recovery (percent)
#B008-ARS				
Laboratory Fortified Blank (B202271-BS1)	<0.001 mg/L	0.005 mg/L	0.005 mg/L	108.0
#B008-ARS				
Karn CSBR-Initial MS Matrix Spike	<0.001 mg/L	0.055 mg/L	0.053 mg/L	104.0
Karn CSBR-Initial MS Matrix Spike Duplicate	<0.001 mg/L	0.055 mg/L	0.054 mg/L	105.0
Karn CSBR-Initial MSD Matrix Spike	<0.001 mg/L	0.055 mg/L	0.054 mg/L	105.0
Karn CSBR-Initial MSD Matrix Spike Duplicate	<0.001 mg/L	0.055 mg/L	0.055 mg/L	107.0

BLANK ANALYSIS

Sample	Analyzed Concentration	QC Decision
#B008-ARS		
Laboratory Reagent Blank	<0.001 mg/L	Acceptable

Comments:

Calculations performed prior to rounding.

NC - not calculated

Control Limits:

Recoveries
- Laboratory Fortified Blank (75 - 125 %)
- Matrix Spike (75 - 125 %)

Relative Range
- Replicates (<25%)

ANN ARBOR TECHNICAL SERVICES, INC.

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Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax 734/995-3731
Michigan Laboratory ID 9604
Wisconsin Laboratory ID 998321720

CHAIN OF CUSTODY RECORD

PROJECT ID / NUMBER
B008-ARS; Barr Engineering

LABORATORY INFORMATION
Ann Arbor Technical Services, Inc.

SAMPLE CUSTODIAN (Print & Signature)
Andrew Dykstra

SHIPPING INFORMATION: SHIPPER (Check one) / TRACKING NUMBER(S) (if applicable)

Date		Fed Ex		UPS		DHL		Courier		Tracking Number	
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Date		Fed Ex		UPS		DHL		Courier		Tracking Number	

RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME	RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME
Andrew Dykstra	9:29 am 7-27-20/9:30						

RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME	RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME

COMMENTS (Preservation, etc.)
Standard turnaround, please filter sample with 45 uM filter for dissolved metals analysis

LINE NO	SAMPLE IDENTIFICATION	DATE	TIME	COMP	GRAB	LABORATORY IDENTIFICATION (ATS Use Only)	NO. OF CONTAINERS	PRIORITY NUMBER	ANALYSIS Soluable Arsenic by EPA 200.9	Sol. Metals Scan (As, Ba, Cd, Cr, Fe, Mn, Pb, Se)	Sol. Mercury (EPA 7470)	Arsenic Speciation (ATS Custom Method)	BOD (APHA 5210B)	COD (APHA 5210D)	DO (APHA 4500/EPA 360.1	pH (APHA 4500H - B				MATRIX Indicate Soil/Water/Air Sediment/Sludge Extract
1.	Karn-MW-10	7/24/2020	10:40		X	0727201-1	1		X	X	X	X								Wastewater
2.																				
3.																				
4.																				
5.																				
6.																				
7.																				
8.																				
9.																				
10.																				
11.																				
12.																				
13.																				
14.																				
15.																				
16.																				
17.																				
18.																				

ANN ARBOR TECHNICAL SERVICES, INC.
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Michigan Laboratory ID: 9604
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CHAIN OF CUSTODY RECORD

PROJECT ID / NUMBER: B008-ARS; Barr Engineering

LABORATORY INFORMATION: Ann Arbor Technical Services, Inc.

SAMPLE CUSTODIAN (Print & Signature): Andrew Dykstra

SHIPPING INFORMATION: SHIPPER (Check one) / TRACKING NUMBER(S) (If applicable)

Date		Fed Ex		UPS		DHL		Courier		Tracking Number	
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Date		Fed Ex		UPS		DHL		Courier		Tracking Number	

RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME	RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME
Andrew Dykstra	7/31/20 9:00	Mark DeLong					

COMMENTS (Preservation, etc.)
Field filtered with 45 um filter. Please hold all samples from 7/29/30 (Kin-## samples).

LINE NO.	SAMPLE IDENTIFICATION	DATE	TIME	COMP.	GRAB	LABORATORY IDENTIFICATION (ATS Use Only)	NO. OF CONTAINERS	PRIORITY NUMBER	ANALYSIS Soluable Arsenic by EPA 200.9	Sol. Metals Scan (As, Ba, Cd, Cr, Fe, Mn, Pb, Se)	Sol. Mercury (EPA 7470)	Arsenic Speciation (ATS Custom Method)	BOD (APHA 5210B)	COD (APHA 5210D)	DO (APHA 4500/EPA 360.1	pH (APHA 4500H - B				MATRIX Indicate Soil/Water/Air Sediment/Sludge Extract
1.	✓ Kin-01	7/29/2020	11:10		X	0731201-1	1	Hold	X											Wastewater
2.	✓ Kin-03	7/29/2020	13:10		X	2	1	Hold	X											Wastewater
3.	✓ Kin-05	7/29/2020	15:10		X	3	1	Hold	X											Wastewater
4.	✓ Kin-09	7/29/2020	19:10		X	4	1	Hold	X											Wastewater
5.	✓ Kin-12	7/29/2020	22:10		X	5	1	Hold	X											Wastewater
6.	✓ Kin-Control-12	7/29/2020	22:15		X	6	1	Hold	X											Wastewater
7.	✓ Karn-CSBR-Initial	7/31/2020	6:00		X	7	3		X	X	X	X								Wastewater
8.																				
9.																				
10.																				
11.																				
12.																				
13.																				
14.																				
15.																				
16.																				
17.																				
18.																				

"Hold" Samples Released For Analysis
Per EMAIL 8/6/20

790 South Wagner Road
Ann Arbor, Michigan 48103
Tel. 734/995-0995 Fax 734/995-3731
Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

CHAIN OF CUSTODY RECORD

OK TO PROCEED, MIKE ELLIS, 8/5/2020
PBS

PROJECT ID / NUMBER: B008-ARS; Barr Engineering

LABORATORY INFORMATION: Ann Arbor Technical Services, Inc.

SAMPLE CUSTODIAN (Print & Signature): Andrew Dykstra

SHIPPING INFORMATION. SHIPPER (Check one) / TRACKING NUMBER(S) (if applicable)

Date		Fed Ex		UPS		DHL		Courier		Tracking Number
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Date		Fed Ex		UPS		DHL		Courier		Tracking Number
Date		Fed Ex		UPS		DHL		Courier		Tracking Number

RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME	RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME
Andrew Dykstra	8/04/2020 - 9:00	Mark DeJong					

COMMENTS (Preservation, etc.)

Field filtered with 45 um filter, Standard turnaround time. Samples preserved with nitric acid were also provided for Karn-CSBR-05-03 and Karn-CSBR-10-05

LINE NO.	SAMPLE IDENTIFICATION	DATE	TIME	COMP.	GRAB	LABORATORY IDENTIFICATION (ATS Use Only)	NO. OF CONTAINERS	PRIORITY NUMBER	Soluable Arsenic by EPA 200.9	Sol. Metals Scan (As, Ba, Cd, Cr, Fe, Mn, Pb, Se)	Sol. Mercury (EPA 7470)	Arsenic Speciation (ATS Custom Method)	BOD (APHA 5210B)	COD (APHA 5210D)	DO (APHA 4500/EPA 360.1	pH (APHA 4500H - B				MATRIX Indicate Soil/Water/Air Sediment/Sludge Extract
1.	Karn-CSBR-05-01 ✓	7/31/2020	18:35		X	20mL vial 080420-1	1		X											Wastewater
2.	Karn-CSBR-10-01 ✓	7/31/2020	18:30		X	20mL vial 2	1		X											Wastewater
3.	Karn-CSBR-05-02 ✓	8/1/2020	6:30		X	125mL 3	1		X											Wastewater
4.	Karn-CSBR-10-02 ✓	8/1/2020	6:30 ~~6:35~~ *		X	125mL 4	1		X											Wastewater
5.	Karn-CSBR-05-03 ✓	8/1/2020	18:35		X	125mL 250mL + HNO3 * 5	~~2~~ 1	MTD	X	X	X	X								Wastewater
6.	Karn-CSBR-10-03 ✓✓	8/1/2020	18:45		X	20mL vial 6	~~1~~ 2	MTD	X											Wastewater
7.	Karn-CSBR-05-04 ✓	8/2/2020	6:47		X	20mL vial 7	1		X											Wastewater
8.	Karn-CSBR-10-04 ✓	8/2/2020	6:52		X	20mL vial 8	1		X											Wastewater
9.	Karn-CSBR-05-05 ✓	8/2/2020	18:40 -		X	125mL 9	1		X											Wastewater
10.	Karn-CSBR-10-05 ✓✓	8/2/2020	18:45		X	250mL HNO3 * 125mL 10	2		X	X	X	X								Wastewater
11.	Karn-CSBR-05-06 ✓	8/3/2020	6:35		X	125mL 11	1		X											Wastewater
12.	Karn-CSBR-10-06 ✓	8/3/2020	6:40		X	125mL 12	1		X											Wastewater
13.	Karn-CSBR-05-07 ✓	8/3/2020	18:45		X	125mL 13	1		X											Wastewater
14.	Karn-CSBR-10-07 ✓	8/3/2020	18:50		X	125mL 14	1		X											Wastewater
15.	Karn-CSBR-05-08 ✓	8/4/2020	6:45		X	125mL 15	1		X											Wastewater
16.	Karn-CSBR-10-08 ✓	8/4/2020	6:50		X	125mL 16	1		X											Wastewater
17.																				
18.						* Do not analyze per Mike Ellis, 8/4/20														
19.																				
20.																				

* KARN-CSBR-10-02 - Sample Time 6:35 per A. DYKSTRA 8/7/20

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Michigan Laboratory ID: 9604
Wisconsin Laboratory ID: 998321720

CHAIN OF CUSTODY RECORD

PROJECT ID / NUMBER
B008-ARS; Barr Engineering

LABORATORY INFORMATION
Ann Arbor Technical Services, Inc.

SAMPLE CUSTODIAN (Print & Signature)
Andrew Dykstra

SHIPPING INFORMATION: SHIPPER (Check one) / TRACKING NUMBER(S) (if applicable)

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Date		Fed Ex		UPS		DHL		Courier		Tracking Number	

RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME	RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME
Andrew Dykstra	8/07/2020 9:00am	Mark Long					

RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME	RELINQUISHED BY (Print & Signature)	DATE / TIME	RECEIVED BY (Print & Signature)	DATE / TIME

COMMENTS (Preservation, etc.)
Field filtered with 45 um filter, Standard turnaround time. Please filter again on Monday August, 10 before analysis

LINE NO	SAMPLE IDENTIFICATION	DATE	TIME	COMP.	GRAB	LABORATORY IDENTIFICATION (ATS Use Only)	NO. OF CONTAINERS	PRIORITY NUMBER	Soluable Arsenic by EPA 200.9	Sol. Metals Scan (As, Ba, Cd, Cr, Fe, Mn, Pb, Se)	Sol. Mercury (EPA 7470)	Arsenic Speciation (ATS Custom Method)	BOD (APHA 5210B)	COD (APHA 5210D)	DO (APHA 4500/EPA 360.1	pH (APHA 4500H - B					MATRIX Indicate Soil/Water/Air Sediment/Sludge Extract
1.	C-2 ✓ Karn-CSBR-05-09	8/4/2020	18:37		X	0807201-1	1		X	X	X	X									Wastewater
2.	C-2 ✓ Karn-CSBR-10-09	8/4/2020	18:42		X	2	1		X	X	X	X									Wastewater
3.	C-2 ✓ Karn-CSBR-05-10	8/5/2020	6:40		X	3	1		X												Wastewater
4.	C-2 ✓ Karn-CSBR-10-10	8/5/2020	6:46		X	4	1		X												Wastewater
5.	C-2 ✓ Karn-CSBR-10-11	8/5/2020	18:43		X	5	1		X												Wastewater
6.	C-2 ✓ Karn-CSBR-05-11	8/5/2020	18:47		X	6	1		X												Wastewater
7.	C-2 ✓ Karn-CSBR-05-12	8/6/2020	6:44		X	7	1		X												Wastewater
8.	C-2 ✓ Karn-CSBR-10-12	8/6/2020	6:49		X	8	1		X												Wastewater
9.	C-1 ✓ Karn-CSBR-05-13	8/6/2020	18:36		X	9	1		X												Wastewater
10.	C-1 ✓ Karn-CSBR-10-13	8/6/2020	18:41		X	10	1		X												Wastewater
11.	C-1 ✓ Karn-CSBR-05-14	8/7/2020	6:30		X	11	1		X	X	X	X									Wastewater
12.	C-1 ✓ Karn-CSBR-10-14	8/7/2020	6:35		X	12	1		X	X	X	X									Wastewater
13.	C-1 ✓ DUP	8/7/2020	--		X	13	1		X	X	X	X									Wastewater
14.																					Wastewater
15.																					
16.																					
17.																					
18.																					
19.																					
20.																					

Appendix F-3

Bench Testing Photo Log

Attachment F-3: Photolog

D.E. Karn Generating Facility
Essexville, Michigan
July 2020

Photo #	Comments
1	Peerless Metal 8/50 Zero Valent Iron
2	Kinetics Experiment Test Vials
3	Kinetics Experiment Setup
4	Kinetics Experiment Hach Test Results
5	CSBR Experiment Setup
6	10-gram ZVI CSBR After Four Batches
7	CSBR Experiment Hach Test Results

Photo 1: Peerless Metal 8/50 Zero Valent Iron

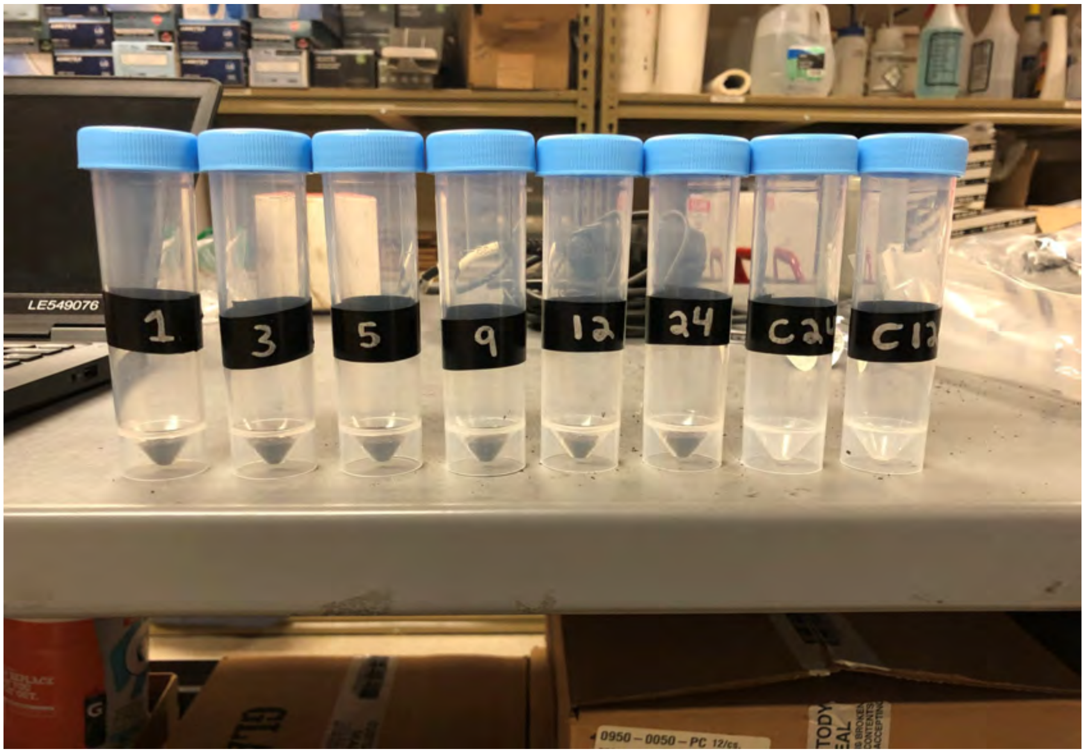


Photo 2: Kinetics Experiment Test Vials

Photo 3: Kinetics Experiment Setup

Photo 4: Kinetics Experiment Hach Test Results

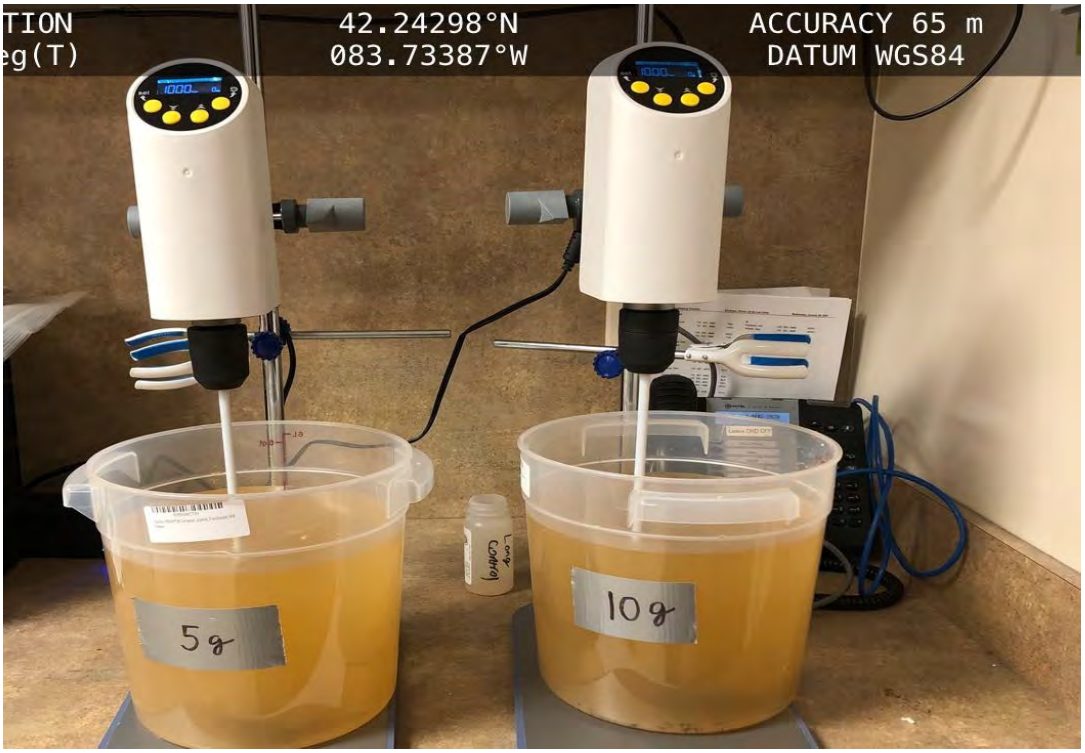


Photo 5: CSBR Experiment Setup

Photo 6: 10-gram ZVI CSBR After Four Batches

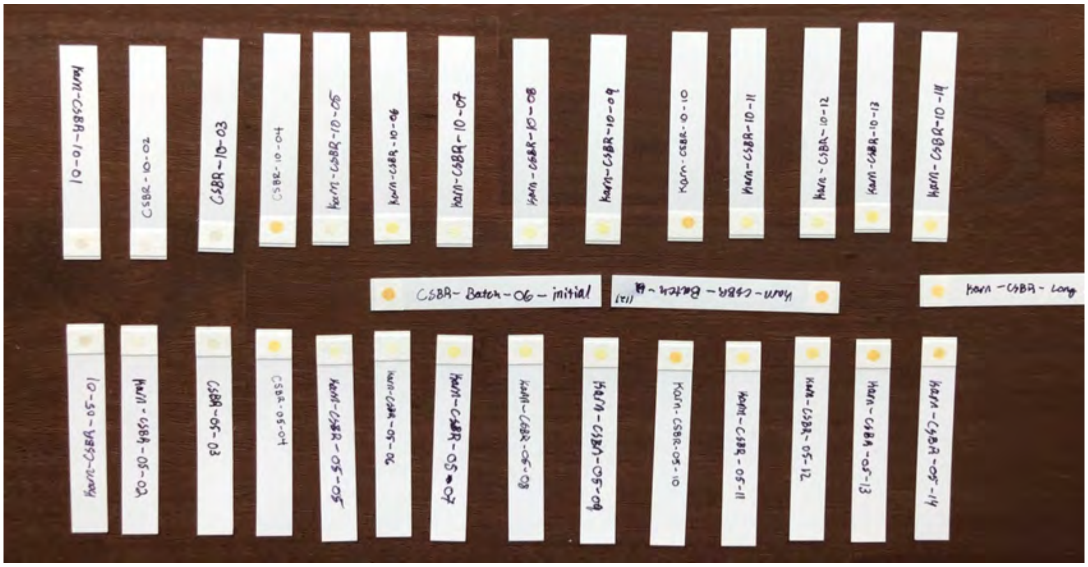


Photo 7: CSBR Experiment Hach Test Results

Appendix F-4

Permeable Reactive Barrier Experiments Data Quality Assurance/Quality Control Review

Appendix F-4:

Permeable Reactive Barrier Experiments Data Quality Assurance/Quality Control Review

A review of the quality control data was conducted to assess the validity of the analytical results for the water samples collected for the Permeable Reactive Barrier Experiments for the DE Karn Generating Facility site, located in Essexville, Michigan. There were 37 water samples collected and analyzed for arsenic, and additional metals parameters and arsenic speciation analysis was performed for select samples. This review was performed in accordance with Barr Engineering Co.'s Standard Operating Procedures (SOPs) for data evaluation, which are based on *The National Functional Guidelines for Organic and Inorganic Data Review* (USEPA, 2008 and 2010). The analyses were performed by Ann Arbor Technical Services (ATS), located in Ann Arbor, Michigan. This data evaluation discusses sample data contained within the work order B008-ARS.

Both field sampling and laboratory analytical procedures were examined in the sampling event review. Field sampling procedures were examined utilizing field (masked) duplicate sample analyses. Laboratory procedures were evaluated by assessing technical holding times, sample preservation methods, method blank samples, accuracy and precision data, and data package completeness.

Field sampling procedures

Field (masked) duplicate sample results were evaluated by calculating the relative percent difference (RPD) values for compounds where both the native and field duplicate sample had concentrations reported above the reporting limit (RL). The RPD formula is as follows:

$$RPD = \frac{|S - D|}{(S + D)/2} \times 100$$

Where:

RPD = relative percent difference
S = original sample result
D = duplicate sample result

One sample (Karn-CSBR-05-14/DUP) served as the field duplicate sample during the sampling event. The acceptance criteria used for the field duplicate samples data precision (30% RPD) was based on Barr's SOPs for routine data evaluation. The field duplicate data met the RPD criteria for precision.

Laboratory Procedures

Technical holding times and preservation were evaluated for each sample and target parameter based on United States Environmental Protection Agency and method recommendations. The technical holding times were within these recommendations for all of the analyses, and the water samples arrived at the laboratory at the correct temperatures and with the correct chemical preservatives.

Method blanks were analyzed by the laboratory for each parameter. No target compounds were detected above the RL in the method blank samples.

The accuracy and precision data review included evaluation of laboratory control spike (LCS), matrix spike (MS), and matrix spike duplicate (MSD) samples. Accuracy was evaluated by comparing laboratory percent recoveries from LCS, MS, and MSD samples to laboratory acceptance criteria. Precision was evaluated by calculating the RPD of the MS/MSD duplicate sample pairs.

The LCS samples displayed acceptable accuracy when compared to the laboratory acceptance criteria.

The laboratory utilized project samples as needed for MS/MSD evaluation when sufficient sample volume was available. Only the MS/MSD samples taken from project samples may be evaluated compared to project data. In instances where MS recoveries failed acceptance criteria and the native sample concentration was significantly greater than the spike added (greater than four times), the spike recovery could not be accurately evaluated; therefore, the criteria did not apply and acceptance of the sample results were based on the acceptable LCS data. The MS/MSDs displayed accuracy and/or precision within laboratory acceptance criteria.

Data completeness was evaluated by comparing the analyses requested with the data package as received. The samples were analyzed in accordance with the chain-of-custody, so the data package was considered complete.

Conclusion

The data are deemed acceptable for the purposes of this project with no qualification assigned during the data evaluation process.

References

United States Environmental Protection Agency (USEPA), 2008. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. EPA QA/R-5. 2008

United States Environmental Protection Agency (USEPA), 2010. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Inorganic Methods Data Review*. EPA QA/R-5. 2010

Appendix F-5

Peerless Metal 8/50 Zero Valent Iron Product Specifications

PEERLESS™

PMP ZERO VALENT IRON AGGREGATE SIZE 8/50

TYPICAL 5 MINUTE ROTAP

SCREEN SIZE	%RETAINED
4	0
8	95-100
16	75- 98
30	30- 58
50	2- 19
100	0- 7

TYPICAL BULK DENSITY 150 POUNDS PER CUBIC FOOT (+ OR -10 POUNDS)

PMP IRON AGGREGATES ARE 100% DRY AND OIL FREE

TYPICAL CHEMISTRY:

Element	Percentage
Iron	95+
Carbon	0.7–2.5
Silicon	1.5–2.0
Manganese	0.60
Sulfur	0.12
Phosphorus	0.14
Nickel	0.20
Chromium	0.20
Molybdenum	0.15
Copper	0.20

18900 Rialto Street* Melvindale, Michigan 48122
Office: (313)-841-5400 Fax: (313)-841-0240 WWW. Peerlessmetal.com 6/2020

Table 1: **Iron and Column Properties**

Iron:		
Source	Peerless Metal Powders, Detroit, MI	
Type	14D Type A	14D Type B
Surface Area	1.22 m^2/g	1.57 m^2/g
Column:		
Flow Velocity	47.7 cm/day (1.56 ft/day)	42.4 cm/day (1.4 ft/day)
Residence Time	25.2 hr	28.2 hr
Pore Volume	300 mL	342 mL
Total Porosity	0.53	0.60
Bulk Density	3.39 g/cm^3	2.98 g/cm^3
Iron to Volume of Solution Ratio	6.4 g : 1 mL	4.9 g : 1 mL
Surface Area to Volume of Solution Ratio	7.8 m^2 : 1 mL	7.7 m^2 : 1 mL

Table 1. Selected Column Parameters

Parameter	Units	Nr. I-002	Nr. I-006
Inner diameter	in	1.5	1.5
	cm	3.81	3.81
Bed Height	in	24	24
	cm	60.96	60.96
Bed volume	mL	695	695
ZVI	g	2360	2200
Bulk density	g/cm3	3.40	3.17
Porosity*	--	0.43	0.45
Pore volume	mL	295	311
Direction of flow	--	upflow	upflow
Flowrate**	mL/min	1.76	1.79
Contact time**	minutes		
Influent		0	0
Port 1		43	43
Port 2		86	87
Port 3		130	130
Effluent		170	170

* Porosity was determined in a separate test by packing ZVI to the bulk density observed in the columns, then measuing the amount of water needed to fill the void space.

** At time of sample collection. Flow and contact time varied over the course of the test. See **Section 2.3**.

Attachment C

D.E. Karn Generating Facility Corrective Action Feasibility Study Addendum

Feasibility Study Addendum
Permeable Reactive Barrier Extension Evaluation

D.E. Karn Generating Facility

Prepared for
Consumers Energy Company

December 2021

3005 Boardwalk Street, Suite 100
Ann Arbor, MI 48108
734.922.4400
www.barr.com

Feasibility Study Addendum – Permeable Reactive Barrier Extension Evaluation

December 2021

Contents

List of Tables

List of Figures

List of Appendices

Abbreviations

µg/L	micrograms per liter
bay	Saginaw Bay
bgs	below ground surface
FS	feasibility study
feet/day	feet per day
GSI	groundwater-surface water interface
PRB	Permeable Reactive Barrier
psf	pounds per square foot
PVC	polyvinyl chloride
QA/QC	quality assurance quality control
RAP	Remedial Action Plan
river	Saginaw River
TOC	total organic carbon
ZVI	zerovalent iron

Executive Summary

This addendum to the feasibility study (FS) for the Consumers Energy Company's D.E. Karn Electrical Power Generating Facility (generating facility) describes a feasibility-level evaluation for extending the permeable reactive barrier (PRB) that was recommended in the FS (reference (1)) to address arsenic-impacted groundwater venting to Saginaw Bay (bay) from the Type III, low-hazard industrial landfill (Karn Landfill) at the generating facility.

Since the FS, additional investigation activities have been performed to collect data for a feasibility-level assessment of extending the PRB along the length of the northern perimeter embankment dike. Results from the investigation activities are summarized in this report and were incorporated into the evaluations completed as part of this addendum to the FS; namely, hydrogeological, geotechnical, and constructability evaluations; a revaluation of FS balancing criteria (i.e., short- and long-term effectiveness; implementability; and permitting and community considerations); and reassessment of schedule and relative cost.

Based on the results of these evaluations, extending the PRB along the length of the northern perimeter embankment dike is the recommended remedial response to move forward into a remedial action plan, because groundwater quality, soil quality, and hydrogeologic conditions in the additional area considered are generally consistent with conditions observed within the FS remedial response area and would allow for mitigation of arsenic impacts by a PRB amended with zerovalent iron (ZVI); a PRB is implementable within the additional extent; key findings for the balancing criteria considered in the FS except for costs and schedule considerations were applicable for the additional extent; and costs and schedule impacts associated with the additional extent were reasonable relative to cost and schedule considerations for a PRB identified in the FS.

1 Introduction and Remedial Response Objectives

This addendum to the feasibility study (FS) for the Consumers Energy Company's (Consumers') D.E. Karn Electrical Power Generating Facility (generating facility) describes a feasibility-level evaluation for extending the permeable reactive barrier (PRB) that was recommended in the FS (reference (1)) to address arsenic-impacted groundwater venting to Saginaw Bay (bay) from the Type III, low-hazard industrial landfill (Karn Landfill) at the generating facility. The generating facility is located at 2742 N. Weadock Highway in Essexville, Michigan east of the Saginaw River (river) on the south end of the bay (Figure 1).

Since the time of the FS, the extent of the remedial response area has been revised to include the entire northern boundary of the Karn Landfill immediately upgradient of the groundwater-surface water interface (GSI), as shown on Figure 2, and is referred to as the revised remedial response area. This addendum to the FS includes an evaluation of the recommended remedial response option, a PRB, in the revised remedial response area. Within this document, the remedial response area evaluated in the FS is referred to as the FS remedial response area, and the extent of the revised remedial response area to the northwest of the FS remedial response area is referred to as the additional remedial response area. The revised remedial response area also includes an area to the southeast of the FS remedial response area, but a detailed evaluation of that area was not conducted because conditions within that area are similar to the FS remedial response area.

1.1 Remedial Response Objectives

The GSI pathway is the primary, relevant exposure pathway of concern; therefore, the primary remedial response objective is the same as the remedial response objective identified in the FS (reference (1)), which is to meet and maintain long-term compliance during post-closure care of the Karn Landfill with mixing zone-based GSI criteria for arsenic in groundwater venting from the Karn Landfill to the bay. Site-specific chronic and acute mixing zone-based concentration values for arsenic are 100 micrograms per liter (µg/L) and 680 µg/L, respectively.

This addendum and the FS were completed to meet the requirements of State of Michigan Part 115, Solid Waste Management, of the Natural Resources and Environmental Protection Act (NREPA), Public Act 451 of 1994, as amended (Part 115, reference (2)) and State of Michigan Part 201, Environmental Remediation of NREPA, Public Act 451 of 1994, as amended (Part 201, reference (3)) and the administrative rules promulgated pursuant thereto (Part 115 and Part 201 Rules). Specifically, this is being pursued under R 299.4319(6)(e) and in compliance with the provisions of section 20120 of Part 201.

1.2 Report Organization

This FS addendum is organized as follows:

Section 2 Additional Investigation Activities: This section summarizes the additional investigation activities conducted to evaluate extending the PRB.

Section 3 PRB Extension Evaluation: This section evaluates extending the PRB, including evaluations of arsenic concentrations, hydrogeological conditions, groundwater and soil quality data, geotechnical conditions, constructability considerations, reconsideration of balancing criteria from the FS, and schedule and cost implications for extending a PRB.

Section 4 Conclusions and Recommendations: This section summarizes results of the evaluation, identifies whether the extended portion of the PRB should be carried forward to the remedial action plan, and outlines recommended next steps.

Section 5 References

2 Additional Investigation Activities

Additional investigation activities conducted since the FS were monitoring well installations, soil and groundwater sampling, slug testing, and pump testing. Data from these activities were used to inform the feasibility-level assessment of extending the PRB along the revised remedial response area. Sections 2.1 through 2.4 describe the investigation activities and results of slug and pump testing. Evaluations of the soil and groundwater data, and updates to the groundwater flow model (groundwater model) based on slug and pump testing results, are discussed in Section 3.

2.1 Monitoring Well Installation and Soil Sampling

Nine temporary monitoring wells (TW-21-009, TW-21-010, TW-21-011S, TW-21-011I, TW-21-011D, TW-21-012S, TW-21-012I, TW-21-012D, and TW-21-013) were installed and developed at five locations shown on Figure 3 between June 28 and July 1, 2021. The temporary monitoring wells were installed along the northwest portion of the northern perimeter embankment dike to characterize groundwater and soil impacts in the additional remedial response area extent and evaluate the hydrogeologic connectivity between the upper and lower sand units.

2.1.1 Monitoring Well Installation and Development

The monitoring wells were installed from June 28 to June 30, 2021. The temporary monitoring wells were screened within three general depth intervals – shallow, intermediate, and deep – which are defined as follows:

- the terminal depth of shallow wells roughly aligned with the top of the glacial till/clay unit encountered beneath the southeast extent of the northern perimeter embankment dike at 25 to 33 feet below the ground surface (bgs);
- the terminal depth of intermediate wells was directly above the intermediate silt/clay unit at 32 to 34 feet bgs; and,
- the terminal depth of deep wells was directly below the intermediate silt/clay unit at 49 to 51 feet bgs.

The temporary monitoring well installations included the following activities:

- installing three shallow temporary monitoring wells with continuous split-spoon soil sample collection;
- installing two nests of a shallow, intermediate, and deep temporary monitoring well with continuous soil sample collection through the deep borings and blind drilling through the shallow and intermediate borings;
- collecting two Shelby tube samples of the intermediate silt/clay unit from the two deep borings;

- constructing wells using 2-inch-diameter polyvinyl chloride (PVC) casings with 5-feet-long mill-slotted screens;
- installing a protective metal riser casing (including a lock) around the 2-inch PVC monitoring wells and two concrete bumper posts around individual- or nested-well locations; and,
- developing the monitoring wells by surging and over-pumping methods until a turbidity of less than 20 nephelometric turbidity units was observed.

Boring logs and well development logs for the monitoring wells are included in Appendix A-1a and Appendix A-1b, respectively.

2.1.2 Soil Logging and Sampling

Where drilling was completed using continuous sampling collection methods, Barr's field technician logged soil stratigraphy in general accordance with ASTM D2488-17e1 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) (reference (4)) and completed field screening at each location, including documentation of visual, olfactory, and photoionization detector measurements. One soil sample was collected in the upper sand unit for laboratory analysis from each soil boring in which continuous soil sampling was conducted. An additional soil sample was collected from TW-21-012D from 32 to 34 feet bgs to characterize conditions of a deeper interval within the upper sand unit. The soil analytical data are presented in Appendix A-2, and the laboratory analytical report and quality assurance quality control (QA/QC) review of the laboratory methods are in Appendix A-3 and Appendix A-4, respectively.

Shelby tube samples were collected from the intermediate silt/clay layer at TW-21-011D and TW-21-012D. The Shelby tube samples were submitted for flexible wall permeameter testing by Materials Testing Consulting, Inc. The results of this testing are included in Appendix A-5, and the hydraulic conductivity of the intermediate silt/clay layer was measured at $2.10x10^{-2}$ and $1.78x10^{-2}$ feet per day (feet/day) for samples collected at TW-21-011D and TW-21-012D, respectively

2.2 Groundwater Sampling

Groundwater samples were collected from temporary monitoring wells TW-21-009 through TW-21-013 on July 6 and 7, 2021, approximately one week after the wells were developed. The groundwater samples were collected using low-flow sampling methods

Field parameters were collected using a YSI Pro DSS® water quality meter and Hach® 2100q turbidimeter, and laboratory analytical parameters were analyzed by the Consumers Trail Street laboratory, Merit Laboratories, and Brighton Analytical. A table comparing groundwater sampling results to applicable relevant Part 201 and site-specific criteria is included in Appendix A-6, and the low-flow sampling logs, the laboratory analytical report, and QA/QC review of the laboratory methods are included in Appendix A-7, Appendix A-8, and Appendix A-4, respectively.

2.3 Slug Testing

Slug tests were conducted at four monitoring wells (TW-21-010, TW-21-011S, TW-21-011D, TW-21-012D) as shown on Figure 3 to estimate hydraulic conductivity for use in the groundwater model.

2.3.1 Data Collection

In a slug test, the water level in a well is instantaneously changed, typically via rapid insertion or removal of a solid “slug.” The recovery of the water level in the well to static conditions is monitored using an integrated pressure transducer/datalogger, and an estimate of the aquifer hydraulic conductivity is obtained by fitting a mathematical model to the observed water level response data.

The slug testing procedure used for each well was as follows:

- An In-Situ LevelTROLL 700 pressure transducer/datalogger was installed more than 5 feet below the water table. Solid plastic slugs, 5 feet long and 1.25 inches or 1.5 inches in diameter, were used to slug test each well.

- Data collection was started just prior to inserting the slug into the well, and the slug was carefully lowered to a depth completely below the water level (a falling head or “slug in” test). Data collection continued until the water level had recovered to approximately 90 to 95% of the pre-insertion value.

- Data collection was resumed with a new log file just prior to removing the slug from the well, and the slug was pulled from the well (a rising head or “slug out” test). Data collection continued until the water level had recovered to approximately 90 to 95% of the pre-removal value.

As recommended by Butler (reference (5)), a series of six slug tests using a combination of falling head and rising head methods were completed at each tested well. Two of the six tests in the series used a smaller diameter slug (1.25 inches vs. 1.5 inches) to vary the water level displacement induced by tests.

2.3.2 Results

The water level response data were analyzed using standard slug test analytical methods. Slug test results were evaluated generally following the recommendations of Butler (reference (5)). The data for each test were filtered to remove the early-time noise that results from the insertion or removal of the solid slug. This is known as the translation method, and it is the recommended approach for processing slug test data with early-time noise (reference (5)).

The data were used to estimate hydraulic conductivity of the sediments surrounding open screen intervals for each well using the Cooper et al. (reference (6)), Hvorslev (reference (7)), or KGS model (reference (8)) method as implemented in the software package AQTESOLV (reference (9)). Outputs from AQTESOLV are presented in Appendix B-1. Slug test results are summarized in Table 1 and were used to update the groundwater model.

Table 1 Summary of Slug Testing Results

Well	Hydrostratigraphic Unit	Solution	Hydraulic Conductivity (feet per day)	Geometric Mean
TW-21-010	Upper Sand	Cooper et al.	44	32
TW-21-011S	Upper Sand	Cooper et al. and Hvorslev[1]	24	
TW-21-011D	Lower Sand	Cooper et al.	1.9	10
TW-21-012D	Lower Sand	KGS model	53	

[1] The slug test at TW-21-011S was analyzed with two different analytical solutions that both provided an acceptable fit to the data. The hydraulic conductivity shown is the average of the estimates from the two solutions.

2.4 Pump Testing

A short-term pumping test was completed on July 14, 2021, at TW-21-012D with monitoring in TW-11-012I to evaluate the competency of the intermediate silt/clay unit as a confining unit between the upper native sand unit and lower native sand unit. The intermediate silt/clay unit is slightly thinner and has lower clay content at TW-21-012D than at TW-21-011D, and TW-21-012D was selected for pump testing to provide a conservative evaluation of the intermediate silt/clay unit's confining nature.

2.4.1 Data Collection

A submersible pump was installed in TW-21-012D with the intake set in the upper part of the screened interval and pressure transducers were installed in TW-21-012D and TW-21-012I to provide nearly continuous water level measurements before, during, and after the pumping test below and above the intermediate silt/clay unit, respectively. Manual static water level measurements were collected from each monitoring well approximately once per hour to assess groundwater drawdown and validate pressure transducer data. The effluent flow rate was measured at TW-21-012D approximately once per hour by measuring the time required by the effluent to fill a one-gallon container.

The pumping rate was approximately 3.3 gallons per minute during the 6-hour test, and the effluent was discharged to the ground approximately 15 feet from TW-21-012D and TW-21-012I, partway down the slope of the perimeter dike. Once the pump was shut off, pressure transducer data were collected from both wells until the water level in TW-21-012D recovered to at least 95% of the pre-testing water level. The pumped well recovered to 95% of static water levels within about 4 minutes.

2.4.2 Results

Maximum drawdown of 1.57 feet was observed in TW-21-012D and no drawdown was observed in TW-21-012I. The results from the pumping test at TW-21-012D were analyzed using industry standard AQTESOLV software (reference (9)). This software allows flexibility in selecting from multiple analysis methods to identify the best fit to the field data collected and the hydrogeologic setting. Outputs from AQTESOLV are presented in Appendix B-2.

The Hantush-Jacob solution, an analytical solution for leaky confined aquifers, was used to estimate hydraulic conductivity values from pump testing results. The horizontal hydraulic conductivity of the lower sand was estimated at 55 feet/day, and the vertical hydraulic conductivity of the intermediate silt/clay unit was estimated at 0.034 feet/day using this solution. The confining nature of the intermediate silt/clay unit is supported by the lack of drawdown observed at TW-21-012I during the pumping test, and the pumping test results were used to update the lower native sand unit hydraulic conductivity in the groundwater model. Due to the sensitivity of confining unit vertical hydraulic conductivity to other adjustable parameters in the Hantush-Jacob solution, the intermediate silt/clay layer vertical hydraulic conductivity estimate was used to corroborate the lab permeability test results.

3 PRB Extension Evaluation

This evaluation incorporates key findings from the FS and results from additional investigation activities to assess the need to extend the PRB along the additional remedial response area and the feasibility of extending the PRB based on the following: arsenic concentrations in the additional remedial response area; hydrogeological evaluation; groundwater and soil quality data evaluation; geotechnical evaluation; constructability evaluation; consideration of the applicability of balancing criteria from the FS to the additional remedial response area; and the estimated schedule and range of costs for implementation of a PRB in the revised remedial response area.

3.1 Arsenic Concentrations

Concentrations of arsenic in groundwater were evaluated against the site-specific mixing zone-based arsenic GSI criteria to assess the extent of locations exceeding mixing zone-based GSI criteria for arsenic in groundwater. Figure 4 shows the concentrations of arsenic in groundwater from July 2021 sampling and the FS and revised remedial response areas. The average arsenic concentration in groundwater within the FS remedial response area in July 2021 was 276 µg/L. The corresponding average arsenic concentration in groundwater within the additional remedial response area extent was 338 µg/L, not including the results of samples collected below the intermediate silt/clay unit. Arsenic concentrations in monitoring wells below the intermediate silt/clay unit were less than the site-specific chronic and acute mixing zone-based GSI criteria for arsenic. Therefore, a PRB is necessary in the additional remedial response area extent, extending to the top of the intermediate silt/clay unit.

3.2 Hydrogeological Evaluation

The PRB in the additional remedial response area extent could key into either the intermediate silt/clay unit or the underlying glacial till. Because of the greater depth of the glacial till in the additional remedial response area, the suitability of the intermediate silt/clay unit as a base for the PRB was evaluated.

3.2.1 Confining Layer Evaluation

As shown on Figure 5 though Figure 7, the intermediate silt/clay unit is continuous in the western portion of the Karn Landfill. The intermediate silt/clay unit thins to the east where it intersects the glacial till unit, and the PRB could be tied into the glacial till unit in this area.

The confining properties of the intermediate silt/clay unit were evaluated based on pump testing results and groundwater quality data. Pump testing results suggest that the intermediate silt/clay unit is confining, and groundwater quality data collected above and below the intermediate silt/clay layer, included in Appendix A-6 and shown on Figure 4, also suggests that the layer is confining due to the difference in water quality in the upper and lower sand units (e.g., arsenic concentrations are more than an order of magnitude lower in the lower sand unit).

The lateral extent and thickness and confining properties of the intermediate silt/clay layer suggest the PRB could be keyed into the intermediate silt/clay unit to the west and into the glacial till unit to the east, and this was further evaluated using the groundwater model for the Karn Landfill.

3.2.2 Groundwater Model Updates

The existing groundwater model for the Karn Landfill (Appendix A of the FS (reference (1)) was updated with hydraulic conductivity estimates from additional investigation activities to evaluate the potential for groundwater to bypass (by going around or under) a PRB in the revised remedial response area before discharging to the bay. Groundwater model files, including from scenarios run for the FS, are included in Appendix C.

The vertical hydraulic conductivity of the intermediate silt/clay unit was updated in the groundwater model based on the lab permeability test results. Pumping test results corroborated the lab permeability test results but were not used directly because the lab permeability test was a more direct measurement of the vertical hydraulic conductivity. Horizontal hydraulic conductivity of the intermediate silt/clay unit remained at the calibrated value (1.86 feet/day). The horizontal hydraulic conductivity of the lower native sand unit was updated in the groundwater model based on the results of slug tests completed at TW-21-011D and TW-21-012D and the pump test completed at TW-21-012D. The vertical hydraulic conductivity of the lower native sand unit was updated to maintain anisotropy of 10, consistent with the calibrated model. A summary of groundwater model hydraulic conductivity updates is shown in Table 2.

Table 2 Summary of Groundwater Model Hydraulic Conductivity Data Updates

Hydrostratigraphic Unit	Parameter	Calibrated Value (feet per day)	Updated Value (feet per day)
Intermediate silt/clay	Vertical hydraulic conductivity	0.168	0.0192
Lower native sand	Horizontal hydraulic conductivity	7.58	9.98
Lower native sand	Vertical hydraulic conductivity	0.692	0.998

The calibrated horizontal hydraulic conductivity of the upper native sand unit was reviewed against the results of slug tests completed at TW-21-010 and TW-21-011S and against previously collected data. Instead of updating and recalibrating the groundwater model, a sensitivity analysis of the upper native sand hydraulic conductivity was performed with predictive scenarios described below.

3.2.2.1 Predictive Scenarios

An existing conditions scenario was run following updates to the hydraulic conductivity of the intermediate silt/clay unit and lower native sand unit, and a 1.5-feet-thick PRB along the northern perimeter embankment dike was evaluated in multiple scenarios with the groundwater model. A PRB construction configuration depicted in Figure 8 was considered with the groundwater model. Using

MODPATH 7 (reference (10)), particles were tracked from the Karn Landfill and upper native sand unit beneath the footprint of the Karn Landfill to receiving waterbodies. The percentage of particles simulated to pass through the area proposed for a PRB for the existing conditions scenario was used as a basis for evaluating potential changes to groundwater flow in other predictive scenarios considered.

Existing Condition Scenario

In the existing conditions scenario, approximately 65% of particles were simulated to pass through the area proposed for the PRB, approximately 34% were simulated to move northwest to the river, west to the intake channel, or south to the discharge channel instead of northeast through the PRB, and less than 1% of particles were simulated to travel downward into the lower native sand before reaching the bay (Figure 9). Currently, groundwater flow to the river meets GSI criteria and the intake and discharge channels are not classified as waters of the state; therefore, remedial response is not needed in these areas. The less than 1% of particles that are simulated to travel downward to the lower native sand unit are not considered significant relative to the greater than 99% of particles that do not travel downward, because the particle tracking results are intended to evaluate groundwater flow at a high level. Further, if small amounts of downward flow through the intermediate silt/clay unit does occur, the arsenic concentrations discussed in Section 3.1 confirm the flow is not significant enough to cause water quality concerns. Scenarios discuss in the following sections will be evaluated relative to this existing condition scenario to understand the effect of the proposed PRB on groundwater flow.

Scenarios Evaluating the Sensitivity of PRB Horizontal Hydraulic Conductivity

Groundwater flow through the PRB is predicted to decrease over time as mineral precipitation would fill void space at the PRB surface and decrease porosity. The sensitivity of the assumed permeability of the PRB was evaluated to assess how plugging and fouling may impact groundwater flow through a PRB. Three sensitivity scenarios were completed using PRB hydraulic conductivity values listed in Table 3, which were based on available literature data. In these scenarios the upper native sand unit was assigned the calibrated hydraulic conductivity values and the PRB was represented as keyed into the uppermost confining unit.

Table 3 Summary of PRB Fouling Characteristics

PRB Condition Represented in Model Scenario	Porosity	Hydraulic Conductivity (feet per day)
Initial condition[1]	0.32	12.1
Moderately fouled[2]	0.17	1.21
Highly fouled[2]	0.02	1.42×10^{-3}

[1] Values assumed from literature data (reference (11))

[2] Values calculated from initial condition values as well as literature methods for porosity reduction and estimating hydraulic conductivity from porosity (reference (12))

Modeling results showed less than a 1% difference between the number of particles passing through the revised remedial response area for scenarios assuming no PRB (the existing conditions scenario), an "initial condition" PRB, and a PRB with moderate fouling. Therefore, groundwater flow is expected to be similar to existing conditions (i.e., groundwater from the Karn Landfill will primarily flow through the PRB area) when the PRB is installed and up to moderate fouling. Approximately 3% of particles bypassed the highly fouled PRB. These particle traces were simulated to diverge from particle traces for the initial condition passing through the PRB as they approached the bay (Figure 10), indicating that if a high degree of fouling occurs, some flow around the PRB could occur, but the flow rates would be low. This information can be used to guide design decisions regarding PRB media refreshment.

Groundwater flow downward through the intermediate silt/clay unit was not simulated to increase due to the PRB. Similar to the existing conditions scenario, the three PRB hydraulic conductivities evaluated had a small number of particles (<1%) travel downward to the lower native sand unit.

Scenarios Evaluating the Sensitivity of Upper Native Sand Horizontal Hydraulic Conductivity

The influence of upper native sand unit horizontal hydraulic conductivity was evaluated through a sensitivity analysis using three different assumed horizontal hydraulic conductivity conditions for the upper native sand. For two scenarios, a uniform hydraulic conductivity value was used for the upper native sand unit. For the third scenario, the model domain was split into two zones where data generally indicates higher (northwest) or lower (southeast) hydraulic conductivity. For each of these three hydraulic conductivity distributions, the two PRB construction configurations were simulated for a total of six scenarios. Horizontal hydraulic conductivity values for the sensitivity scenarios are summarized in Table 4, and the distribution of hydraulic conductivity data in the upper native sand unit is shown on Figure 11. In all six runs, vertical hydraulic conductivity was assumed to be one-tenth the horizontal hydraulic conductivity, and the PRB was assumed to have a hydraulic conductivity of 1.2 feet/day, representing moderate fouling.

Table 4 Summary of Upper Native Sand Unit Hydraulic Conductivity Sensitivity Analysis

Scenario	Horizontal Hydraulic Conductivity (feet per day)	Data Source
Baseline	11.1	Model calibration
Uniformly higher hydraulic conductivity	32.5	Geometric mean of upper native sand slug test results at TW-21-010 and TW-21-011S
Spatially variable hydraulic conductivity	14.4 in northwest zone 2.53 in southeast zone	Geometric mean of representative data within each model zone

Minimal differences (1 to 4% of particles) were observed in the horizontal direction between particle traces from model runs with different upper native sand hydraulic conductivity values. These results indicate that heterogeneity of hydraulic conductivities within the upper native sand unit, that may not be adequately characterized for inclusion in the groundwater model, are not likely to impact the overall effectiveness of a PRB based on the minimal differences in the observed horizontal direction of particles when different hydraulic conductivities were modeled.

Differences were observed in the vertical movement of particle traces depending on the upper native sand hydraulic conductivity. Similar to the existing conditions scenario, less than 1% of particles were simulated to flow downward to the lower native sand unit in predictive scenarios with hydraulic conductivity at or below 14.4 feet/day in the upper native sand unit and with the PRB keyed into the uppermost confining unit. The associated particles were simulated to move downward into the intermediate silt/clay unit where the upper native sand was represented as less than 6 feet thick in the groundwater model; however, factors besides the intermediate silt/clay unit thickness were involved (i.e., simulated head in the upper native sand unit and represented thickness of the upper native sand unit). In the sensitivity scenario with uniformly higher hydraulic conductivity, no particles were simulated to flow downward to the lower native sand unit. Therefore, if the actual hydraulic conductivity in the northwest portion of the Karn Landfill is higher than suggested by the geometric mean of the representative data in the northwest zone and the model calibration (e.g., if low hydraulic conductivity estimates are disproportionately lowering the mean), no downward flow to the lower native sand would be expected.

Predictive Scenario Summary

In all of the predictive scenarios evaluated, approximately 65% of particles were simulated to pass through the PRB and reach the bay (Figure 9) and zero to less than 1% of particles were simulated to travel downward into the lower native sand. Predictive scenarios results had minimal sensitivity to PRB fouling and the modeled differences in upper native sand unit horizontal hydraulic conductivity. These model results, combined with water quality data from the lower native sand, support keying the PRB into the intermediate silt/clay unit in the additional remedial response area extent.

3.3 Groundwater and Soil Quality Evaluation

Groundwater and soil quality data from the FS remedial response area extent were compared to groundwater and soil quality data collected from the additional remedial response area extent to assess differences in groundwater and soil quality data between these two areas and potential implications differences may have on the effectiveness of a PRB.

3.3.1 Groundwater Quality Comparison

Groundwater quality will primarily influence the effectiveness of a PRB based on: 1) the ability of a PRB amended with zerovalent iron (ZVI) to provide long-term attenuation of arsenic to below site-specific mixing zone-based criteria, 2) the rate and magnitude of fouling/plugging of the PRB, and 3) the potential for adverse changes to non-arsenic parameters.

Groundwater quality data collected from wells screened in the upper sand unit in the additional remedial response area in July 2021 (included in Appendix A-6) were compared to data collected from wells screened in the upper sand unit in the FS remedial response area (i.e., MW-8, MW-10, MW-12, and MW-14) in August 2020, October 2020, and July 2021 (included in Appendix A-9). For each location, the most recent data available for each parameter was used in the comparison. Groundwater quality data collected from temporary wells installed in the lower sand unit, TW-21-011D and TW-21-012D, were not included in this comparison because remedial response is not needed in the lower sand unit due to arsenic concentrations being below site-specific mixing zone-based criteria. A comparison of the average values for select parameters in each extent is included in Table 5.

Table 5 Feasibility Study Area and Additional Area Groundwater Quality Comparison

Parameter	Units	Average Value	
		FS Remedial Response Area	Additional Remedial Response Area
Alkalinity, total, as $CaCO_3$	micrograms per liter (µg/L)	447,500	331,286
Total Arsenic	µg/L	276	338
Total Calcium	µg/L	223,750	136,600
Total Iron	µg/L	3,769	1,495
Total Magnesium	µg/L	64,300	27,814
Total Manganese	µg/L	557	407
Oxidation reduction potential	millivolts	-52.0	-123
pH	standard units.	7.2	8.3
Total Potassium	µg/L	12,775	6,883
Sulfate, as SO_4	µg/L	452,225	154,729

Key observations from this evaluation are as follows:

- The data do not suggest that iron concentrations will be higher downgradient of the additional remedial response area than downgradient of the FS remedial response area.
- The oxidation reduction potential within the additional remedial response area suggests that the aquifer is a reducing environment consistent with conditions observed within the FS remedial response area. This indicates that arsenic speciation will be similar between the two areas, and arsenic will primarily be in the more soluble arsenite form (As^{3+}).
- The average pH observed within the additional remedial response area was higher than the average pH observed within the FS remedial response area.
    - Higher groundwater pH can lead to greater mineral deposition within the PRB and/or localized areas where groundwater pH may approach a relevant criterion immediately downgradient of the PRB.
    - Observations included in the FS of ZVI's propensity to increase the pH of the Karn Landfill groundwater suggest that ZVI at a 5% amendment ratio will likely not increase groundwater pH above 9.0 standard units under in-situ conditions

- Groundwater quality minerals and parameters that may affect the rate and magnitude of plugging and fouling of a PRB, which include calcium, magnesium, manganese, alkalinity, and sulfate, have lower concentrations within the additional remedial response area than within the FS remedial response area. However, rate of plugging and fouling within the additional remedial response area extent is expected to be similar to the FS remedial response area extent due to the higher pH observed within the additional remedial response area extent.

Together, these observations suggest that a PRB installed in the additional remedial response area would have the ability to provide effective, long-term removal of arsenic to below site-specific mixing-zone based GSI criteria, consistent with findings from the FS for a PRB installed in the FS remedial response area. Changes to groundwater quality downgradient of a PRB are anticipated to be consistent between the two areas based on this evaluation.

3.3.2 Soil Quality Comparison

Soil quality in the upper sand unit was compared between the additional and FS remedial response areas based on soil samples collected from the TW-21-009 through TW-21-013 borings installed in July 2021 and the DEK-SB-20001 through DEK-SB-20010 borings installed in July 2020. The locations of the 2020 and 2021 soil samples are shown on Figure 3. The analytical results from the 2021 soil samples are included in Appendix A-2 and analytical results for the 2020 soil samples are included in Appendix A-10.

Field observations of the upper sand unit were similar in both areas. The saturated soils in these areas were primarily classified as poorly graded, fine to medium grained, tan to dark gray sands. A comparison of analytical data from each area included concentrations of total organic carbon (TOC), arsenic, and iron. A comparison of the average values in each extent for each parameter is included in Table 6.

Table 6 Feasibility Study Extent and Additional Remedial Response Area Extent Soil Quality Comparison

Parameter	Units	Average Value	
		FS Remedial Response Area	Additional Remedial Response Area
Carbon, total organic	milligrams per kilogram (mg/kg)	2,380	1,590
Moisture	%	15.9	19.2
Solids, percent	%	84.0	80.0
Arsenic	mg/kg	7.73	7.39
Iron	mg/kg	4,080	3,450

For each of these parameters, average concentrations in the two areas were generally consistent. Average arsenic and iron concentrations were approximately 4% and 15% lower, respectively, between the additional and FS remedial response areas. The average TOC concentration was approximately 33% lower within the additional remedial response area compared to the FS remedial response area. High TOC concentrations can result in biofouling of PRBs, but literature suggests that biofouling is not a concern for ZVI-amended PRBs (reference (13)), and so the differences in TOC between the two areas does not affect this evaluation. A comparison of field observations and analytical data collected between these two areas suggests that performance of a PRB would be similar between the additional and FS remedial response areas.

3.4 Geotechnical Evaluation

The geotechnical stability of the original PRB alignment was studied in the FS by evaluating sections through the southeast portion of the northern perimeter embankment dike. However, it was necessary to evaluate the stability of the extended portion of the PRB due to presence of a stratigraphic unit that was not evaluated in the geotechnical model for the FS – the intermediate silt/clay unit. The intermediate silt/clay was previously studied by Golder (reference (14)) and was found to be sensitive based on field vane testing, possibly because of calcium carbonate cement. Therefore, a geotechnical evaluation was performed to evaluate stability of the extended portion by developing a geotechnical model in SLOPE/W® software, produced by GEO-SLOPE International, Ltd. of Calgary, Alberta, a two-dimensional limit equilibrium slope stability modeling software (reference (15)). Material parameters were assigned using data from previous geotechnical investigations consistent with the FS (reference (1)).

A section was evaluated through Pond A into the bay at the northern portion of the northern perimeter embankment dike, as shown on Figure 3, which represents the area with the greatest elevation change from the Karn Landfill to the bay, while intersecting the intermediate silt/clay unit. The intermediate silt/clay unit is generally a low-plasticity organic silt/clay, OL in USCS classification (reference (16)). Barr conducted an additional model scenario to evaluate the consequences of disturbing the cemented structure of the intermediate silt/clay through the PRB excavation process. In that model scenario, remolded strength values were selected for the intermediate silt/clay to represent the strength of the material in the absence of cementation. The remolded strength of the intermediate silt/clay was conservatively selected as the 25th percentile remolded strength from the field vane tests conducted by Golder in the ponds (reference (14)), 500 pounds per square foot (psf).

The phreatic surface in the stability model was set at approximately 582 feet based on results from the groundwater model. Construction loading during trenching activities was modeled consistent with the FS (reference (1)), using discrete strip loads at the dynamic max load for a one-pass trencher, approximately 2,300 psf (16 pounds per square inch), roughly centered on the dike alignment.

Results for drained and undrained loading were generally similar to those for Pond A East as described in the FS and are summarized in Table 7. The results showed acceptable factors of safety relative to the threshold factors of safety of 1.30 for undrained loading and 1.50 for drained loading (40 CFR § 257.74(e)(1)). Remolded cases also had acceptable factors of safety relative to the 1.30 undrained threshold and the alternative 1.20 liquefaction threshold from 40 CFR § 257.74(e)(1), which was taken to be the nearest approximation of the remolded case. These results indicate no new conclusions for the geotechnical stability of the dike relative to what was identified in the FS (reference (1)); therefore, it is anticipated that construction activities for the extended PRB would not destabilize the northern perimeter embankment dike or cause slope failure.

Table 7 Factors of Safety for Slope Stability

	Loading Conditions		
	Drained Factor of Safety (minimum 1.50)	Undrained Factor of Safety (minimum 1.30)	Remolded[1] Factor of Safety (minimum 1.20)
Existing Conditions	2.33	2.33	1.75
Trencher Loading	1.84	2.31	1.71

[1] Critical slip surfaces for the remolded cases were forced along the interface between the intermediate silt/clay and the underlying lower native sand by making the underlying lower native sand impenetrable in SLOPE/W. In the remolded case, the intermediate silt/clay is modeled with remolded strength, and other units are modeled with undrained strengths, if applicable.

3.5 Constructability Evaluation

Constructability considerations evaluated were the existing constraints, the anticipated PRB geometry, and the anticipated PRB design parameters. These considerations were evaluated for a one-pass trenching technology; however, this construction is likely feasible with multiple PRB installation technologies.

Constraints including the landfill final cover system, perimeter embankment dike geometry, existing infrastructure, and existing stratigraphy were evaluated for assessing the PRB constructability. The landfill final cover system will restrict the PRB work platform width to the perimeter embankment dike crest, but the perimeter embankment dike crest width of approximately 24 feet should be sufficient for one-pass trenching. However, the perimeter embankment dike crest slopes may require minor grading to create a level work platform. Locations of utilities and other existing infrastructure will need to be verified during remedy design, and caution will be required when working in areas near overhead power lines, storm water culverts, or existing instrumentation to mitigate damage to existing infrastructure. The Karn Landfill stratigraphy is not anticipated to include large cobble seams or boulders that would obstruct the operation of a one-pass trenching technology. Thickness of the intermediate silt/clay unit was observed to be approximately 9.5 and 5.0 feet at TW-21-011D and TW-21-012D, respectively, and those observations generally agree with observations from other deep borings in the vicinity and the modeled thickness of the layer from the Earth Volumetric Studio model previously completed by Barr. A minimum embedment depth requirement of 2 feet to 3 feet is anticipated in this unit, which is achievable for the thicknesses observed, while an embedment of 5 feet is anticipated in areas where the PRB would be embedded into the glacial till

PRB geometry assumptions for depth, width, alignment, and continuity were evaluated for assessing the PRB constructability. The depth of the PRB is anticipated to range from 25 feet to 45 feet and reaching this design depth range is achievable by the one-pass trenching technology. One-pass trenching methods typically minimize the number of depth changes for production efficiency; however, the technology does have the capability to install to a variable design depth profile as needed. A minimum width of 1.5 feet is anticipated for the remedy design and is achievable with the one-pass trenching technology (standard machine widths are 1.5 feet, 2 feet, and 2.5 feet). The one-pass trenching operation will likely require the alignment be offset several feet from the centerline of the dike crest to allow for traffic and material staging on the crest, which will serve as the working platform, however this should not create a constructability concern.

PRB parameter assumptions of strength, permeability, uniformity, continuity, and ZVI amendment rate were evaluated for assessing the PRB constructability. Industry standard strength and permeability ranges are anticipated for the remedy design and are achievable by the one-pass trenching technology. Uniformity and continuity requirements are achievable with the one-pass trenching operation which is able to construct a well-mixed final barrier through the subsurface layers and achieve a consistent ZVI amendment rate.

Results of the constructability evaluation indicate that it is feasible to construct the extended PRB with one-pass trenching technology. It is likely that other common PRB installation technologies could achieve the anticipated remedy design; however, one-pass trenching is anticipated to be the more efficient, lower cost, and effective installation method.

3.6 Reconsideration of FS Balancing Criteria

The same balancing criteria considered in the FS were reconsidered for a PRB installed in the additional remedial response area extent based on results of evaluations conducted since the FS. Key findings for each of these elements (effectiveness, implementability, permitting considerations, community considerations, and advantages and disadvantages) were applicable for a PRB installed along the additional remedial response area extent, with the exception of schedule and cost which are discussed below

3.7 Schedule and Cost Considerations

It is anticipated that construction of the PRB along the length of the revised remedial response area could be completed in approximately four to six months and costs for implementation in the revised remedial response area would increase, relative to the costs estimated for the FS remedial response area, based on the additional length of the PRB and increased depth of installation in select areas. Assumptions used to estimate the PRB lifetime costs and construction duration are similar to the FS.

4 Conclusions and Recommendations

Since the FS was written, additional evaluations were completed to investigate the need for and feasibility of a PRB along the length of the revised remedial response area as shown on Figure 2. Conclusions of these evaluations include the following:

- Remedial response should be implemented in the upper sand unit within the revised remedial response area due to groundwater arsenic concentrations above mixing zone-based GSI criteria.
- Remedial response is not required within the lower sand unit within the revised remedial response area because arsenic concentrations are below mixing zone-based GSI criteria and the intermediate silt/clay layer is confining.
- A PRB installed along the length of the revised remedial response area and keyed into the uppermost confining unit (i.e., the intermediate silt/clay unit to the northwest or the glacial till to the southeast) would not alter groundwater flow directions in a manner that would limit the effectiveness of a PRB. A PRB installed in this manner would effectively capture groundwater that is currently flowing into the bay.
- Groundwater quality, soil quality, and hydrogeologic conditions within the additional remedial response area extent are generally consistent with conditions observed within the FS remedial response area extent and would allow for mitigation of arsenic impacts by a PRB amended with ZVI.
- Based on geotechnical and constructability evaluations, a PRB is implementable within the additional remedial response area, but the increased thickness of the upper sand unit and the relative thinness of the intermediate silt/clay layer in this area, which the PRB would be embedded into, will result in greater complexity and cost for the implementation of a PRB in this area.

Based on these results, a PRB installed along the length of the revised remedial response area is recommended to be carrier forward to the remedial action plan.

5 References

References in this document are presented in ISO 690-Numerical Reference citation style. References below that begin with a "—" indicate that the author is the same as the one listed above it in bold. For example, the author of reference (3) is the same as the author of reference (2) (i.e., Legislative Council, State of Michigan).

1. **Barr Engineering Co.** Feasibility Study: D.E. Karn Generating Facility. February 2021.

2. **Legislative Council, State of Michigan.** Natural Resources and Environmental Protection Act (Excerpt) Act 451 of 1994 Part 115 Solid Waste Management.

3. —. Natural Resources and Environmental Protection Act (Excerpt) Act 451 of 1994 Part 201 Environmental Remediation. 2020.

4. **ASTM International.** ASTM Standard D2488-17 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures). West Conshohocken, PA : ASTM International, 2017.

5. **Butler, J. J.** *The Design, Performance, and Analysis of Slug Tests.* Boca Raton : CRC Press LLC, 1998.

6. **Cooper Jr., Hilton H., Bredehoeft, John D. and Papadopulos, Istavros S.** Response of a finite-diameter well to an instantaneous charge of water. *Water Resources Research.* March 1967, Vol. 3, 1, pp. 263-269.

7. **Hvorslev, M. Juul.** Time Lag and Soil Permeability in Ground-Water Observations. s.l. : U.S. Army Corps of Engineers, April 1951. Bulletin No. 36.

8. **Hyder, Zafar, et al.** Slug tests in partially penetrating wells. *Water Resources Research.* 1994, Vol. 30, 11, pp. 2945– 2957.

9. **HydroSOLVE, Inc.** AQTESOLV for Windows-Version 4.5 User's Guide. 2007.

10. **Pollock, D.W.** MODPATH v7.2.01: A particle-tracking model for MODFLOW: U.S. Geological Survey Software Release. December 15, 2017.

11. **S.M. Stoller Corporation.** Variation in Hydraulic Conductivity Over Time at the Monticello Permeable Reactive Barrier. s.l. : U.S. Department of Energy Office of Legacy Management, February 2005.

12. **Li, Lin, Benson, Craig H. and Lawson, Elizabeth M.** Impact of Mineral Fouling on Hydraulic Behavior of Permeable Reactive Barriers. *Ground Water.* July-August 2005, Vol. 43, 4, pp. 582-596.

13. **The Interstate Technology and Regulatory Council.** Permeable Reactive Barrier: Technology Update. June 2011.

14. **Golder Associates Inc.** Geotechnical Report for the D.E. Karn Solid Waste Disposal Area. January 15, 2014.

15. **GEO-SLOPE International Ltd.** Stability Modeling with GeoStudio. 2020.

16. **ASTM International.** ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System). West Conshohocken, PA : ASTM International, 2017.

Figures

Site Boundary

Background: 2013 National Geographic Society

SITE LOCATION
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 1

Barr Footer: ArcGIS 10.8.1, 2021-08-23 10:30 File: I:\Projects\22\09\1015\Maps\Reports\FeasibilityStudy_PRB_AdditionalExtent\Figure1_SiteLocation.mxd User: MAC2

Notes:
- GSI = Groundwater-Surface Water Interface

Aerial Image: USDA NAIP 2020

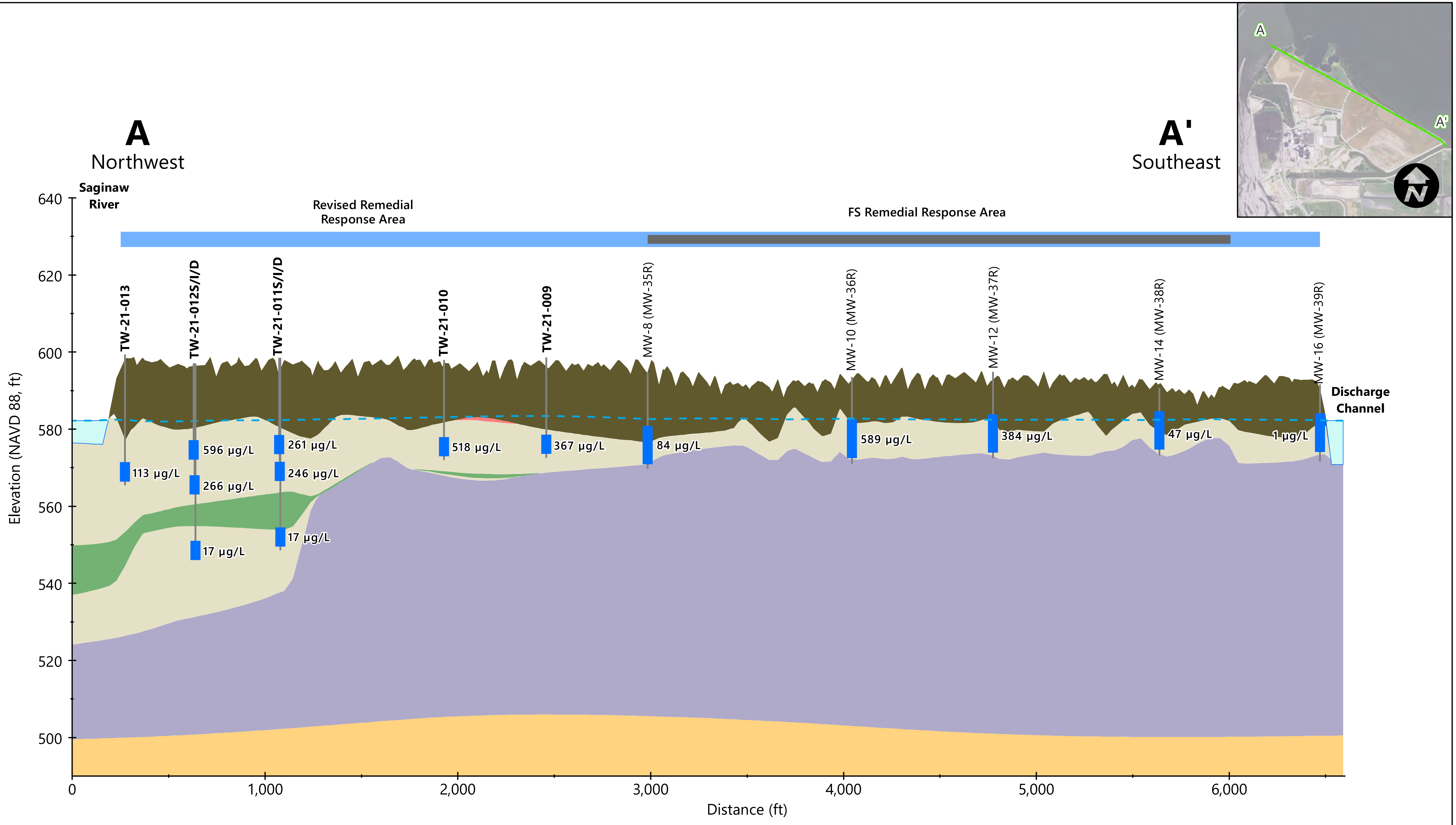
SITE LAYOUT
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 2

Aerial Image: USDA NAIP 2020

PRB EXTENSION INVESTIGATION LOCATIONS
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 3



Stratigraphy

- ■ Ash/Fill
- 🟥 Peat/Organics
- ▨ Sand
- 🟩 Intermediate Silt/Clay with Organics
- ▨ Clay
- 🟧 Bedrock

- - - Water Table (May 2020)

▮ 113 µg/L Well/Piezometer Screen and July 2021 Total Arenic Concentration (**Bold** If Installed in 2021)

| Boring

▬ FS Remedial Response Area

▬ Revised Remedial Response Area

NOTES
- Select borings shown are located along the norther perimeter embankment dike and were used to evaluate the potential effectiveness of the extended PRB footprint.
- Stratigraphy shown in the cross section is consistent with EVS modeling results included in the February 2021 Feasibility Study and does not account for soil observations from borings completed in 2021 because the existing modeling results generally agreed with borings completed in 2021.
- Water table is approximate and based on water levels measured in May 2020.
- Grid based modeling has inherent limitations to accurately represent steep slopes. Constructed slopes are approximate and may not exactly match constructed grades.
- Groundwater sampling was performed at TW-21-009 through TW-21-013 on July 6 and 7, 2021. Groundwater sampling was performed at all other locations shown on July 27, 2021.

JULY 2021 TOTAL ARSENIC CONCENTRATIONS FOR SELECT WELLS ALONG THE NORTHERN PERIMETER EMBANKMENT DIKE

D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 4

BARR

- ⊙ Boring Included in 3D Model
- ⊙ 2021 Temporary Well Installed for PRB Extension Evaluation
- Section Locations
- Karn Landfill
- Weadock Landfill
- Closed Bottom Ash Pond
- Karn Lined Impoundment

Notes:
- Only borings included in development of the three-dimensional (3D) geologic model are shown on this figure, except for temporary wells installed in 2021, which are shown on this figure and cross sections for location purposes only. Geologic data from those borings were not used to inform the geologic model.
- Years included in parentheses indicate the year a boring was completed, if multiple borings with the same name have been completed on site.

N

0 500 1000

Feet

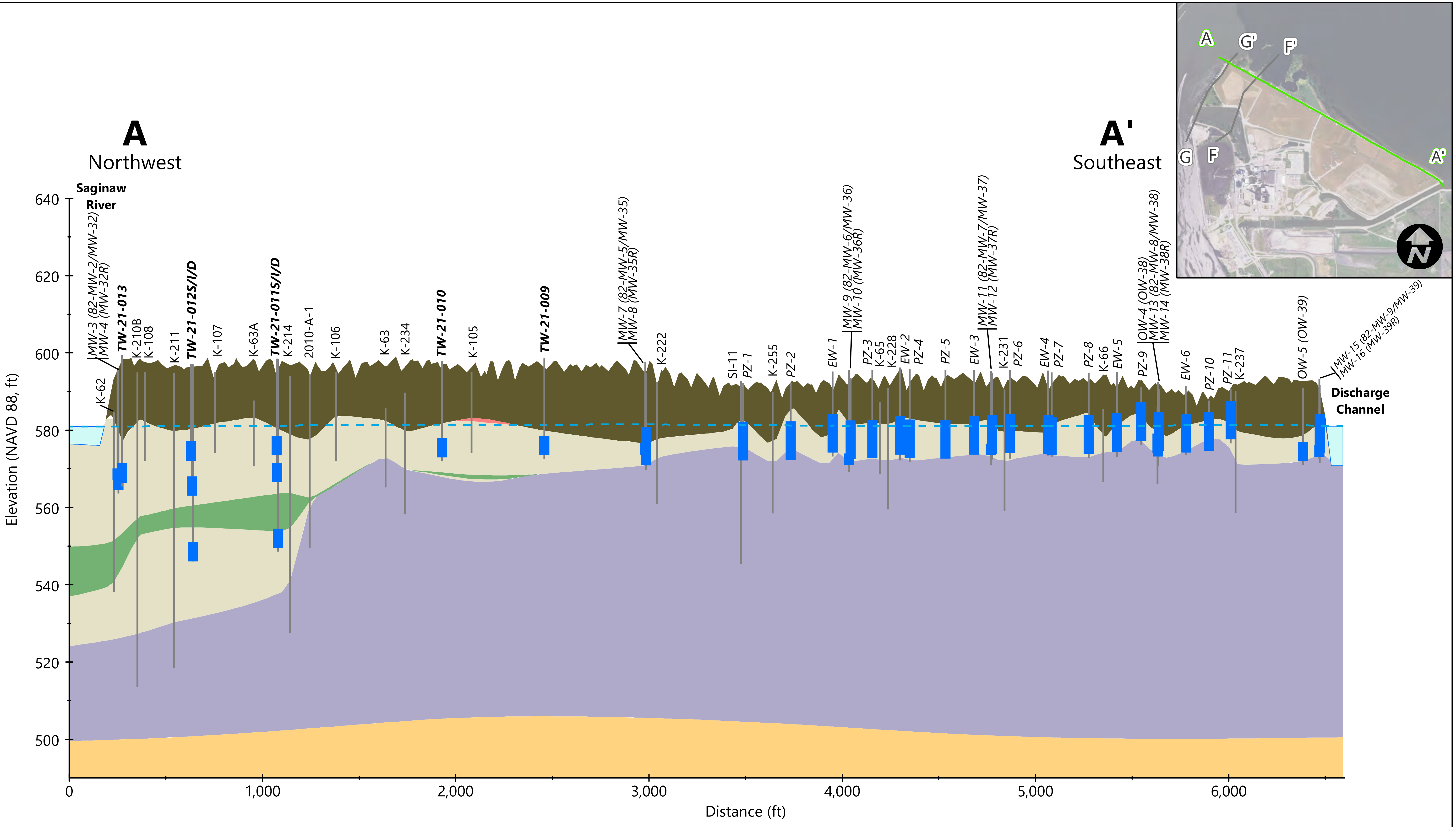
Aerial Image: USDA NAIP 2020

CROSS SECTION LOCATIONS

D.E. Karn Generating Facility
Consumer Energy Company
Essexville, MI

FIGURE 5

BARR



Stratigraphy

🟫 Ash/Fill
🟥 Peat/Organics
⬜ Sand
🟩 Intermediate Silt/Clay with Organics
🟪 Clay
🟧 Bedrock

- - - Water Table (July 2021)

▮ Well/Piezometer Screen
Italicized If Active
Bold if Installed In 2021

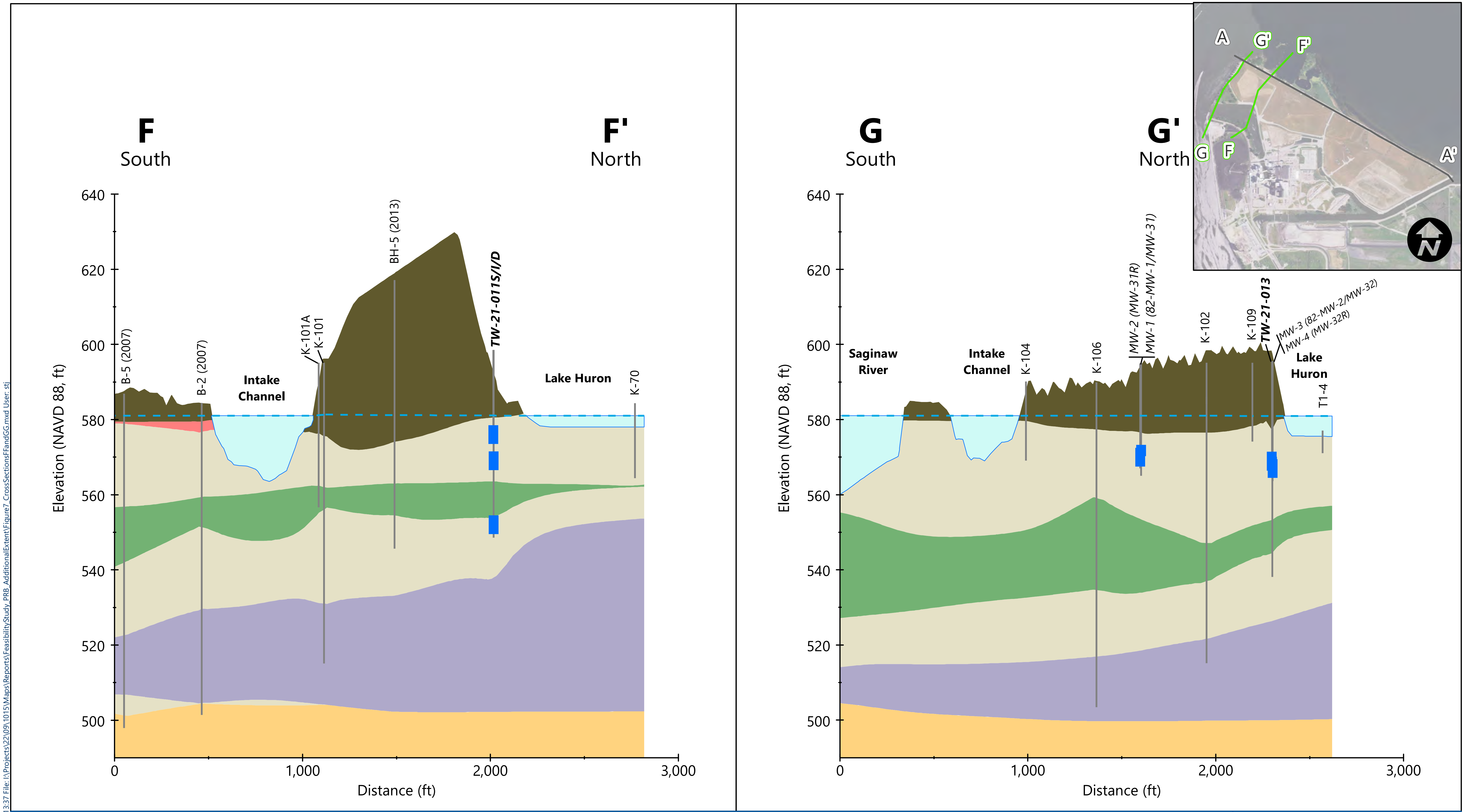
| Boring

NOTES
- The cross section is a two-dimensional slice through a three-dimensional interpolation of available site data.
- Stratigraphy shown in the cross section is consistent with EVS modeling results included in the February 2021 Feasibility Study and does not account for soil observations from borings completed in 2021 because the existing modeling results generally agreed with borings completed in 2021.
- Borings within 50 feet of the cross section line are projected onto this cross section. Due to the projection, the surveyed ground surface at a boring may not match the ground surface shown on the cross section.
- Water table is approximate and based on water levels measured in July 2021.
- Grid based modeling has inherent limitations to accurately represent steep slopes. Constructed slopes are approximate and may not exactly match constructed grades.

BARR

CROSS SECTION A-A'
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 6



Stratigraphy

- ▨ Ash/Fill
- ▨ Peat/Organics
- ▨ Sand
- ▨ Intermediate Silt/Clay with Organics
- ▨ Clay
- ▨ Bedrock

- - - Water Table (July 2021)

▮ Well/Piezometer Screen
Italicized If Active
Bold if Installed In 2021

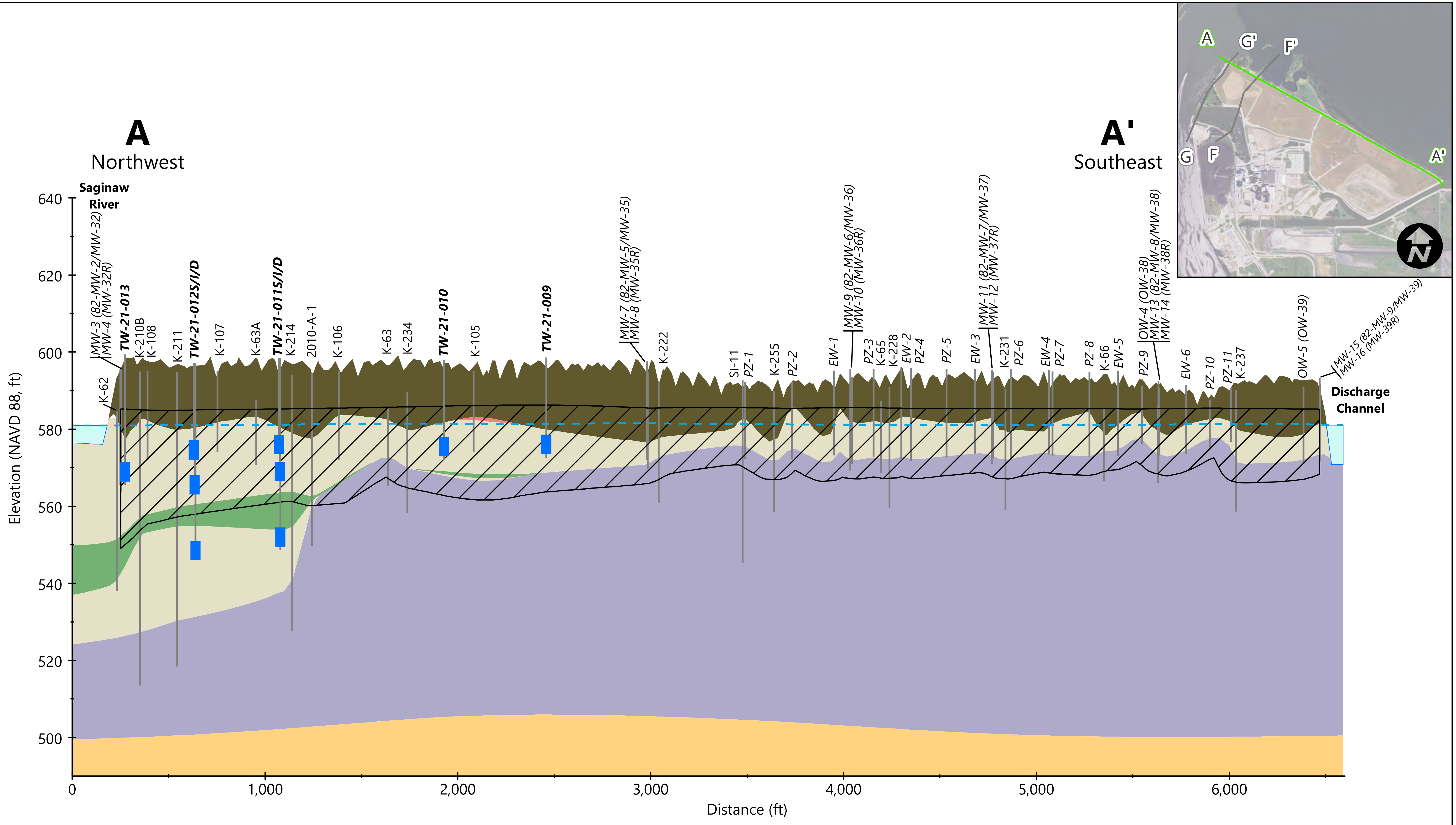
| Boring

NOTES
- The cross section is a two-dimensional slice through a three-dimensional interpolation of available site data.
- Stratigraphy shown in the cross section is consistent with EVS modeling results included in the February 2021 Feasibility Study and does not account for soil observations from borings completed in 2021 because the existing modeling results generally agreed with borings completed in 2021.
- Borings within 50 feet of the cross section line are projected onto this cross section. Due to the projection, the surveyed ground surface at a boring may not match the ground surface shown on the cross section.
- Water table is approximate and based on water levels measured in July 2021.
- Grid based modeling has inherent limitations to accurately represent steep slopes. Constructed slopes are approximate and may not exactly match constructed grades.

BARR

CROSS SECTIONS F-F' AND G-G'
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 7



Stratigraphy
- ■ Ash/Fill
- ■ Peat/Organics
- ■ Sand
- ■ Intermediate Silt/Clay with Organics
- ■ Clay
- ■ Bedrock

- - - Water Table (July 2021)

▮ Well/Piezometer Screen
Italicized If Active
Bold if Installed In 2021

| Boring

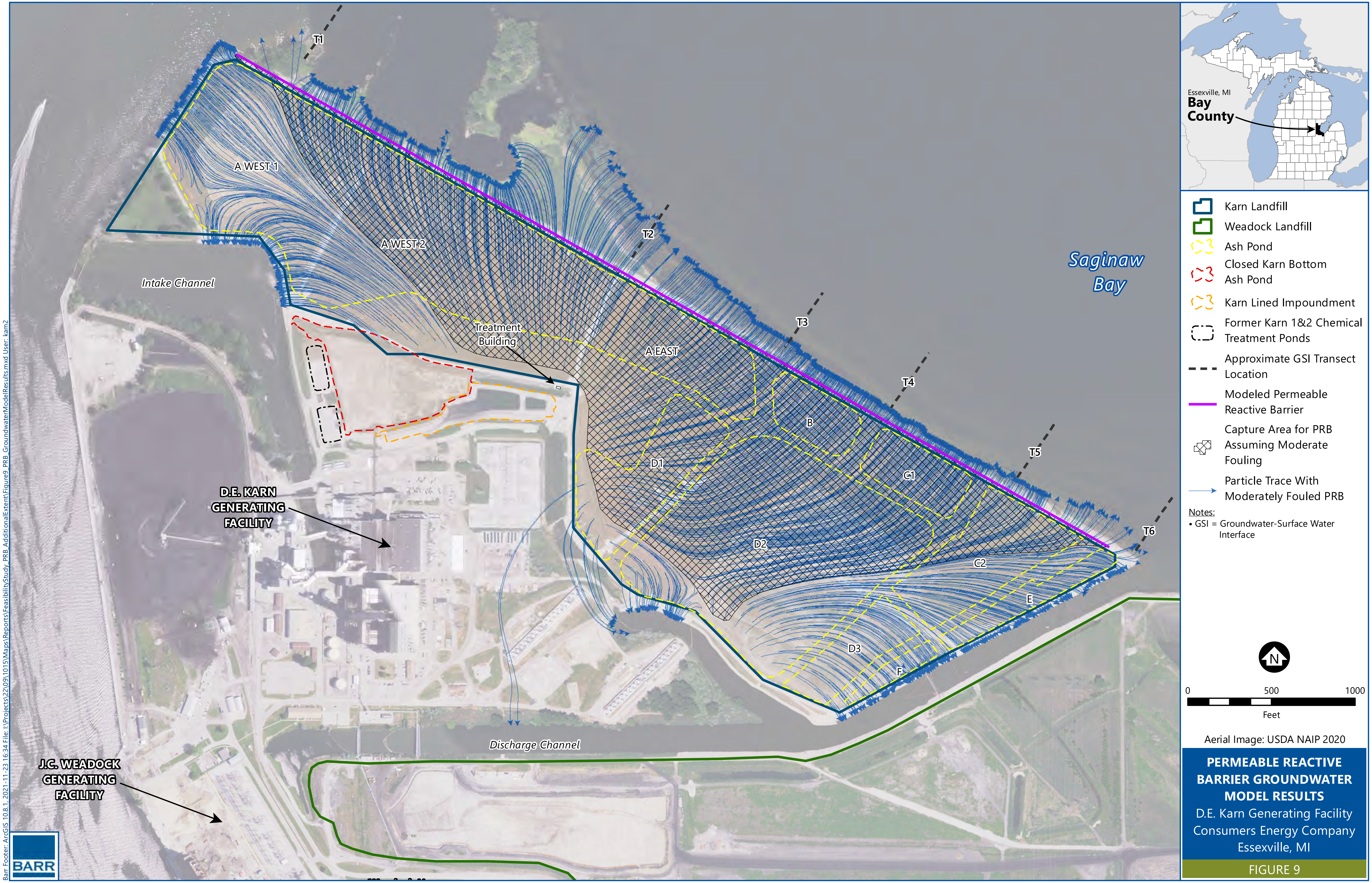
▨ Potential PRB Extent

NOTES
- The cross section is a two-dimensional slice through a three-dimensional interpolation of available site data.
- Stratigraphy shown in the cross section is consistent with EVS modeling results included in the February 2021 Feasibility Study and does not account for soil observations from borings completed in 2021 because the existing modeling results generally agreed with borings completed in 2021.
- Borings within 50 feet of the cross section line are projected onto this cross section. Due to the projection, the surveyed ground surface at a boring may not match the ground surface shown on the cross section.
- Water table is approximate and based on water levels measured in July 2021.
- Grid based modeling has inherent limitations to accurately represent steep slopes. Constructed slopes are approximate and may not exactly match constructed grades.

BARR

CROSS SECTION A-A'
WITH POTENTIAL PRB
INSTALLATION DEPTHS
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 8



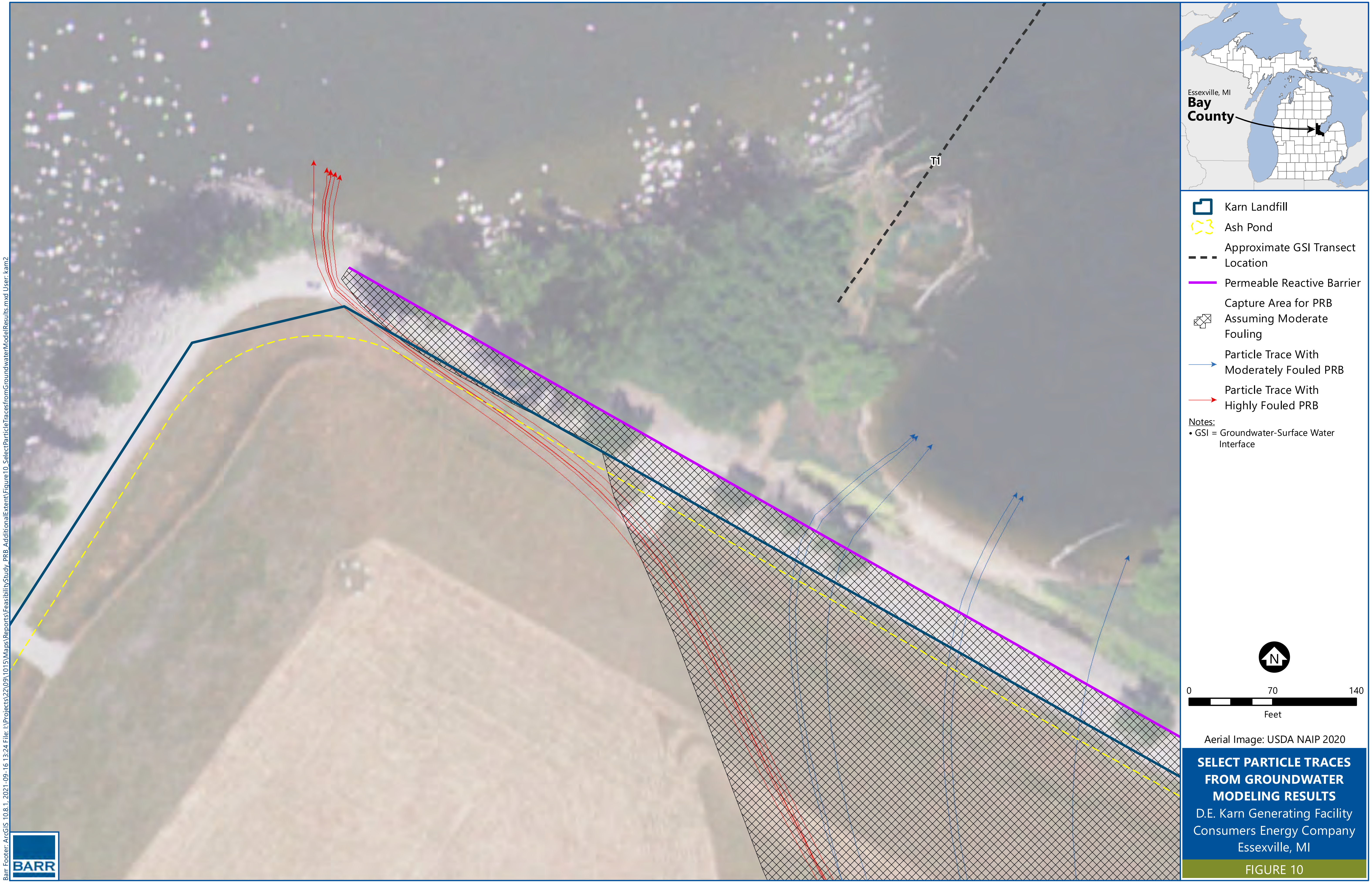
Notes:
- GSI = Groundwater-Surface Water Interface

Aerial Image: USDA NAIP 2020

PERMEABLE REACTIVE BARRIER GROUNDWATER MODEL RESULTS

D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

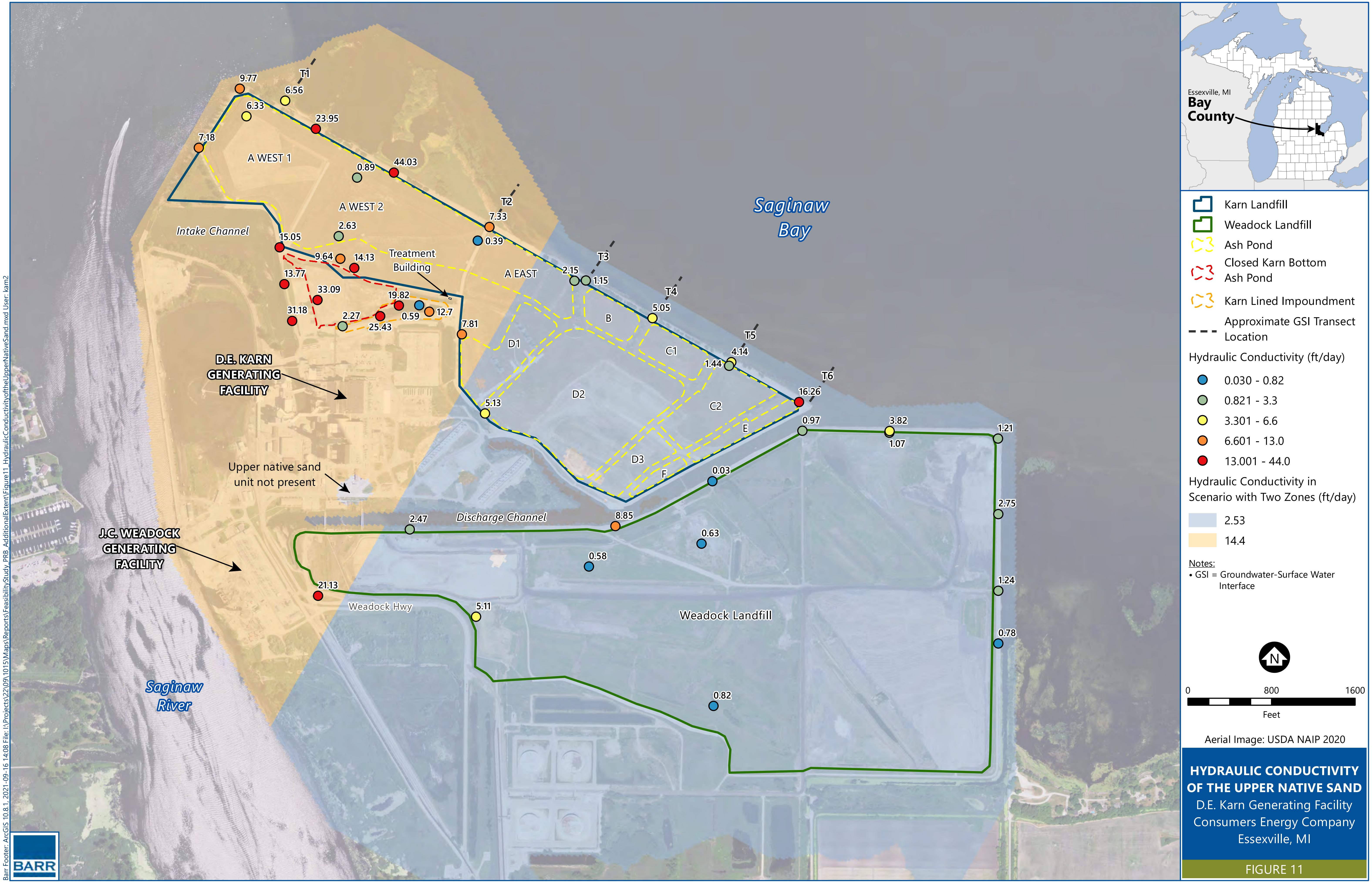
FIGURE 9



SELECT PARTICLE TRACES FROM GROUNDWATER MODELING RESULTS

D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 10



Karn Landfill
Weadock Landfill
Ash Pond
Closed Karn Bottom Ash Pond
Karn Lined Impoundment
Approximate GSI Transect Location

Hydraulic Conductivity (ft/day)
- ● 0.030 - 0.82
- ● 0.821 - 3.3
- ● 3.301 - 6.6
- ● 6.601 - 13.0
- ● 13.001 - 44.0

Hydraulic Conductivity in Scenario with Two Zones (ft/day)
- ▨ 2.53
- ▨ 14.4

Notes:
- GSI = Groundwater-Surface Water Interface

Aerial Image: USDA NAIP 2020

HYDRAULIC CONDUCTIVITY OF THE UPPER NATIVE SAND
D.E. Karn Generating Facility
Consumers Energy Company
Essexville, MI

FIGURE 11

Appendices

Appendix A

Boring Logs, Well Development Logs, Groundwater Data, Soil Data

Appendix A-1a

Boring Logs

Barr Engineering Company
3005 Boardwalk St, Suite 100
Ann Arbor, MI 48108
Telephone: 734-922-4400

LOG OF BORING TW-21-009

SHEET 1 OF 1

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	598.6 ft
Project No.:	22/09-1015	Top of Casing Elev.:	601.6 ft
Location:	Essexville, MI	Drilling Method:	Hollow Stem Auger
Coordinates:	N 783,969.2 ft E 13,263,613.0 ft	Sampling Method:	Split Spoon
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Completion Depth:	26.0 ft

Depth, feet: 0, 5, 10, 15, 20, 25, 30

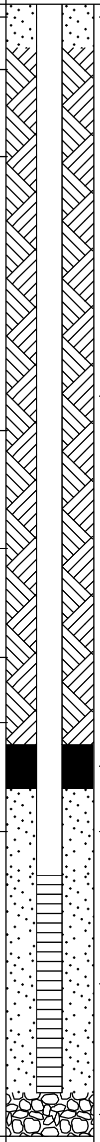
Elevation, feet: 595, 590, 585, 580, 575, 570

Blows/6in.:
- 6-3-4-4.
- 7-5-6-7.
- 5-5-8-14.
- 8-6-10-8.
- 2-4-22-15.
- 3-6-10-10.
- 4-34-50/5.5"-.
- 6-11-11-11.
- 6-4-5-7.
- 5-3-3-6.
- 2-2-4-5.
- 2-6-12-11.
- 2-2-2-3.

ENVIRONMENTAL DATA:
- **PID:**0.1
- **PID:**0.1 **D/O/S:**None/ None/ None
- **PID:**0.1
- **PID:**0.4 **D/O/S:**None/ None/ None
- **PID:**0.1
- **PID:**0.1 **D/O/S:**None/ None/ None
- **PID:**0.1
- **PID:**0.1 **D/O/S:**None/ None/ None
- **PID:**0.2
- **PID:**0.2 **D/O/S:**None/ None/ None
- **PID:**0.1

USCS	LITHOLOGIC DESCRIPTION
	FILL: sand with gravel; gray; moist; roadbase.
	FILL: fine to medium sand; tan; moist; few silt. At 1.4 ft, black fabric debris.
	FILL: lean clay; grayish brown; stiff; moist; trace gravel. At 2 ft, fine to medium sand lens.
	FILL: fine to medium sand and coal cinders; dark gray; moist; trace gravel.
	FILL: lean clay; grayish brown; stiff; moist; trace gravel.
	FILL: fine to medium sand and coal cinders; dark gray; moist; trace gravel. At 14.5 ft, crushed limestone rock fragments.
	FILL: lean clay; grayish brown; moist; trace gravel. At 15.8 ft, fine to medium sand; orange; few silt. At 16.4 ft, wood debris.
SP	POORLY GRADED SAND (SP): fine to medium grained; tan; moist to wet; few silt; possible fill.
SP	POORLY GRADED SAND (SP): fine to medium grained; gray; wet; few silt, trace shells.
	End of boring 26.0 feet

WELL OR PIEZOMETER CONSTRUCTION DETAIL



- Stick-up Protective Cover
- Bentonite Grout 1-17 ft
- Bentonite Chip 17-18 ft
- Filter Pack Sand 18-25 ft
- 2-inch dia. PVC 10-Slot Screen 20-25 ft
- Natural Collapse 25-26 ft

Date Boring Started:	6/30/21
Date Boring Completed:	6/30/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks:

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

Barr Engineering Company
3005 Boardwalk St, Suite 100
Ann Arbor, MI 48108
Telephone: 734-922-4400

LOG OF BORING TW-21-010

SHEET 1 OF 1

Project: Consumers D.E. Karn Corrective Action
Project No.: 22/09-1015
Location: Essexville, MI
Coordinates: N 784,229.8 ft E 13,263,151.6 ft
Datum: XY: NAD83 MI StPln South Int Ft; Z: NAVD88

Surface Elevation: 598.0 ft
Top of Casing Elev.: 601.2 ft
Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon
Completion Depth: 26.0 ft

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0							FILL: sand with gravel; gray; moist; roadbase.	Stick-up Protective Cover	
			5-3-2-2.	**PID:**0.4			FILL: fine to medium sand; tan; moist; few silt.		
							At 1.8 ft, fine to medium grained sand and coal cinders; dark gray.		
			7-4-5-5.	**PID:**0.3 **D/O/S:**None/ None/ None			At 2.5 ft, lean clay; grayish brown; stiff; moist; trace gravel.		595
							FILL: fine to medium grained sand and coal cinders; dark gray; trace gravel.		
5			2-3-3-4.				FILL: lean clay; grayish brown; moist; trace gravel and sand.		
				PID:0.0			FILL: fine to medium sand; brown; moist; few silt, trace clayey lenses.		
			2-1-3-5.						
				PID:0.1 **D/O/S:**None/ None/ None					590
			5-20-25-13.				At 8.3 ft, crushed limestone rock fragments; trace fossils.	Bentonite Grout 1-17 ft	
							FILL: coal ash; gray; moist.		
10				**PID:**0.2			FILL: fine to medium sand and coal cinders; dark gray; moist.		
			2-8-16-12.				FILL: lean clay; grayish brown; stiff; moist; trace gravel. At 11 ft, crushed limestone rock fragments. At 11.5 ft, fine to medium sand and coal cinders; dark gray.		
				PID:0.1 **D/O/S:**None/ None/ None					
			2-4-8-52.						585
							At 13.5 ft, fine to medium sand and coal cinders; dark gray.		
				PID:0.1					
15			2-2-4-13.				FILL: fine to medium sand; orange; moist; few silt.		
			3-3-4-8.	**PID:**0.2 **D/O/S:**None/ None/ None			POORLY GRADED SAND (SP): fine to medium grained; orange; moist; few silt. From 16-19 ft, tan; trace gravel.		
								Bentonite Chip 17-18 ft	580
				PID:0.3					
			5-3-5-5.				From 19-26 ft, gray; trace shells.	Filter Pack Sand 18-25 ft	
20				**PID:**0.1					
			5-2-4-6.		SP				
			WH-WH-5-6.	**PID:**0.1 **D/O/S:**None/ None/ None				2-inch dia. PVC 10-Slot Screen 20-25 ft	575
25			1-1-2-6.	**PID:**0.2				Natural Collapse 25-26 ft	
							End of boring 26.0 feet		
									570
30									

Date Boring Started: 6/30/21
Date Boring Completed: 6/30/21
Logged By: A. Schumacher
Drilling Contractor: Pearson
Drill Rig: CME750X

Remarks: WH - Weight of Hammer

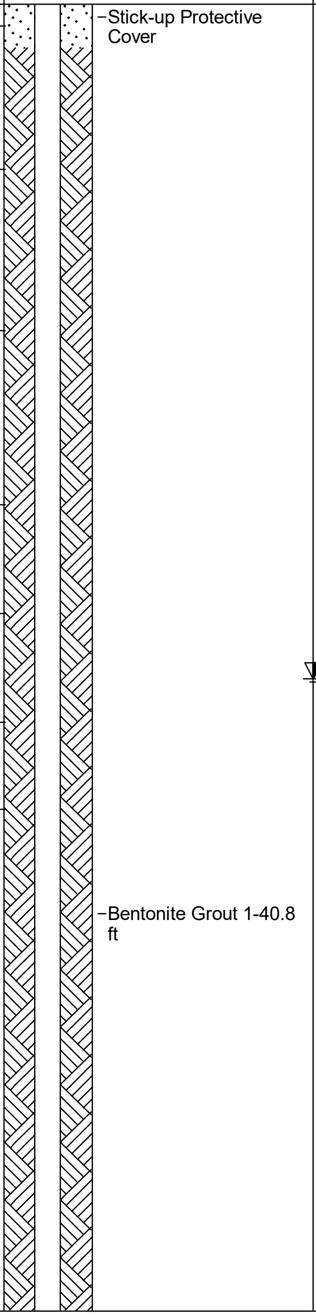
PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

BARR
Barr Engineering Company
3005 Boardwalk St, Suite 100
Ann Arbor, MI 48108
Telephone: 734-922-4400

LOG OF BORING TW-21-011D

SHEET 1 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	598.5 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger
Location:	Essexville, MI	Sampling Method:	Split Spoon
Coordinates:	N 784,644.2 ft E 13,262,410.8 ft	Completion Depth:	50.0 ft
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Top of Casing Elev.:	601.8 ft



Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0							FILL: fine to medium grained; brown; moist; poorly graded sand with silt.	Stick-up Protective Cover	
			2-1-2-5.	**PID:**0.1 **D/O/S:**None/ None/ None			FILL: brown; moist; trace sand and fine gravel; lean clay.		
			2-3-5-5.						595
				PID:0.5			FILL: dark gray; moist; trace gravel; coal ash and sand.		
5			2-3-9-13.	**PID:**0.1 **D/O/S:**None/ None/ None					
			3-6-7-9.	**PID:**1.0					
				PID:0.3			FILL: fine grained; tan; moist; few silt, trace clay and gravel; poorly graded sand. From 8-8.3 ft, coal ash and sand.		590
			4-4-4-5.						
10									
			3-6-14-12.	**PID:**0.3			From 11.1-11.5 ft, coal ash and sand.		
				PID:0.2 **D/O/S:**None/ None/ None			FILL: grayish brown; moist; trace gravel; lean clay.		
			4-4-5-10.						585
							FILL: fine grained; tan; moist to wet; few silt with coal ash, trace clay and gravel; poorly graded sand.		
15			4-13-15-17.	**PID:**0.4					
				PID:0.3 **D/O/S:**None/ None/ None	SP		POORLY GRADED SAND (SP): fine to medium grained; tan; wet; few silt, trace gravel.		
			2-3-5-8.						
			2-2-4-4.		SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray to dark gray; wet; trace shells.		580
20				**PID:**0.0 **D/O/S:**None/ None/ None					
			1-1-3-2.					Bentonite Grout 1-40.8 ft	
			2-4-4-6.	**PID:**0.5					575
25			2-3-7-10.						
				PID:0.6 **D/O/S:**None/ None/ None					
			2-4-6-7.						
				PID:0.3					570
			2-4-9-16.						
30							From 29.5-29.8 ft, few gravel.		

Date Boring Started:	6/28/21
Date Boring Completed:	6/28/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Shelby tube collected from 34 to 36 feet below ground surface.
WH - Weight of Hammer

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

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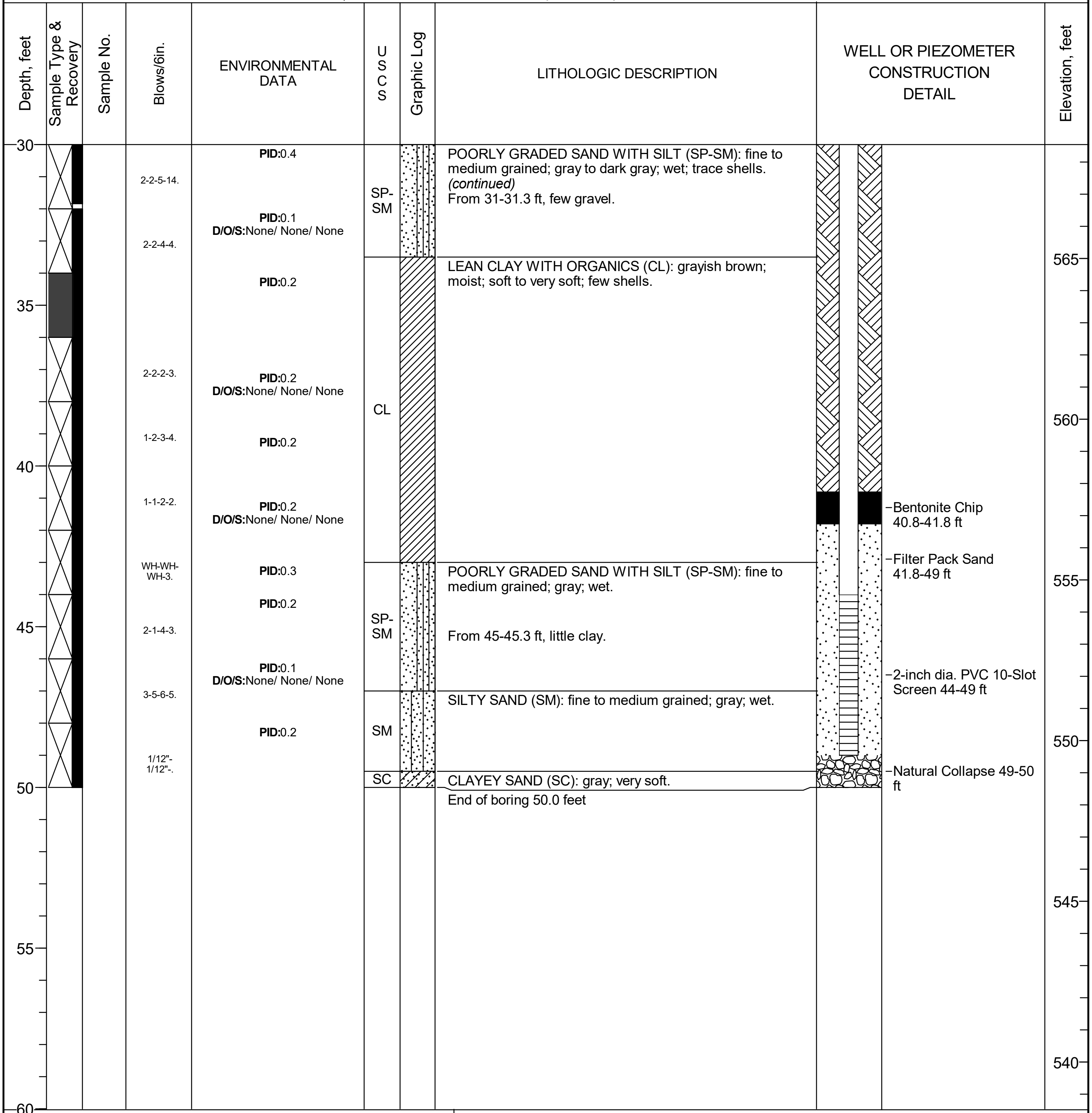
LOG OF BORING TW-21-011D

SHEET 2 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	598.5 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger
Location:	Essexville, MI	Sampling Method:	Split Spoon
Coordinates:	N 784,644.2 ft E 13,262,410.8 ft	Completion Depth:	50.0 ft
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Top of Casing Elev.:	601.8 ft



Depth, feet	Blows/6in.	ENVIRONMENTAL DATA	USCS	LITHOLOGIC DESCRIPTION
30	2-2-5-14.	**PID:**0.4	SP-SM	POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray to dark gray; wet; trace shells. *(continued)* From 31-31.3 ft, few gravel.
	2-2-4-4.	**PID:**0.1 **D/O/S:**None/ None/ None		
		PID:0.2	CL	LEAN CLAY WITH ORGANICS (CL): grayish brown; moist; soft to very soft; few shells.
35	2-2-2-3.	**PID:**0.2 **D/O/S:**None/ None/ None		
	1-2-3-4.	**PID:**0.2		
40	1-1-2-2.	**PID:**0.2 **D/O/S:**None/ None/ None		
	WH-WH-WH-3.	**PID:**0.3 **PID:**0.2	SP-SM	POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray; wet.
45	2-1-4-3.			From 45-45.3 ft, little clay.
	3-5-6-5.	**PID:**0.1 **D/O/S:**None/ None/ None		
		PID:0.2	SM	SILTY SAND (SM): fine to medium grained; gray; wet.
	1/12"-1/12"-.		SC	CLAYEY SAND (SC): gray; very soft.
50				End of boring 50.0 feet

WELL OR PIEZOMETER CONSTRUCTION DETAIL:
- Bentonite Chip 40.8-41.8 ft
- Filter Pack Sand 41.8-49 ft
- 2-inch dia. PVC 10-Slot Screen 44-49 ft
- Natural Collapse 49-50 ft

Date Boring Started:	6/28/21
Date Boring Completed:	6/28/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Shelby tube collected from 34 to 36 feet below ground surface.
WH - Weight of Hammer

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

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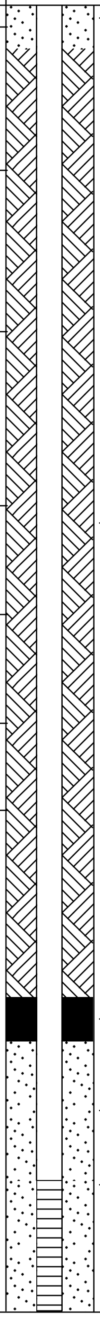
LOG OF BORING TW-21-011I

SHEET 1 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	598.5 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger
Location:	Essexville, MI	Sampling Method:	Split Spoon
Coordinates:	N 784,645.7 ft E 13,262,408.2 ft	Completion Depth:	32.0 ft
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Top of Casing Elev.:	601.6 ft

Depth, feet	Sample Type & Recovery	Sample No.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0						FILL: fine to medium grained; brown; moist; poorly graded sand with silt.	Stick-up Protective Cover	
			PID:0.1 **D/O/S:**None/ None/ None			FILL: brown; moist; trace sand and fine gravel; lean clay.		
			PID:0.5			FILL: dark gray; moist; trace gravel; coal ash and sand.		595
5			**PID:**0.1 **D/O/S:**None/ None/ None					
			PID:1.0					
			PID:0.3			FILL: fine grained; tan; moist; few silt, trace clay and gravel; poorly graded sand. From 8-8.3 ft, coal ash and sand.		590
10			**PID:**0.3			From 11.1-11.5 ft, coal ash and sand.		
			PID:0.2 **D/O/S:**None/ None/ None			FILL: grayish brown; moist; trace gravel; lean clay.	Bentonite Grout 1-22.8 ft	585
						FILL: fine grained; tan; moist to wet; few silt with coal ash, trace clay and gravel; poorly graded sand.		
15			**PID:**0.4					
			PID:0.3 **D/O/S:**None/ None/ None	SP		POORLY GRADED SAND (SP): fine to medium grained; tan; wet; few silt, trace gravel.		
				SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray to dark gray; wet; trace shells.		580
20			**PID:**0.0 **D/O/S:**None/ None/ None					
			PID:0.5				Bentonite Chip 22.8-23.8 ft	575
25							Filter Pack Sand 23.8-32 ft	
			PID:0.6 **D/O/S:**None/ None/ None				2-inch dia. PVC 10-Slot Screen 27-32 ft	
			PID:0.3					570
30						From 29.5-29.8 ft, few gravel.		



Date Boring Started:	6/28/21
Date Boring Completed:	6/28/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Blind drilled to 32 feet below ground surface.
Lithology details taken from TW-21-011D.

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

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LOG OF BORING TW-21-011I

SHEET 2 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	598.5 ft	Top of Casing Elev.: 601.6 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger	
Location:	Essexville, MI	Sampling Method:	Split Spoon	
Coordinates:	N 784,645.7 ft E 13,262,408.2 ft			
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Completion Depth:	32.0 ft	

Depth, feet	Sample Type & Recovery	Sample No.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
30			**PID:**0.4	SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray to dark gray; wet; trace shells. *(continued)* From 31-31.3 ft, few gravel.		
						End of boring 32.0 feet		
								565
35								
								560
40								
								555
45								
								550
50								
								545
55								
								540
60								

Date Boring Started:	6/28/21
Date Boring Completed:	6/28/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Blind drilled to 32 feet below ground surface.
Lithology details taken from TW-21-011D.

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
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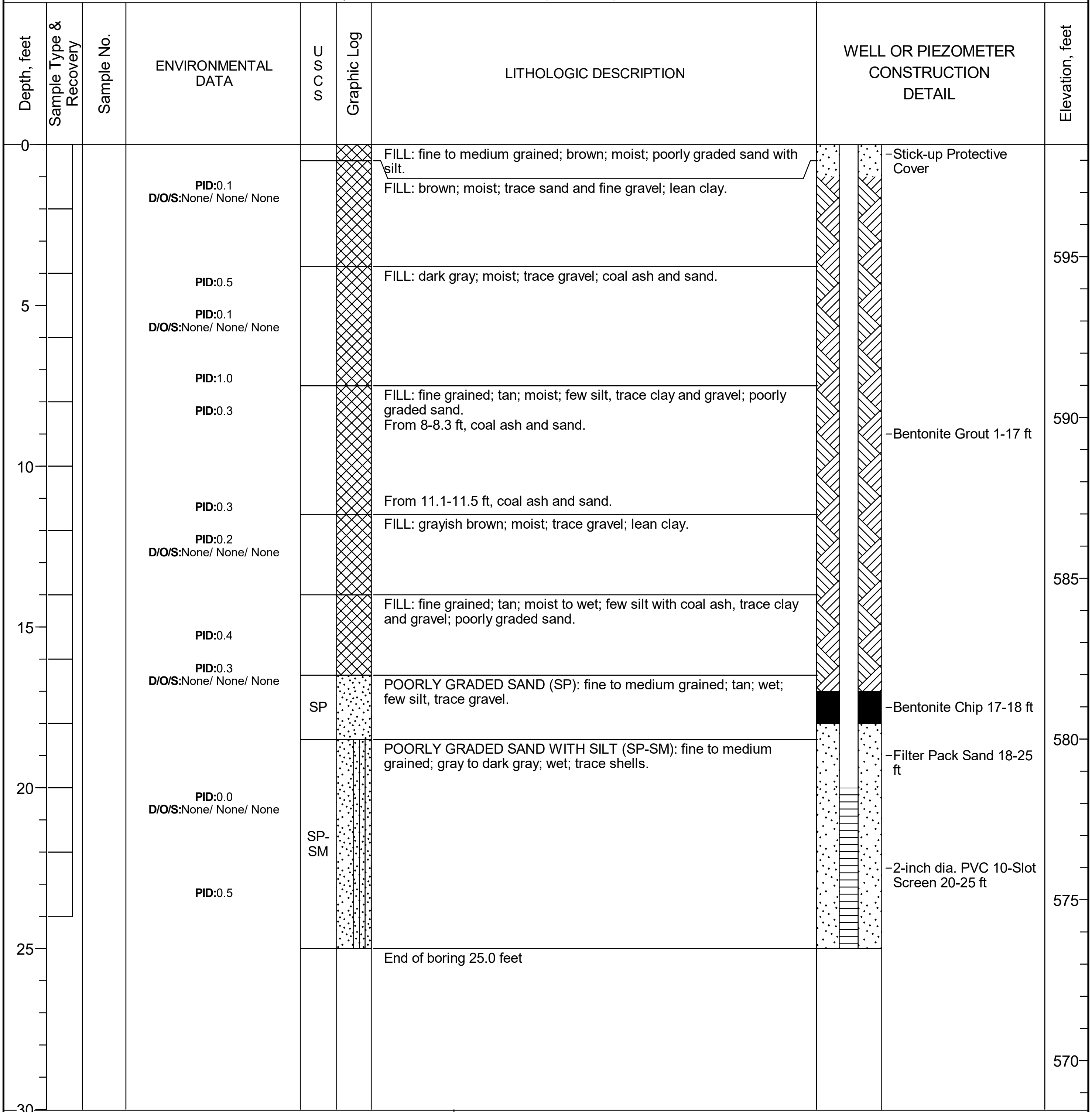
LOG OF BORING TW-21-011S

SHEET 1 OF 1

Project: Consumers D.E. Karn Corrective Action
Project No.: 22/09-1015
Location: Essexville, MI
Coordinates: N 784,647.5 ft E 13,262,405.1 ft
Datum: XY: NAD83 MI StPln South Int Ft; Z: NAVD88

Surface Elevation: 598.5 ft
Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon
Completion Depth: 25.0 ft

Top of Casing Elev.: 601.8 ft



Depth, feet	ENVIRONMENTAL DATA	USCS	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0			FILL: fine to medium grained; brown; moist; poorly graded sand with silt.	Stick-up Protective Cover	
	PID:0.1 **D/O/S:**None/ None/ None		FILL: brown; moist; trace sand and fine gravel; lean clay.		595
5	**PID:**0.5 **PID:**0.1 **D/O/S:**None/ None/ None **PID:**1.0		FILL: dark gray; moist; trace gravel; coal ash and sand.		
10	**PID:**0.3 **PID:**0.3		FILL: fine grained; tan; moist; few silt, trace clay and gravel; poorly graded sand. From 8-8.3 ft, coal ash and sand. From 11.1-11.5 ft, coal ash and sand.	Bentonite Grout 1-17 ft	590
	PID:0.2 **D/O/S:**None/ None/ None		FILL: grayish brown; moist; trace gravel; lean clay.		585
15	**PID:**0.4 **PID:**0.3 **D/O/S:**None/ None/ None		FILL: fine grained; tan; moist to wet; few silt with coal ash, trace clay and gravel; poorly graded sand.		
		SP	POORLY GRADED SAND (SP): fine to medium grained; tan; wet; few silt, trace gravel.	Bentonite Chip 17-18 ft	
20	**PID:**0.0 **D/O/S:**None/ None/ None **PID:**0.5	SP-SM	POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray to dark gray; wet; trace shells.	Filter Pack Sand 18-25 ft 2-inch dia. PVC 10-Slot Screen 20-25 ft	580 575
25 30			End of boring 25.0 feet		570

Date Boring Started: 6/28/21
Date Boring Completed: 6/28/21
Logged By: A. Schumacher
Drilling Contractor: Pearson
Drill Rig: CME750X

Remarks: Blind drilled to 25 feet below ground surface.
Lithology details taken from TW-21-011D.

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

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LOG OF BORING TW-21-012D

SHEET 1 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	597.0 ft
Project No.:	22/09-1015	Top of Casing Elev.:	600.3 ft
Location:	Essexville, MI	Drilling Method:	Hollow Stem Auger
Coordinates:	N 784,862.4 ft E 13,262,027.7 ft	Sampling Method:	Split Spoon
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Completion Depth:	51.0 ft

Depth, feet	Blows/6in.	ENVIRONMENTAL DATA	USCS	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0	4-2-6-11.			FILL: fine to medium grained; tan; moist; few silt; poorly graded sand. FILL: grayish brown; moist; stiff; trace gravel and ash; lean clay.	Stick-up Protective Cover	
	6-13-18-16.	**PID:**0.0 **D/O/S:**None/ None/ None		From 2.5-3 ft, dark gray fine to medium grained sand and coal cinders.		595
5	10-11-12-12.	**PID:**0.4 **PID:**0.1		From 4.7-5 ft, dark gray fine to medium grained sand and coal cinders. FILL: fine to medium grained; orange; moist; few silt; poorly graded sand.		
	12-23-17-12.	**PID:**0.0 **D/O/S:**None/ None/ None		From 6-7 ft, coal cinders present; dark gray. FILL: grayish brown; moist; stiff; trace gravel and ash; lean clay.		590
	8-6-7-7.			From 8-8.5 ft, dark gray fine to medium sand and coal cinders.		
10	2-6-8-9.	**PID:**0.1		FILL: gray; moist; wax-like texture, few gravel, trace orange mottling, trace sand; lean clay.		
	5-8-6-12.	**PID:**0.0 **PID:**0.6 **D/O/S:**None/ None/ None		From 12-14.3 ft, alternating 6-in layers of grayish brown lean clay with trace gravel and sand and orange fine to medium grained sand with trace coal cinders and silt. Lean clay gets sandier and less stiff with depth.		585
15	3-5-9-8.			POORLY GRADED SAND (SP/SM): fine to medium grained; tan; moist to wet; few to little silt.		
	5-5-5-7.	**PID:**0.4 **D/O/S:**None/ None/ None	SP/SM			580
▼	6-4-4-6.			From 19-19.5 ft, trace shells and gravel. POORLY GRADED SAND (SP/SM): fine to medium grained; gray; wet; few silt and shells, trace gravel.		▼
20	3-4-7-8.	**PID:**0.7				
	4-3-6-9.	**PID:**0.7 **D/O/S:**None/ None/ None			Bentonite Grout 1-43 ft	575
25	1-2-4-6.	**PID:**0.7	SP/SM			
	WH-WH-3-2.	**PID:**0.8 **D/O/S:**None/ None/ None		At 27.5 ft, increased gravel.		570
	8-12-19-21.	**PID:**0.4		At 29 ft, light gray.		
30						

Date Boring Started:	6/29/21
Date Boring Completed:	6/29/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Access road (gravel) at surface. Shelby tube collected from 36 to 38 feet below ground surface.
WH - Weight of Hammer

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
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LOG OF BORING TW-21-012D

SHEET 2 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	597.0 ft	Top of Casing Elev.:	600.3 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger		
Location:	Essexville, MI	Sampling Method:	Split Spoon		
Coordinates:	N 784,862.4 ft E 13,262,027.7 ft				
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Completion Depth:	51.0 ft		

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
30			10-16-32-32. 9-12-16-14.	**PID:**0.8 **D/O/S:**None/ None/ None	SP/SM		POORLY GRADED SAND (SP/SM): fine to medium grained; gray; wet; few silt and shells, trace gravel. *(continued)*		565
				PID:3.0	SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray; wet; few shells.		
35			2-1-1-1.		CL		LEAN CLAY (CL): gray; moist; soft; few sand and silt, trace shell fragments.		
					CL		ORGANIC LEAN CLAY (CL): dark brown; moist; trace wood fragments.		560
			1-2-2-3.	**PID:**0.5 **D/O/S:**None/ None/ None	SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; grayish brown; moist.		
					CL		ORGANIC LEAN CLAY (CL): dark brown; moist.		
40			1-1-3-2.	**PID:**0.3 **PID:**0.4 **D/O/S:**None/ None/ None	SC		CLAYEY SAND (SC): brown/grayish brown; moist to wet; soft; trace shells.		555
			1-1-2-4.	**PID:**0.4	SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray; moist to wet; few clay.	Bentonite Chip 43-44 ft	
45			2-2-4-8. 5-13-22-25. 5-10-12-22.	**PID:**0.5 **D/O/S:**None/ None/ None **PID:**0.4	SP		POORLY GRADED SAND (SP): fine to medium grained; gray; wet; few silt.	Filter Pack Sand 44-51 ft 2-inch dia. PVC 10-Slot Screen 46-51 ft	550
50							End of boring 51.0 feet		545
55									540
60									

Date Boring Started:	6/29/21
Date Boring Completed:	6/29/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Access road (gravel) at surface. Shelby tube collected from 36 to 38 feet below ground surface.
WH - Weight of Hammer

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

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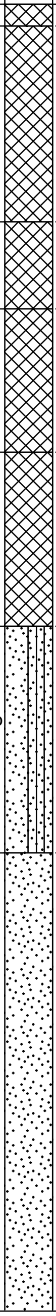
LOG OF BORING TW-21-012I

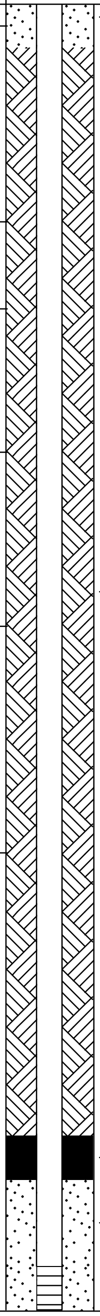
SHEET 1 OF 2

Project: Consumers D.E. Karn Corrective Action
Project No.: 22/09-1015
Location: Essexville, MI
Coordinates: N 784,864.4 ft E 13,262,024.6 ft
Datum: XY: NAD83 MI StPln South Int Ft; Z: NAVD88

Surface Elevation: 597.1 ft
Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon
Completion Depth: 34.0 ft

Top of Casing Elev.: 600.4 ft





Depth, feet	Sample Type & Recovery	Sample No.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
0						FILL: fine to medium grained; tan; moist; few silt; poorly graded sand.	Stick-up Protective Cover	
						FILL: grayish brown; moist; stiff; trace gravel and ash; lean clay.		
			PID:0.0 **D/O/S:**None/ None/ None					595
						From 2.5-3 ft, dark gray fine to medium grained sand and coal cinders. From 4.7-5 ft, dark gray fine to medium grained sand and coal cinders.		
			PID:0.4					
5			**PID:**0.1			FILL: fine to medium grained; orange; moist; few silt; poorly graded sand.		
			PID:0.0 **D/O/S:**None/ None/ None			From 6-7 ft, coal cinders present; dark gray.		
						FILL: grayish brown; moist; stiff; trace gravel and ash; lean clay.		590
						From 8-8.5 ft, dark gray fine to medium sand and coal cinders.		
10			**PID:**0.1			FILL: gray; moist; wax-like texture, few gravel, trace orange mottling, trace sand; lean clay.		
			PID:0.0			From 12-14.3 ft, alternating 6-in layers of grayish brown lean clay with trace gravel and sand and orange fine to medium grained sand with trace coal cinders and silt.		585
			PID:0.6 **D/O/S:**None/ None/ None			Lean clay gets sandier and less stiff with depth.	Bentonite Grout 1-26 ft	
						POORLY GRADED SAND (SP to SP-SM): fine to medium grained; tan; moist to wet; few to little silt.		
15								
			PID:0.4 **D/O/S:**None/ None/ None	SP to SP-SM				580
						From 19-19.5 ft, trace shells and gravel.		
						POORLY GRADED SAND (SP): fine to medium grained; gray; wet; few silt and shells, trace gravel.		
20			**PID:**0.7					
			PID:0.7 **D/O/S:**None/ None/ None					575
			PID:0.7	SP				
25								
			PID:0.8 **D/O/S:**None/ None/ None				Bentonite Chip 26-27 ft	
								570
			PID:0.4			At 27.5 ft, increased gravel.	Filter Pack Sand 27-34 ft	
						At 29 ft, light gray.		
30								

Date Boring Started: 6/29/21
Date Boring Completed: 6/29/21
Logged By: A. Schumacher
Drilling Contractor: Pearson
Drill Rig: CME750X

Remarks: Blind drilled to 34 feet below ground surface.
Lithology details taken from TW-21-012D.

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

LOG OF BORING TW-21-012I

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	597.1 ft	Top of Casing Elev.: 600.4 ft	
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger		
Location:	Essexville, MI	Sampling Method:	Split Spoon		
Coordinates:	N 784,864.4 ft E 13,262,024.6 ft				
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Completion Depth:	34.0 ft		

Depth, feet	Sample Type & Recovery	Sample No.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
30				SP		POORLY GRADED SAND (SP): fine to medium grained; gray; wet; few silt and shells, trace gravel. *(continued)*	−2-inch dia. PVC 10-Slot Screen 29-34 ft	
			PID:0.8 **D/O/S:**None/ None/ None					565
				SP-SM		POORLY GRADED SAND WITH SILT (SP-SM): fine to medium grained; gray; wet; few shells. End of boring 34.0 feet		
35								
								560
40								
								555
45								
								550
50								
								545
55								
								540
60								

Date Boring Started:	6/29/21
Date Boring Completed:	6/29/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Blind drilled to 34 feet below ground surface.
Lithology details taken from TW-21-012D.

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

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LOG OF BORING TW-21-012S

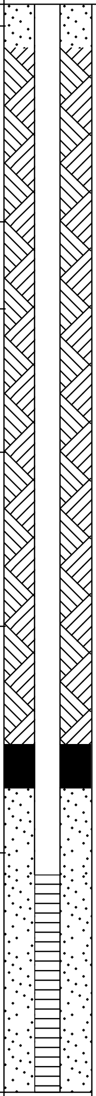
SHEET 1 OF 1

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	597.1 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger
Location:	Essexville, MI	Sampling Method:	Split Spoon
Coordinates:	N 784,867.0 ft E 13,262,020.9 ft	Completion Depth:	25.0 ft
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88	Top of Casing Elev.:	600.2 ft

Depth, feet	ENVIRONMENTAL DATA
2.5	**PID:**0.0 **D/O/S:**None/ None/ None
4.5	**PID:**0.4
5	**PID:**0.1
6	**PID:**0.0 **D/O/S:**None/ None/ None
10	**PID:**0.1
12	**PID:**0.0
14	**PID:**0.6 **D/O/S:**None/ None/ None
16.5	**PID:**0.4 **D/O/S:**None/ None/ None
20.5	**PID:**0.7
22.5	**PID:**0.7 **D/O/S:**None/ None/ None

Depth, feet	USCS	LITHOLOGIC DESCRIPTION
0–0.5		FILL: fine to medium grained; tan; moist; few silt; poorly graded sand.
0.5–5		FILL: grayish brown; moist; stiff; trace gravel and ash; lean clay. From 2.5-3 ft, dark gray fine to medium grained sand and coal cinders. From 4.7-5 ft, dark gray fine to medium grained sand and coal cinders.
5–7		FILL: fine to medium grained; orange; moist; few silt; poorly graded sand. From 6-7 ft, coal cinders present; dark gray.
7–10.3		FILL: grayish brown; moist; stiff; trace gravel and ash; lean clay. From 8-8.5 ft, dark gray fine to medium sand and coal cinders.
10.3–14.3		FILL: gray; moist; wax-like texture, few gravel, trace orange mottling, trace sand; lean clay. From 12-14.3 ft, alternating 6-in layers of grayish brown lean clay with trace gravel and sand and orange fine to medium grained sand with trace coal cinders and silt. Lean clay gets sandier and less stiff with depth.
14.3–19.5	SP to SP-SM	POORLY GRADED SAND (SP to SP-SM): fine to medium grained; tan; moist to wet; few to with silt. From 19-19.5 ft, trace shells and gravel.
19.5–25	SP	POORLY GRADED SAND (SP): fine to medium grained; gray; wet; few silt and shells, trace gravel.
25		End of boring 25.0 feet

WELL OR PIEZOMETER CONSTRUCTION DETAIL



- Stick-up Protective Cover
- Bentonite Grout 1-17 ft
- Bentonite Chip 17-18 ft
- Filter Pack Sand 18-25 ft
- 2-inch dia. PVC 10-Slot Screen 20-25 ft

Depth, feet	Elevation, feet
0	
5	
10	
15	
20	
25	
30	
	595
	590
	585
	580
	575
	570

Date Boring Started:	6/29/21
Date Boring Completed:	6/29/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Blind drilled to 25 feet below ground surface.
Lithology details taken from TW-21-012D.

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

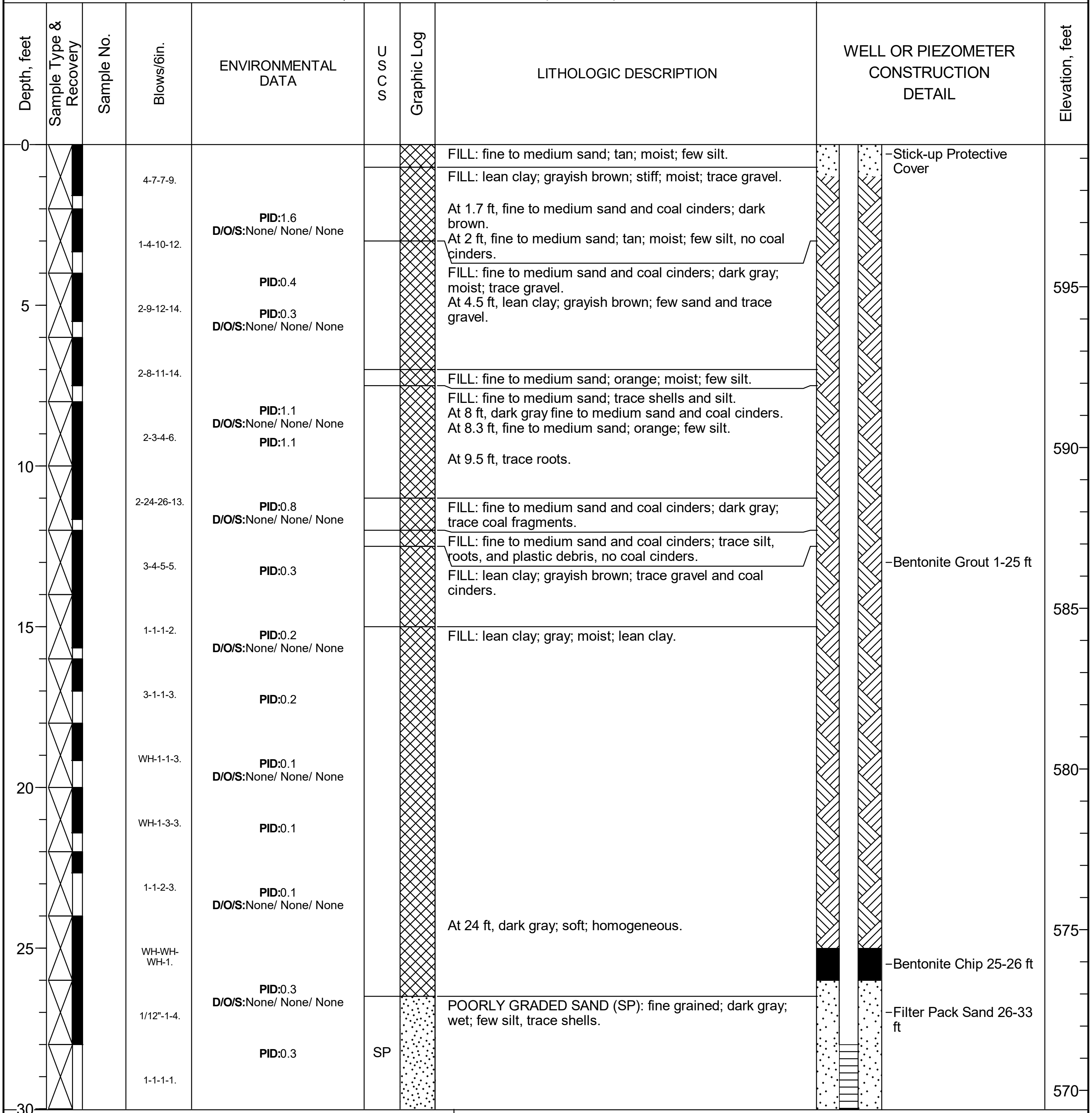
Barr Engineering Company
3005 Boardwalk St, Suite 100
Ann Arbor, MI 48108
Telephone: 734-922-4400

LOG OF BORING TW-21-013

SHEET 1 OF 2

Project: Consumers D.E. Karn Corrective Action
Project No.: 22/09-1015
Location: Essexville, MI
Coordinates: N 785,020.9 ft E 13,261,697.9 ft
Datum: XY: NAD83 MI StPln South Int Ft; Z: NAVD88

Surface Elevation: 599.4 ft
Top of Casing Elev.: 602.6 ft
Drilling Method: Hollow Stem Auger
Sampling Method: Split Spoon
Completion Depth: 34.0 ft



Blows/6in.:
4-7-7-9.
1-4-10-12.
2-9-12-14.
2-8-11-14.
2-3-4-6.
2-24-26-13.
3-4-5-5.
1-1-1-2.
3-1-1-3.
WH-1-1-3.
WH-1-3-3.
1-1-2-3.
WH-WH-WH-1.
1/12"-1-4.
1-1-1-1.

ENVIRONMENTAL DATA:
PID:1.6
D/O/S: None/ None/ None
PID:0.4
PID:0.3
D/O/S: None/ None/ None
PID:1.1
D/O/S: None/ None/ None
PID:1.1
PID:0.8
D/O/S: None/ None/ None
PID:0.3
PID:0.2
D/O/S: None/ None/ None
PID:0.2
PID:0.1
D/O/S: None/ None/ None
PID:0.1
PID:0.1
D/O/S: None/ None/ None
PID:0.3
D/O/S: None/ None/ None
PID:0.3

LITHOLOGIC DESCRIPTION:

FILL: fine to medium sand; tan; moist; few silt.

FILL: lean clay; grayish brown; stiff; moist; trace gravel.

At 1.7 ft, fine to medium sand and coal cinders; dark brown.
At 2 ft, fine to medium sand; tan; moist; few silt, no coal cinders.

FILL: fine to medium sand and coal cinders; dark gray; moist; trace gravel.
At 4.5 ft, lean clay; grayish brown; few sand and trace gravel.

FILL: fine to medium sand; orange; moist; few silt.

FILL: fine to medium sand; trace shells and silt.
At 8 ft, dark gray fine to medium sand and coal cinders.
At 8.3 ft, fine to medium sand; orange; few silt.

At 9.5 ft, trace roots.

FILL: fine to medium sand and coal cinders; dark gray; trace coal fragments.

FILL: fine to medium sand and coal cinders; trace silt, roots, and plastic debris, no coal cinders.

FILL: lean clay; grayish brown; trace gravel and coal cinders.

FILL: lean clay; gray; moist; lean clay.

At 24 ft, dark gray; soft; homogeneous.

POORLY GRADED SAND (SP): fine grained; dark gray; wet; few silt, trace shells.

Date Boring Started: 6/30/21
Date Boring Completed: 6/30/21
Logged By: A. Schumacher
Drilling Contractor: Pearson
Drill Rig: CME750X

Remarks: Access road (gravel) at surface.
WH - Weight of Hammer

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

Barr Engineering Company
3005 Boardwalk St, Suite 100
Ann Arbor, MI 48108
Telephone: 734-922-4400

LOG OF BORING TW-21-013

SHEET 2 OF 2

Project:	Consumers D.E. Karn Corrective Action	Surface Elevation:	599.4 ft
Project No.:	22/09-1015	Drilling Method:	Hollow Stem Auger
Location:	Essexville, MI	Sampling Method:	Split Spoon
Coordinates:	N 785,020.9 ft E 13,261,697.9 ft	Completion Depth:	34.0 ft
Datum:	XY: NAD83 MI StPln South Int Ft; Z: NAVD88		

Top of Casing Elev.: 602.6 ft

Depth, feet	Sample Type & Recovery	Sample No.	Blows/6in.	ENVIRONMENTAL DATA	USCS	Graphic Log	LITHOLOGIC DESCRIPTION	WELL OR PIEZOMETER CONSTRUCTION DETAIL	Elevation, feet
30			1-1-1-1.	**PID:**0.4 **D/O/S:**None/ None/ None	SP		POORLY GRADED SAND (SP): fine grained; dark gray; wet; few silt, trace shells. *(continued)*	2-inch dia. PVC 10-Slot Screen 28-33 ft	
			4-4-6-12.	**PID:**0.4 **D/O/S:**None/ None/ None				Natural Collapse 33-34 ft	
				PID:0.3			End of boring 34.0 feet		
35									565
40									560
45									555
50									550
55									545
60									540

Date Boring Started:	6/30/21
Date Boring Completed:	6/30/21
Logged By:	A. Schumacher
Drilling Contractor:	Pearson
Drill Rig:	CME750X

Remarks: Access road (gravel) at surface.
WH - Weight of Hammer

PID = Headspace; D/O/S = Discoloration/Odor/Sheen; FID/MC = FID/Methane Corrected; G/S/F = Gravel/Sand/Fines
Additional data may have been collected in the field which is not included on this log.

Appendix A-1b

Well Development Logs

Barr Engineering Company
WELL DEVELOPMENT LOG

Client: Consumers
Well Number: TW-21-009
Location: DE Karn
Date(s): 7/1/21
Project #: 22091016
Developer: Pearson/AMS3

GENERAL DATA

Casing diameter ("):	2 inch
Well Depth – Before Development:*	27.89
Well Depth – After Development:*	27.90
Type of Development	Surge
Type of Pump:	Submersible
Pumping Rate:	~2gal/min
Total Volume Removed:	~40gal
Well Volume:	—
Purge time:	1740-1800
SWL:	20.13'

WELL CONSTRUCTION

Top Sealed?	Yes(Lock)
Bolts Straight?	N/A
Concrete Pad?	Yes
Odor:	none noticed
Purge Appearance:	Clear

DEVELOPMENT LOG

Date/Time	Temp. °C	Cond. @ 25 µS/cm	pH, standard units	Turbidity, NTU	Appearance/ Comments (i.e. sediment/color/ Cloudiness)
* surged well 3 times &					
allowed to clear to <20NTU					

Notes/Observations:

*** The following sections to be filled out by geologist overseeing well installation ***

WELL INSTALLATION NOTES

Geologist Initials: AMS3
Screen Length (ft): 5
Screen Interval: bgs 20-25'
Volume Flushed from Borehole (gal): 40 gal

pH PROFILING NOTES *(FOR SCREENED INTERVAL)*

Initial Color:
pH Range:
Able to pump continuously? (Y/N):
Pumping Rate during pH profiling (gpm):

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

W:\Branch Office\Ann Arbor\AR\Field Forms\Well Development Log_Blank.doc

BARR

Barr Engineering Company
WELL DEVELOPMENT LOG

Client: Consumers	**Well Number:** TW-21-010
Location: DE Karn	**Date(s):** 7/1/21
Project #: 22091016	**Developer:** Pearson/AMS3

GENERAL DATA

Casing diameter ("):	2 inch
Well Depth – Before Development:*	27.88
Well Depth – After Development:*	28.02
Type of Development	Surge
Type of Pump:	Submersible
Pumping Rate:	~2 gal/min
Total Volume Removed:	~70 gal
Well Volume:	–
Purge time:	1620-1655
SWL:	19.90

DEVELOPMENT LOG

Date/Time	Temp. °C	Cond. @ 25 µS/cm	pH, standard units	Turbidity, NTU	Appearance/ Comments (i.e. sediment/color/ Cloudiness)
	* Surged well	3	times &	allowed	
to	clear	to	<20	NTU	

WELL CONSTRUCTION

Top Sealed?	Yes (Lock)
Bolts Straight?	N/A
Concrete Pad?	Yes
Odor:	none noticed
Purge Appearance:	Clear

Notes/Observations:

*** The following sections to be filled out by geologist overseeing well installation ***

WELL INSTALLATION NOTES

Geologist Initials: AMS3

Screen Length (ft): 5'

Screen Interval: bgs 20-25'

Volume Flushed from Borehole (gal): 70 gal

pH PROFILING NOTES (*FOR SCREENED INTERVAL*)

Initial Color:

pH Range:

Able to pump continuously? (Y/N):

Pumping Rate during pH profiling (gpm):

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

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BARR

Barr Engineering Company
WELL DEVELOPMENT LOG

Client: Consumers	**Well Number:** TW-21-01 S/I/D
Location: DE Karn	**Date(s):** 7/1/21
Project #: 22091016	**Developer:** Pearson/AMS3

GENERAL DATA		**DEVELOPMENT LOG**					
Casing diameter ("):	2 inch	Date/Time	Temp. °C	Cond. @ 25 µS/cm	pH, standard units	Turbidity, NTU	Appearance/ Comments (i.e. sediment/color/ Cloudiness)
Well Depth – Before Development:*	D=NM I 35.30 S=27.57						
Well Depth – After Development:*	D=52.37 I=35.35 S=27.58						
Type of Development	Surge	*All wells surged 3 times & allowed					
Type of Pump:	Submersible	to clear to < 20NTU					
Pumping Rate:	~2gal/min						
Total Volume Removed:	varied.						
Well Volume:	varied.						
Purge time:	D=0820-0850 I=0855-0920 S=0925-0945						
SWL:	D=20.37' I=20.39' S=20.60'						
WELL CONSTRUCTION							
Top Sealed?	Yes (Lock)						
Bolts Straight?	N/A						

Concrete Pad?	Yes	**Notes/Observations:**
Odor:	none noticed at S/I/D	
Purge Appearance:	clear	

*** The following sections to be filled out by geologist overseeing well installation ***

WELL INSTALLATION NOTES		**pH PROFILING NOTES (*FOR SCREENED INTERVAL*)**	
Geologist Initials: AMS3		Initial Color:	pH Range:
Screen Length (ft): 5	Screen Interval: bgs D=44-49 I=27-32' S=20-25'	Able to pump continuously? (Y/N):	
Volume Flushed from Borehole (gal): Varied		Pumping Rate during pH profiling (gpm):	

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

W:\Branch Office\Ann Arbor\AR\Field Forms\Well Development Log_Blank.doc

Barr Engineering Company
WELL DEVELOPMENT LOG

Client: Consumers	**Well Number:** TW-21-012S/I/D
Location: DE Karn	**Date(s):** 7/1/21
Project #: 22091016	**Developer:** Pearson

GENERAL DATA

Casing diameter ("):	2 inch
bTOC Well Depth – Before Development:*	D=54.63 I=36.70 S=27.85
Well Depth – After Development:*	D=54.80 I=36.71 S=27.86
Type of Development	Surge
Type of Pump:	Submersible
Pumping Rate:	~2 gal/min
Total Volume Removed:	varied.
Well Volume:	varied.
Purge time:	D=1000–1035 I=1040–1115 S=1120–1210
SWL: bTOC	D=18.91 I=19.39 S=19.23

DEVELOPMENT LOG

Date/Time	Temp. °C	Cond. @ 25 µS/cm	pH, standard units	Turbidity, NTU	Appearance/ Comments (i.e. sediment/color/ Cloudiness)

*All wells surged 3 times & allowed to clear to <20NTU

WELL CONSTRUCTION

Top Sealed?	Yes (Lock)
Bolts Straight?	N/A
Concrete Pad?	Yes
Odor:	none noticed
Purge Appearance:	Clear

Notes/Observations:

*** The following sections to be filled out by geologist overseeing well installation ***

WELL INSTALLATION NOTES

Geologist Initials: AMS3	
Screen Length (ft): 5'	Screen Interval: bgs D=46-51 I=29-34 S=20-25
Volume Flushed from Borehole (gal): Varied	

pH PROFILING NOTES (*FOR SCREENED INTERVAL*)

Initial Color:	pH Range:
Able to pump continuously? (Y/N):	
Pumping Rate during pH profiling (gpm):	

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

Barr Engineering Company
WELL DEVELOPMENT LOG

Client:	Consumers	**Well Number:**	TW-21-013
Location:	DE Karn	**Date(s):**	7/1/21
Project #:	22097016	**Developer:**	Pearson/AMS3

GENERAL DATA

Casing diameter ("):	2 inch
Well Depth – Before Development:*	36.48
Well Depth – After Development:*	36.52
Type of Development	Surge
Type of Pump:	Submersible
Pumping Rate:	~2gal/min
Total Volume Removed:	~90gal
Well Volume:	—
Purge time:	1215–1300
SWL:	21.40

DEVELOPMENT LOG

Date/Time	Temp. °C	Cond. @ 25 µS/cm	pH, standard units	Turbidity, NTU	Appearance/ Comments (i.e. sediment/color/ Cloudiness)

*Surged 3 times & allowed to Clear to <20NTU

WELL CONSTRUCTION

Top Sealed?	Yes (Lock)
Bolts Straight?	N/A
Concrete Pad?	Yes
Odor:	none noticed
Purge Appearance:	Clear

Notes/Observations:

*** The following sections to be filled out by geologist overseeing well installation ***

WELL INSTALLATION NOTES

Geologist Initials: AMS3

Screen Length (ft): 5

Screen Interval: bgs 28-33

Volume Flushed from Borehole (gal): 90gal

pH PROFILING NOTES (*FOR SCREENED INTERVAL*)

Initial Color:

pH Range:

Able to pump continuously? (Y/N):

Pumping Rate during pH profiling (gpm):

*Measurements are referenced from top of riser pipe, unless otherwise indicated.

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Appendix A-2

Soil Analytical Data

Appendix A-2
Soil Analytical Data
D.E. Karn Generating Facility
Consumers Energy

Location		TW-21-009	TW-21-010	TW-21-011D	TW-21-012D	TW-21-012D	TW-21-013
Date		6/30/2021	6/30/2021	6/28/2021	6/29/2021	6/29/2021	6/30/2021
Depth		22 - 24 ft	20 - 22 ft	22 - 23 ft	22 - 24 ft	32 - 34 ft	30 - 32 ft
Sample Type		N	N	N	N	N	N
Parameter	Units						
General Parameters							
Carbon, total organic	% wt	**0.16**	**0.13**	**0.18**	**0.35**	**0.072**	**0.062**
Carbon, total organic	mg/kg	**1600**	**1300**	**1800**	**3500**	**720**	**620**
Moisture	%	**21**	**18**	**20**	**21**	**16**	**19**
Solids, percent	%	**79**	**81**	**81**	**77**	**82**	**82**
Sulfur, as S	mg/kg	**300**	**300**	**300**	**300**	**200**	< 300 U
Metals							
Arsenic	mg/kg	**6.26**	**11.1**	**12.2**	**9.88**	**2.10**	**2.77**
Iron	mg/kg	**3510**	**4020**	**3660**	**4990**	**2010**	**2520**

Footnotes

N Sample Type: Normal

U The analyte was analyzed for, but was not detected.

Appendix A-3

Soils Lab Report

Consumers Energy
Count on Us®
Laboratory Services
A CENTURY OF EXCELLENCE

135 W. Trail St.
Jackson, MI 49201

phone 517-788-1251
fax 517-788-2533

To: HDRegister, P22-521

From: EBlaj, T-258

Date: July 27, 2021

Subject: DE KARN PRB – SOILS – 2021 Q3

CC: CDBatts, Karn/Weadock

Mike Ellis, PE
Barr Engineering Co.
3005 Boardwalk Drive, Suite 100
Ann Arbor, MI 48108

Chemistry Project: 21-0821

Barr Engineering conducted soil sampling at the DE Karn solid waste disposal area on 06/28/2021 through 6/30/2021. The samples were received for analysis by the Chemistry department of Laboratory Services on 07/02/2021.

Samples for Total Organic Carbon and Total Sulfur (by Combustion) have been subcontracted to ALS Environmental and the results are listed under the analyst initials "ALS". Please note that the subcontracted work is not reported under the CE laboratory scope of accreditation.

The report that follows presents the results of the requested analytical testing; the results apply only to the samples as received. All samples have been analyzed in accordance with the 2016 TNI Standard and the applicable A2LA accreditation scope for Laboratory Services. Any exceptions to applicable test method criteria and standard compliance are noted in the Case Narrative, or flagged with applicable qualifiers in the analytical results section.

Reviewed and approved by:

Emil Blaj
Sr. Technical Analyst
Project Lead

ilac-MRA
ACCREDITED
Certificate #1097.04

Testing performed in accordance with the A2LA scope of accredidation specified in the listed certificate.
The information contained in this report is the sole property of Consumers Energy. It cannot be reproduced except in full, and with consent from Consumers Energy, or the customer for which this report was issued.

CASE NARRATIVE

I. Sample Receipt

All samples were received within hold time and in good conditions; no anomalies were noted on the Sample Log-In Shipment Inspection Form during sample check-in. Identification of all samples included in the work order/project is provided in the sample summary section. Sample preservation and temperature upon receipt was verified by the sample custodian and confirmed to meet method requirements.

II. Methodology

Unless otherwise indicated, sample preparation and analysis was performed in accordance with the corresponding test methods from "Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100); SW-846, "Test Methods for Evaluating Solid Waste – Physical/Chemical Methods", USEPA (latest revisions), and Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 22nd Edition, 2012.

III. Results/Quality Control

Analytical results for this report are presented by laboratory sample ID, container, & aliquot number. When submitted for analysis, results for the field blanks, field duplicates, and/or recoveries of the field matrix spike & matrix spike duplicate samples are included in the results section; all other quality control data are listed in the Quality Control Summary associated with the particular test method, as appropriate. Unless specifically noted in the case narrative, all method quality control requirements have been met. If any results are qualified, the corresponding data flags/qualifiers are listed on the last page of the results section. Any additional information on method performance, when applicable, is presented in this section of the case narrative. When data flags are not needed, the qualifiers text box on the last page is left blank, and a statement confirms that no exceptions occurred.

DEFINITIONS / QUALIFIERS

The following qualifiers and/or acronyms are used in the report, where applicable:

Acronym	Description
RL	Reporting Limit
ND	Result not detected or below Reporting Limit
NT	Non TNI analyte
LCS	Laboratory Control Sample
LRB	Laboratory Reagent Blank (also referred to as Method Blank)
DUP	Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
RPD	Relative Percent Difference
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
TDL	Target Detection Limit
SM	Standard Methods Compendium

Qualifier	Description
*	Generic data flag, applicable description added in the corresponding notes section
B	The analyte was detected in the LRB at a level which is significant relative to sample result
D	Reporting limit elevated due to dilution
E	Estimated due to result exceeding the linear range of the analyzer
H	The maximum recommended hold time was exceeded
I	Dilution required due to matrix interference; reporting limit elevated
J	Estimated due to result found above MDL but below PQL (or RL)
K	Reporting limit raised due to matrix interference
M	The precision for duplicate analysis was not met; RPD outside acceptance criteria
N	Non-homogeneous sample made analysis questionable
PI	Possible interference may have affected the accuracy of the laboratory result
Q	Matrix Spike or Matrix Spike Duplicate recovery outside acceptance criteria
R	Result confirmed by new sample preparation and reanalysis
X	Other notation required; comment listed in sample notes and/or case narrative

Work Order Sample Summary

Customer Name: Karn/Weadock Complex
Work Order ID: Karn Soil Samples from BARR
Date Received: 7/2/2021
Chemistry Project: 21-0821

Sample #	Field Sample ID	Matrix	Sample Date	Site
21-0821-01	TW-21-011D (17-18')	Soil	06/28/2021 01:00 PM	DEK Solid Waste Disposal Area
21-0821-02	TW-21-011D (22-23')	Soil	06/28/2021 01:05 PM	DEK Solid Waste Disposal Area
21-0821-03	TW-21-012D (22-24')	Soil	06/29/2021 12:00 PM	DEK Solid Waste Disposal Area
21-0821-04	TW-21-012D (32-34')	Soil	06/29/2021 12:05 PM	DEK Solid Waste Disposal Area
21-0821-05	TW-21-013 (30-32')	Soil	06/30/2021 10:30 AM	DEK Solid Waste Disposal Area
21-0821-06	TW-21-009 (22-24')	Soil	06/30/2021 01:50 PM	DEK Solid Waste Disposal Area
21-0821-07	TW-21-010 (20-22')	Soil	06/30/2021 04:30 PM	DEK Solid Waste Disposal Area

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-011D (22-23')**
Lab Sample ID: 21-0821-02
Matrix: Soil

Laboratory Project: **21-0821**
Collect Date: 06/28/2021
Collect Time: 01:05 PM

Metadata

Metals by EPA 6020B: As, Fe, Soils/Solids

Aliquot #: 21-0821-02-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Arsenic	12.2		mg/kg	0.2	07/15/2021	AB21-0715-05
Iron	3660		mg/kg	5.0	07/15/2021	AB21-0715-05

Dry Weight by ASTM D2216

Aliquot #: 21-0821-02-C01-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Percent Solids	81		%	1.0	07/16/2021	AB21-0715-10

Total Organic Carbon by Walkley Black, Soil Method

Aliquot #: 21-0821-02-C01-A03 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Total Organic Carbon	1800		mg/kg	300	07/23/2021	AB21-0723-11

Total Sulfur by ASTM E1915

Aliquot #: 21-0821-02-C01-A04 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Sulfur	300		mg/kg	300	07/26/2021	AB21-0727-15

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0821**
Field Sample ID:	**TW-21-012D (22-24')**	Collect Date:	06/29/2021
Lab Sample ID:	21-0821-03	Collect Time:	12:00 PM
Matrix:	Soil		

Metals by EPA 6020B: As, Fe, Soils/Solids

Aliquot #: 21-0821-03-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Arsenic	9.88		mg/kg	0.2	07/15/2021	AB21-0715-05
Iron	4990		mg/kg	5.0	07/15/2021	AB21-0715-05

Dry Weight by ASTM D2216

Aliquot #: 21-0821-03-C01-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Percent Solids	77		%	1.0	07/16/2021	AB21-0715-10

Total Organic Carbon by Walkley Black, Soil Method

Aliquot #: 21-0821-03-C01-A03 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Total Organic Carbon	3500		mg/kg	300	07/23/2021	AB21-0723-11

Total Sulfur by ASTM E1915

Aliquot #: 21-0821-03-C01-A04 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Sulfur	300		mg/kg	300	07/26/2021	AB21-0727-15

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0821**
Field Sample ID:	**TW-21-012D (32-34')**	Collect Date:	06/29/2021
Lab Sample ID:	21-0821-04	Collect Time:	12:05 PM
Matrix:	Soil		

Metals by EPA 6020B: As, Fe, Soils/Solids

Aliquot #: 21-0821-04-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Arsenic	2.10		mg/kg	0.2	07/15/2021	AB21-0715-05
Iron	2010		mg/kg	5.0	07/15/2021	AB21-0715-05

Dry Weight by ASTM D2216

Aliquot #: 21-0821-04-C01-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Percent Solids	82		%	1.0	07/16/2021	AB21-0715-10

Total Organic Carbon by Walkley Black, Soil Method

Aliquot #: 21-0821-04-C01-A03 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Total Organic Carbon	720		mg/kg	300	07/23/2021	AB21-0723-11

Total Sulfur by ASTM E1915

Aliquot #: 21-0821-04-C01-A04 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Sulfur	200		mg/kg	200	07/26/2021	AB21-0727-15

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0821**
Field Sample ID:	**TW-21-013 (30-32')**	Collect Date:	06/30/2021
Lab Sample ID:	21-0821-05	Collect Time:	10:30 AM
Matrix:	Soil		

Metals by EPA 6020B: As, Fe, Soils/Solids

Aliquot #: 21-0821-05-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Arsenic	2.77		mg/kg	0.2	07/15/2021	AB21-0715-05
Iron	2520		mg/kg	5.0	07/15/2021	AB21-0715-05

Dry Weight by ASTM D2216

Aliquot #: 21-0821-05-C01-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Percent Solids	82		%	1.0	07/16/2021	AB21-0715-10

Total Organic Carbon by Walkley Black, Soil Method

Aliquot #: 21-0821-05-C01-A03 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Total Organic Carbon	620		mg/kg	300	07/23/2021	AB21-0723-11

Total Sulfur by ASTM E1915

Aliquot #: 21-0821-05-C01-A04 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Sulfur	ND		mg/kg	300	07/26/2021	AB21-0727-15

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0821**
Field Sample ID:	**TW-21-009 (22-24')**	Collect Date:	06/30/2021
Lab Sample ID:	21-0821-06	Collect Time:	01:50 PM
Matrix:	Soil		

Metals by EPA 6020B: As, Fe, Soils/Solids

Aliquot #: 21-0821-06-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Arsenic	6.26		mg/kg	0.2	07/15/2021	AB21-0715-05
Iron	3510		mg/kg	5.0	07/15/2021	AB21-0715-05

Dry Weight by ASTM D2216

Aliquot #: 21-0821-06-C01-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Percent Solids	79		%	1.0	07/16/2021	AB21-0715-10

Total Organic Carbon by Walkley Black, Soil Method

Aliquot #: 21-0821-06-C01-A03 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Total Organic Carbon	1600		mg/kg	300	07/23/2021	AB21-0723-11

Total Sulfur by ASTM E1915

Aliquot #: 21-0821-06-C01-A04 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Sulfur	300		mg/kg	300	07/26/2021	AB21-0727-15

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-010 (20-22')**
Lab Sample ID: 21-0821-07
Matrix: Soil

Laboratory Project: **21-0821**
Collect Date: 06/30/2021
Collect Time: 04:30 PM

Metals by EPA 6020B: As, Fe, Soils/Solids

Aliquot #: 21-0821-07-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Arsenic	11.1		mg/kg	0.2	07/15/2021	AB21-0715-05
Iron	4020		mg/kg	5.0	07/15/2021	AB21-0715-05

Dry Weight by ASTM D2216

Aliquot #: 21-0821-07-C01-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Percent Solids	81		%	1.0	07/16/2021	AB21-0715-10

Total Organic Carbon by Walkley Black, Soil Method

Aliquot #: 21-0821-07-C01-A03 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Total Organic Carbon	1300		mg/kg	300	07/23/2021	AB21-0723-11

Total Sulfur by ASTM E1915

Aliquot #: 21-0821-07-C01-A04 **Analyst: ALS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking
Sulfur	300		mg/kg	300	07/26/2021	AB21-0727-15

Analytical Report

Report Date: 07/27/21

Data Qualifiers	Exception Summary
	No exceptions occured.

CONSUMERS ENERGY

Chemistry Department

General Standard Operating Procedure

PROC CHEM-1.2.01
PAGE 1 OF 2
REVISION 3
ATTACHMENT A

TITLE: SAMPLE LOG-IN – SHIPMENT INSPECTION FORM

Project Log-In Number: 21-0821

Inspection Date: 07-02-2021 **Inspection By:** EB

Sample Origin/Project Name: ____

Shipment Delivered By: Enter the type of shipment carrier.

Pony ____ FedEx ____ UPS ____ USPS ____ Airborne ____

Other/[✓ Hand Carry] (whom) JAdams

Tracking Number: ____ Shipping Form Attached: Yes ____ No ____

Shipping Containers: Enter the type and number of shipping containers received.

Cooler ✓ Cardboard Box ____ Custom Case ____ Envelope/Mailer ____

Loose/Unpackaged Containers ____ Other ____

Condition of Shipment: Enter the as-received condition of the shipment container.

Damaged Shipment Observed: None ✓ Dented ____ Leaking ____

Other ____

Shipment Security: Enter if any of the shipping containers were opened before receipt.

Shipping Containers Received: Opened ____ Sealed ✓

Enclosed Documents: Enter the type of documents enclosed with the shipment.

CoC ✓ Work Request ____ Air Data Sheet ____ Other ____

Temperature of Containers: Measure the temperature of several sample containers.

As-Received Temperature Range 2.4°C Samples Received on Ice: Yes ✓ No ____

M&TE # and Expiration 015402 6/3/22

Number and Type of Containers: Enter the total number of sample containers received.

Container Type	Water	Soil	Other	Broken	Leaking
VOA (40mL or 60mL)					
Quart/Liter (g/p)					
[✓ 9-oz] (amber glass jar)		7			
2-oz (amber glass)					
125 mL (plastic)					
24 mL vial (glass)					
500 mL (plastic)					
Other ____					

page 2 of 2 not needed.

CHAIN OF CUSTODY

CONSUMERS ENERGY COMPANY – LABORATORY SERVICES

Consumers Energy

135 WEST TRAIL ST., JACKSON, MI 49201 · (517) 788-1251

SAMPLING SITE: DE Karn

PROJECT NUMBER: 22091016.01/400/100

PAGE 1 OF 1

SEND REPORT TO: MEllis@Barr.com

SAMPLING TEAM: Anne Schumacher (BARR)

DATE SHIPPED: CMS Courier 7/2/21

SITE SKETCH ATTACHED? CIRCLE ONE: YES [✓ NO]

PHONE:

ANALYSIS REQUESTED

CE CONTROL #	SAMPLE DATE	SAMPLE TIME	SAMPLE MATRIX	SAMPLE DESCRIPTION / LOCATION	DEPTH	# OF CONTAINERS	See Table							REMARKS
21-0821-01	06/28/2021	1300	SOIL	TW-21-011D (17-18')	17-18'	1	X							*HOLD FOR ANALYSIS*
-02	↓	1305		TW-21-011D (22-23')	22-23'									
-03	06/29/2021	1200		TW-21-012D (22-24')	22-24'									
-04	↓	1205		TW-21-012D (32-34')	32-34									
-05	06/30/2021	1030		TW-21-013 (30-32')	30-32									
-06		1350		TW-21-009 (22-24)	22-24									
-07	↓	1630	↓	TW-21-010 (20-22)	20-22	↓	↓							

RELINQUISHED BY: (SIGNATURE)
DATE / TIME 7/2/21 0930
RECEIVED BY: (SIGNATURE)

RELINQUISHED BY: (SIGNATURE)
DATE / TIME 7-2-21 15:30
RECEIVED BY: (SIGNATURE)

RELINQUISHED BY: (SIGNATURE)
DATE / TIME
RECEIVED BY: (SIGNATURE)

COMMENTS

2.4°c

* 015402

ORIGINAL TO LAB COPY TO CUSTOMER

14-Sep-2021

Emil Blaj
Consumers Energy Company
Laboratory Services
135 W Trail St
Jackson, MI 49201

Re: **210-0821** Work Order: **21070726**

Dear Emil,

ALS Environmental received 7 samples on 09-Jul-2021 10:50 AM for the analyses presented in the following report.

The analytical data provided relates directly to the samples received by ALS Environmental - Holland and for only the analyses requested.

Sample results are compliant with industry accepted practices and Quality Control results achieved laboratory specifications. Any exceptions are noted in the Case Narrative, or noted with qualifiers in the report or QC batch information. Should this laboratory report need to be reproduced, it should be reproduced in full unless written approval has been obtained from ALS Environmental. Samples will be disposed in 30 days unless storage arrangements are made.

The total number of pages in this report is 18.

If you have any questions regarding this report, please feel free to contact me:

ADDRESS: 3352 128th Avenue, Holland, MI, USA
PHONE: +1 (616) 399-6070 FAX: +1 (616) 399-6185

Sincerely,

Electronically approved by: Bill Carey

Bill Carey
Project Manager

ALS Group, USA

Date: 14-Sep-21

Client: Consumers Energy Company
Project: 210-0821
Work Order: **21070726**

Work Order Sample Summary

Lab Samp ID	Client Sample ID	Matrix	Tag Number	Collection Date	Date Received	Hold
21070726-02	TW-21-011D (22-23')	Soil		6/28/2021 13:05	7/9/2021 10:50	☐
21070726-03	TW-21-012D (22-24')	Soil		6/29/2021 12:00	7/9/2021 10:50	☐
21070726-04	TW-21-012D (32-34')	Soil		6/29/2021 12:05	7/9/2021 10:50	☐
21070726-05	TW-21-013 (30-32')	Soil		6/30/2021 10:30	7/9/2021 10:50	☐
21070726-06	TW-21-009 (22-24')	Soil		6/30/2021 13:50	7/9/2021 10:50	☐
21070726-07	TW-21-010 (20-22')	Soil		6/30/2021 16:30	7/9/2021 10:50	☐

Client: Consumers Energy Company
Project: 210-0821
WorkOrder: **21070726**

QUALIFIERS, ACRONYMS, UNITS

Qualifier	Description
*	Value exceeds Regulatory Limit
**	Estimated Value
a	Analyte is non-accredited
B	Analyte detected in the associated Method Blank above the Reporting Limit
E	Value above quantitation range
H	Analyzed outside of Holding Time
Hr	BOD/CBOD - Sample was reset outside Hold Time, value should be considered estimated.
J	Analyte is present at an estimated concentration between the MDL and Report Limit
ND	Not Detected at the Reporting Limit
O	Sample amount is > 4 times amount spiked
P	Dual Column results percent difference > 40%
R	RPD above laboratory control limit
S	Spike Recovery outside laboratory control limits
U	Analyzed but not detected above the MDL
X	Analyte was detected in the Method Blank between the MDL and Reporting Limit, sample results may exhibit background or reagent contamination at the observed level.

Acronym	Description
DUP	Method Duplicate
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection (see MDL)
LOQ	Limit of Quantitation (see PQL)
MBLK	Method Blank
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
PQL	Practical Quantitation Limit
RPD	Relative Percent Difference
TDL	Target Detection Limit
TNTC	Too Numerous To Count
A	APHA Standard Methods
D	ASTM
E	EPA
SW	SW-846 Update III

Units Reported	Description
% of sample	Percent of Sample
as noted	

ALS Group, USA

Date: *14-Sep-2021*

Client: Consumers Energy Company
Project: 210-0821
Work Order: 21070726
Sample ID: TW-21-011D (22-23')
Lab ID: 21070726-02
Collection Date: 6/28/2021 01:05 PM
Matrix: SOIL

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
MOISTURE			**SW3550C**			Analyst: **CDG**
Moisture	**20**		**0.10**	**% of sample**	1	7/12/2021 10:22 AM
ORGANIC CARBON - WALKLEY-BLACK			**WALKLEY-BLACK 1969**			Analyst: **KF**
Organic Carbon - W-B	**0.18**		**0.031**	**% by wt-dry**	1	7/23/2021 01:25 PM
SUBCONTRACTED ANALYSES			**SUBCONTRACT**			Analyst: **ALS**
Subcontracted Analyses	**See report**			**as noted**	1	7/27/2021

Note: See Qualifiers page for a list of qualifiers and their definitions.

Client: Consumers Energy Company
Project: 210-0821 **Work Order:** 21070726
Sample ID: TW-21-012D (22-24') **Lab ID:** 21070726-03
Collection Date: 6/29/2021 12:00 PM **Matrix:** SOIL

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
MOISTURE			**SW3550C**			Analyst: **CDG**
Moisture	**21**		**0.10**	**% of sample**	1	7/12/2021 10:22 AM
ORGANIC CARBON - WALKLEY-BLACK			**WALKLEY-BLACK 1969**			Analyst: **KF**
Organic Carbon - W-B	**0.35**		**0.032**	**% by wt-dry**	1	7/23/2021 01:25 PM
SUBCONTRACTED ANALYSES			**SUBCONTRACT**			Analyst: **ALS**
Subcontracted Analyses	**See report**			**as noted**	1	7/27/2021

Note: See Qualifiers page for a list of qualifiers and their definitions.

Client: Consumers Energy Company
Project: 210-0821 **Work Order:** 21070726
Sample ID: TW-21-012D (32-34') **Lab ID:** 21070726-04
Collection Date: 6/29/2021 12:05 PM **Matrix:** SOIL

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
MOISTURE			**SW3550C**			Analyst: **CDG**
Moisture	**16**		**0.10**	**% of sample**	1	7/12/2021 10:22 AM
ORGANIC CARBON - WALKLEY-BLACK			**WALKLEY-BLACK 1969**			Analyst: **KF**
Organic Carbon - W-B	**0.072**		**0.030**	**% by wt-dry**	1	7/23/2021 01:25 PM
SUBCONTRACTED ANALYSES			**SUBCONTRACT**			Analyst: **ALS**
Subcontracted Analyses	**See report**			**as noted**	1	7/27/2021

Note: See Qualifiers page for a list of qualifiers and their definitions.

Client: Consumers Energy Company
Project: 210-0821 **Work Order:** 21070726
Sample ID: TW-21-013 (30-32') **Lab ID:** 21070726-05
Collection Date: 6/30/2021 10:30 AM **Matrix:** SOIL

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
MOISTURE			**SW3550C**			Analyst: **CDG**
Moisture	**19**		**0.10**	**% of sample**	1	7/12/2021 10:22 AM
ORGANIC CARBON - WALKLEY-BLACK			**WALKLEY-BLACK 1969**			Analyst: **KF**
Organic Carbon - W-B	**0.062**		**0.031**	**% by wt-dry**	1	7/23/2021 01:25 PM
SUBCONTRACTED ANALYSES			**SUBCONTRACT**			Analyst: **ALS**
Subcontracted Analyses	**See report**			**as noted**	1	7/27/2021

Note: See Qualifiers page for a list of qualifiers and their definitions.

Client: Consumers Energy Company

Project: 210-0821 **Work Order:** 21070726

Sample ID: TW-21-009 (22-24') **Lab ID:** 21070726-06

Collection Date: 6/30/2021 01:50 PM **Matrix:** SOIL

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
MOISTURE			**SW3550C**			Analyst: **CDG**
Moisture	**21**		**0.10**	**% of sample**	1	7/12/2021 10:22 AM
ORGANIC CARBON - WALKLEY-BLACK			**WALKLEY-BLACK 1969**			Analyst: **KF**
Organic Carbon - W-B	**0.16**		**0.032**	**% by wt-dry**	1	7/23/2021 01:25 PM
SUBCONTRACTED ANALYSES			**SUBCONTRACT**			Analyst: **ALS**
Subcontracted Analyses	**See report**			**as noted**	1	7/27/2021

Note: See Qualifiers page for a list of qualifiers and their definitions.

ALS Group, USA

Date: *14-Sep-2021*

Client: Consumers Energy Company
Project: 210-0821
Work Order: 21070726
Sample ID: TW-21-010 (20-22')
Lab ID: 21070726-07
Collection Date: 6/30/2021 04:30 PM
Matrix: SOIL

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
MOISTURE			**SW3550C**			Analyst: **CDG**
Moisture	**18**		**0.10**	**% of sample**	1	7/12/2021 10:22 AM
ORGANIC CARBON - WALKLEY-BLACK			**WALKLEY-BLACK 1969**			Analyst: **KF**
Organic Carbon - W-B	**0.13**		**0.031**	**% by wt-dry**	1	7/23/2021 01:25 PM
SUBCONTRACTED ANALYSES			**SUBCONTRACT**			Analyst: **ALS**
Subcontracted Analyses	**See report**			**as noted**	1	7/27/2021

Note: See Qualifiers page for a list of qualifiers and their definitions.

ALS Group, USA

Date: 14-Sep-21

Client: Consumers Energy Company
Work Order: 21070726
Project: 210-0821

QC BATCH REPORT

Batch ID: **R321883** Instrument ID **MOIST** Method: **SW3550C**

MBLK Sample ID: **WBLKS-R321883** Units: **% of sample** Analysis Date: **7/12/2021 10:22 AM**
Client ID: Run ID: **MOIST_210712A** SeqNo: **7573794** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	ND	0.10								

LCS Sample ID: **LCS-R321883** Units: **% of sample** Analysis Date: **7/12/2021 10:22 AM**
Client ID: Run ID: **MOIST_210712A** SeqNo: **7573793** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	99.99	0.10	100	0	100	98-102	0			

DUP Sample ID: **21070504-01A DUP** Units: **% of sample** Analysis Date: **7/12/2021 10:22 AM**
Client ID: Run ID: **MOIST_210712A** SeqNo: **7573775** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	9.38	0.10	0	0	0	0-0	10.06	7	10	

DUP Sample ID: **21070726-01A DUP** Units: **% of sample** Analysis Date: **7/12/2021 10:22 AM**
Client ID: **TW-21-011D (17-18')** Run ID: **MOIST_210712A** SeqNo: **7573786** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Moisture	15.34	0.10	0	0	0	0-0	15.22	0.785	10	

The following samples were analyzed in this batch:

21070726-02A	21070726-03A	21070726-04A
21070726-05A	21070726-06A	21070726-07A

Note: See Qualifiers Page for a list of Qualifiers and their explanation.

Client: Consumers Energy Company
Work Order: 21070726
Project: 210-0821

QC BATCH REPORT

Batch ID: **R322727** Instrument ID **WETCHEM** Method: **Walkley-Black 196**

MBLK Sample ID: **WBLKS1-210723-R322727** Units: **% by wt** Analysis Date: **7/23/2021 01:25 PM**
Client ID: Run ID: **WETCHEM_210723G** SeqNo: **7605221** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon - W-B	ND	0.025								

LCS Sample ID: **WLCSS1-210723-R322727** Units: **% by wt** Analysis Date: **7/23/2021 01:25 PM**
Client ID: Run ID: **WETCHEM_210723G** SeqNo: **7605222** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon - W-B	0.1102	0.025	0.1	0	110	90-140	0			

MS Sample ID: **21070726-07A MS** Units: **% by wt** Analysis Date: **7/23/2021 01:25 PM**
Client ID: **TW-21-010 (20-22')** Run ID: **WETCHEM_210723G** SeqNo: **7605230** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon - W-B	0.3777	0.025	0.2421	0.1094	111	90-140	0			

MSD Sample ID: **21070726-07A MSD** Units: **% by wt** Analysis Date: **7/23/2021 01:25 PM**
Client ID: **TW-21-010 (20-22')** Run ID: **WETCHEM_210723G** SeqNo: **7605231** Prep Date: DF: **1**

Analyte	Result	PQL	SPK Val	SPK Ref Value	%REC	Control Limit	RPD Ref Value	%RPD	RPD Limit	Qual
Organic Carbon - W-B	0.3786	0.025	0.2427	0.1094	111	90-140	0.3777	0.242	20	

The following samples were analyzed in this batch:

21070726-02A	21070726-03A	21070726-04A
21070726-05A	21070726-06A	21070726-07A

Note: See Qualifiers Page for a list of Qualifiers and their explanation.

ALS Environmental

Chain of Custody Form

Page 1 of 1

COC ID: 123456

☐ Cincinnati, OH +1 513 733 5336
☐ Everett, WA +1 425 356 2600
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☑ Holland, MI +1 616 399 6070
☐ Houston, TX +1 281 530 5656
☐ Middletown, PA +1 717 944 5541
☐ Salt Lake City, UT +1 801 266 7700
☐ Spring City, PA +1 610 948 4903
☐ York, PA +1 717 505 5280

ALS Project Manager:

Work Order #: 21070726

Customer Information		Project Information	
Purchase Order	PR21070807	Project Name	Same
Work Order	21-0821	Project Number	
Company Name	CONSUMERS ENERGY	Bill To Company	
Send Report To	EMIL BLAJ	Invoice Attn.	
Address	135 W. Trail	Address	
City/State/Zip	JACKSON, MI 49201	City/State/Zip	
Phone	517-788-5888	Phone	
Fax	517-788-2533	Fax	
e-Mail Address	emil.blaj@cmsenergy.com	e-Mail Address	

Parameter/Method Request for Analysis

A	Total Organic Carbon by Walkley Black
B	Total Sulfur by ASTM E1915-20
C	
D	
E	
F	
G	
H	
I	
J	

No.	Sample Description	Date	Time	Matrix	Pres.	# Bottles	A	B	C	D	E	F	G	H	I	J	Hold
1	TW-21-011D (17-18')	6-28-21	1300	Soil		1	✓	✓									
2	TW-21-011D (22-23')	↓	1305			1	✓	✓									
3	TW-21-012D (22-24')	6-29-21	1200			1	✓	✓									
4	TW-21-012D (32-34')	↓	1205			1	✓	✓									
5	TW-21-013 (30-32')	6-30-21	1030			1	✓	✓									
6	TW-21-009 (22-24')		1350			1	✓	✓									
7	TW-21-010 (20-22')	↓	1630			1	✓	✓									
8																	
9																	
10																	

Sampler(s): Please Print & Sign

Shipment Method: UPS

Required Turnaround Time: ☑ STD 10 Wk Days ☐ 5 Wk Days ☐ 2 Wk Days ☐ 24 Hour ☐ Other ________

Results Due Date:

Relinquished by:	Date: 7-08-21	Time: 1530	Received by: UPS
Relinquished by: UPS	Date: 7/9/21	Time: 1050	Received by (Laboratory):
Logged by (Laboratory):	Date: 7/9/21	Time: 1412	Checked by (Laboratory):

Notes:

Cooler Temp. 5.2°C IR1

QC Package: (Check Box Below)
☐ Level II: Standard QC
☐ Level III: Std QC + Raw Data
☐ Level IV: SW846 CLP-Like
☐ Other: ________

Preservative Key: 1-HCL 2-HNO3 3-H2SO4 4-NaOH 5-Na2S2O3 6-NaHSO4 7-Other 8-4 degrees C 9-5035

Note: Any changes must be made in writing once samples and COC Form have been submitted to ALS Environmental.

24 LBS

1 OF 1

DANIEL RUTAN
(517) 788-7177
CONSUMERS ENERGY
135 W TRAIL ST
JACKSON MI 49201-1314

SHIP TO:
BILL
CAREY
3352 128TH AVENUE
HOLLAND MI 49424

MI 495 9-04

UPS GROUND

TRACKING #: 1Z 457 873 03 6999 4456

BILLING: P/P
DIRECT DELIVERY ONLY

REF 1:110657
REF 2:CHEMISTRY

WS 24.0.17

LP2844 45.0A 04/2021

ALS Group, USA

Sample Receipt Checklist

Client Name: **CONSENJACK**

Date/Time Received: **09-Jul-21 10:50**

Work Order: **21070726**

Received by: **LYS**

Checklist completed by Lydia Sweet 09-Jul-21
eSignature Date

Reviewed by: Bill Carey 12-Jul-21
eSignature Date

Matrices: Soil
Carrier name: UPS

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shipping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	
Sample(s) received on ice?	Yes ☑	No ☐	
Temperature(s)/Thermometer(s):	5.2/5.2C	IR1	
Cooler(s)/Kit(s):			
Date/Time sample(s) sent to storage:	7/9/2021 2:30:18 PM		
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH acceptable upon receipt?	Yes ☐	No ☐	N/A ☑
pH adjusted?	Yes ☐	No ☐	N/A ☑
pH adjusted by:	-		

Login Notes:

Client Contacted:

Date Contacted:

Person Contacted:

Contacted By:

Regarding:

Comments:

CorrectiveAction:

September 10, 2021 Service Request No:T2101170

Bill Carey
ALS - Holland
3352 128th Avenue
Holland, MI 49424

Laboratory Results for: 21070726

Dear Bill,

Enclosed are the results of the sample(s) submitted to our laboratory July 13, 2021
For your reference, these analyses have been assigned our service request number **T2101170.**

All analyses were performed according to our laboratory’s quality assurance program. All results are intended to be considered in their entirety, and ALS Environmental is not responsible for use of less than the complete report. Results apply only to the items submitted to the laboratory for analysis and individual items (samples) analyzed, as listed in the report.

Respectfully submitted,

ALS Group USA, Corp. dba ALS Environmental

On behalf of Wendy Hyatt

Wendy Hyatt
Laboratory Director

ADDRESS 4208 S Santa Rita Avenue, Tucson, AZ 85714
PHONE +1 520 573 1061 | FAX +1 520 623 9218
ALS Group USA, Corp.
dba ALS Environmental

ALS

Subcontractor:
ALS Environmental
4208 S.Santa Rita Ave.

Tucson, AZ 85714

TEL: (520) 623-8501
FAX: (520) 573-1062
Acct #:

Salesperson ALSHN Account

CHAIN-OF-CUSTODY RECORD

T2101170 5
ALS - Holland
21070726

Date: 12-Jul-21
COC ID: 17202
Due Date: 21-Jul-21

Customer Information		Project Information		Parameter/Method Request for Analysis	
Purchase Order		Project Name	21070726	A	Subcontracted Analyses (SUBCONTRACT)
Work Order		Project Number		B	
Company Name	ALS Group USA, Corp	Bill To Company	ALS Group USA, Corp	C	
Send Report To	Bill Carey	Inv Attn	Accounts Payable	D	
Address	3352 128th Ave	Address	3352 128th Ave	E	
				F	
City/State/Zip	Holland, Michigan 49424	City/State/Zip	Holland, Michigan 49424	G	
Phone	(616) 399-6070	Phone	(616) 399-6070	H	
Fax	(616) 399-6185	Fax	(616) 399-6185	I	
eMail Address	bill.carey@alsglobal.com	eMail CC		J	

ALS Sample ID	Client Sample ID	Matrix	Collection Date 24hr	Bottle	A	B	C	D	E	F	G	H	I	J
21070726-01A	TW-21-011D (17-18')	Soil	28/Jun/2021 13:00	(1) 4OZGNEAT	X									
21070726-02A	TW-21-011D (22-23')	Soil	28/Jun/2021 13:05	(1) 4OZGNEAT	X									
21070726-03A	TW-21-012D (22-24')	Soil	29/Jun/2021 12:00	(1) 4OZGNEAT	X									
21070726-04A	TW-21-012D (32-34')	Soil	29/Jun/2021 12:05	(1) 4OZGNEAT	X									
21070726-05A	TW-21-013 (30-32')	Soil	30/Jun/2021 10:30	(1) 4OZGNEAT	X									
21070726-06A	TW-21-009 (22-24')	Soil	30/Jun/2021 13:50	(1) 4OZGNEAT	X									
21070726-07A	TW-21-010 (20-22')	Soil	30/Jun/2021 16:30	(1) 4OZGNEAT	X									

Comments:

Please analyze these samples for Sulfur by ASTM E1915-20. Thank you.

Relinquished by:	Date/Time	Received by:	Date/Time	Cooler IDs	Report/QC Level
	7/12/21 1500		7/13/21 1315		Std
Relinquished by:	Date/Time	Received by:	Date/Time		

4208 S.Santa Rita Ave.
Tucson, AZ 85714
T: +1 520 573 1061
www.alsglobal.com

Sample Receipt Form T2101170 5

ALS - Holland
21070726

Client/Project: ALS Holland

Work Order Number:

Received by: Cynthia Vroegh **Date & Time:** 7/13/21 1315 **Matrix:** Solid

Samples were received via?: FedEx **Samples were received in:** Cooler

Were custody seals on containers? ○ Yes ● No ○ NA **If yes, how many and where?**

If present were custody seals intact? ○ Yes ● No **If present, were they signed and dated?** ○ Yes ● No

Arrival Temp C	Temp Blank C	Tracking Number
9.8	NA	981776823575

Packing material used? Bags | Bubble Wrap | Wet Ice

Did all the bottles arrive in good condition (unbroken)? ● Yes ○ No ○ NA **If No, record comments below**

Did all sample labels and tags agree with COC? ● Yes ○ No ○ NA **If No, record discrepancies below**

Were all the appropriate containers and volumes received for the tests indicated? ● Yes ○ No ○ NA

Are samples received deemed acceptable? ● Yes ○ No

Comments:
7 - 4oz wm clear glass jars 21070726

Notes, discrepancies, & resolutions:
Fridge A

As a part of ISO 17025 protocols, ALS must notify clients that the quoted analytical methods performed by ALS may have minor modifications from the methods as published. These modifications are written into our Standard Operating Procedures and do not impact the quality of the data. Receipt of this document will be considered an acceptance of the procedures used by the laboratory for analysis unless notified by the client.
Modifications may include, but are not limited to:

- **The analysis of a sample matrix that differs from that stated in the published method (example - ASTM D5865 Standard Test Method for Gross Calorific Value of Coal and Coke is used for other matrices such as biomass, Tire Derived Fuel, etc.).**
- **Analyzing a sample mass that differs from those in the published method (example - to accommodate samples with high concentrations of analyte, samples of limited volume, or to comply with the instrument manufacturer's operating guidelines).**
- **Instruments used for the analysis may differ from those listed in the published method (example - using ICP- OES when the method references flame Atomic Absorption Spectroscopy)**

Client: ALS Environmental - Holland (MI)
3352 128th Avenue
Holland, MI 49424
Attn: Bill Carey

Project: 21070726 **Date Received:** July 13, 2021

Certificate of Analysis

Sample ID:	Sample Date and Time:		Lab #:	Moisture, Total D3173 wt%		Sulfur, Total E1915 Moist Free wt%	
TW-21-011D (22-23')	6/28/21	1305	T2101170-002	19.74		0.03	
TW-21-012D (22-24')	6/29/21	1200	T2101170-003	19.65		0.03	
TW-21-012D (32-34')	6/29/21	1205	T2101170-004	15.37		0.02	
TW-21-013 (30-32')	6/30/21	1030	T2101170-005	17.77		<0.03	
TW-21-009 (22-24')	6/30/21	1350	T2101170-006	18.28		0.03	
TW-21-010 (20-22')	6/30/21	1630	T2101170-007	18.80		0.03	

Appendix A-4

PRB Additional Extent Evaluation Soil and Groundwater Data QAQC Review

Appendix A-4:

PRB Additional Extent Evaluation Soil and Groundwater Data Quality Assurance/Quality Control Review

A review of the quality control data was conducted to assess the validity of the analytical results for the soil and groundwater samples collected June 28 to 30 and July 6 to 7, 2021, respectively, at the D.E. Karn Generating Facility, located in Essexville, Michigan. This review was performed in accordance with Barr Engineering Co.'s Standard Operating Procedures for data evaluation, which are based on *The National Functional Guidelines for Organic and Inorganic Data Review* (United States Environmental Protection Agency [USEPA], 2008 and 2010). Most of the analyses were performed by Consumers Trail Street Laboratory located in Jackson, Michigan with soil total organic carbon (TOC) tested by ALS in Holland, Michigan, groundwater analysis of sulfide tested by Merit Laboratories located in East Lansing, Michigan, and TOC tested in groundwater by Brighton Analytical located in Brighton, Michigan. This data evaluation discusses sample data contained within the Consumers' work orders 21-0821 for soil and 21-0819 for groundwater.

Laboratory analytical procedures were evaluated by assessing technical holding times, sample preservation methods, method blank samples, accuracy and precision data, and data package completeness based on the information provided in the laboratory reports.

Laboratory Procedures

Technical holding times were evaluated for each sample and target parameter based on USEPA and method recommendations. The technical holding times were within these recommendations for all analyses. The soil and groundwater samples collected during the sampling events arrived at the laboratory at the correct temperatures.

The Consumers laboratory data reports noted that all method quality control requirements were met, and no deviations were noted. No specific method blank data was provided, except for the TOC soil data tested by ALS Holland.

The accuracy and precision data review included evaluation of laboratory control spike (LCS), matrix spike (MS), matrix spike duplicate (MSD), and laboratory duplicate samples as provided in the laboratory data reports. Accuracy was evaluated by comparing laboratory percent recoveries from LCS, MS, and MSD samples to laboratory acceptance criteria. Precision was evaluated by calculating the relative percent difference of the MS/MSD and laboratory duplicate sample pairs.

The LCS samples displayed acceptable accuracy when compared to the laboratory acceptance criteria and no deviations were noted in the laboratory reports.

The laboratory utilized project samples as needed for MS/MSD evaluation when sufficient sample volume was available. Only the MS/MSD samples taken from project samples may be evaluated compared to project data. The MS/MSDs displayed accuracy and/or precision within laboratory acceptance criteria and no deviations were noted in the laboratory reports.

The laboratory duplicate sample data displayed acceptable precision when compared to the laboratory acceptance criteria and no deviations were noted in the laboratory reports.

Data completeness was evaluated by comparing the analyses requested with the data package as received. The samples were analyzed in accordance with the chain-of-custody, so the data package was considered complete.

Conclusion

The data are deemed acceptable for the purposes of this project with no qualification assigned during the data evaluation process.

References

United States Environmental Protection Agency (USEPA), 2008. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*. EPA QA/R-5. 2008

United States Environmental Protection Agency (USEPA), 2010. *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Inorganic Methods Data Review*. EPA QA/R-5. 2010

Appendix A-5

MTC Shelby Tube Results

MTC
mtc-test.com 800.968.8378

PROJECT NO.: 211257
DATE: 7/21/2021
SHEET: 1 OF 1

PROJECT DE Karn RAP Assistance, 22091015.01
CLIENT Barr Engineering
CONTRACTOR
ENGINEER/ARCHITECT

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER ASTM D 5084

MTC SAMPLE NO.: 158727
TEST DATE: 07/20/2021
SAMPLE LOCATION: TW-21-011D, 35.4-35.0 ft
SAMPLE CONDITION: Undisturbed
SAMPLE DESCRIPTION: Brown Silt, Organic smell and texture noted (visual / manual classification)
TYPE OF SAMPLE: Shelby Tube

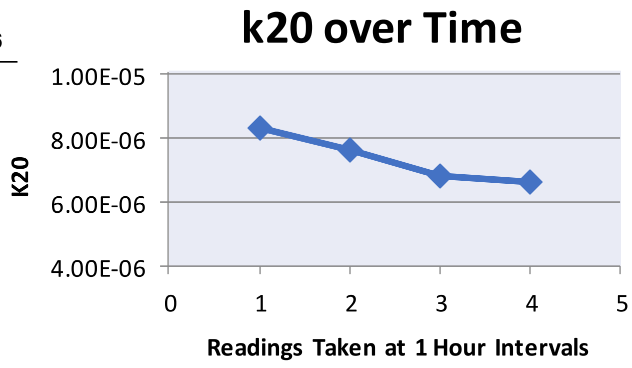
SAMPLE DIMENSIONS - INITIAL
DIAMETER (IN): 2.874
HEIGHT (IN): 3.012
AREA (SQ IN): 6.487
DRY UNIT WEIGHT (PCF): 74.0
WATER CONTENT (%): 43.9

TYPE OF PERMEANT: De-Aired Water
MAXIMUM BACK PRESSURE USED (PSI): 60.0 psi
MAXIMUM EFFECTIVE CONSOLIDATION STRESS: 2.0 psi
MINIMUM EFFECTIVE CONSOLIDATION STRESS: 1.0 psi
RANGE OF HYDRAULIC GRADIENT: 5.084 – 7.130

SAMPLE DIMENSIONS - FINAL
DIAMETER (IN): 2.860
HEIGHT (IN): 2.999
AREA (SQ IN): 6.423
DRY UNIT WEIGHT (PCF): 73.7
WATER CONTENT (%): 46.9
SATURATION: 100% *

AVERAGE HYDRAULIC CONDUCTIVITY (CM/SEC): 7.37 x 10^{-6}

REMARKS: *Assumed Specific Gravity - 2.65



REPORT BY:

REVIEWED BY: Timothy J. Lauterbach

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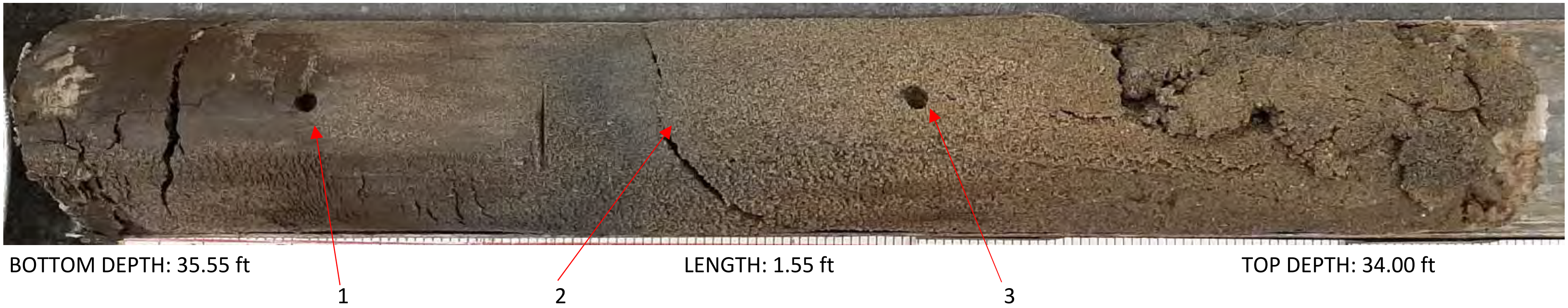
MTC PROJECT NO.: 211257
DATE: 7/8/2021
SAMPLE ID: TW-21-011D 34-36

Shelby Tube Extrusion Photo Log



MATERIAL DESCRIPTION/CLASSIFICATION:

1. Brown Silt with organic smell and texture from 34.95 to 35.55 ft - pocket pen reading of 1.25 at 35.30 ft
2. Contact between Brown Silt and Brown Poorly Graded Sand at 34.95 ft
3. Brown Poorly Graded Sand from 34.00 to 34.95 ft - pocket pen reading of 0.25 at 34.65 ft

Comments: When extruding the sample, the bottom material was pushed out the back end of the tube. Thus, the recovered sample is shorter compared to when the sample was in the tube. The bottom material is classified as brown clayey silt and was collected.

MTC
mtc-test.com 800.968.8378

PROJECT NO.: 211257
DATE: 7/21/2021
SHEET: 1 OF 1

PROJECT DE Karn RAP Assistance, 22091015.01
CLIENT Barr Engineering
CONTRACTOR
ENGINEER/ARCHITECT

MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER ASTM D 5084

MTC SAMPLE NO.: 158728
TEST DATE: 07/20/2021
SAMPLE LOCATION: TW-21-012D, 37.5-37.9 ft
SAMPLE CONDITION: Undisturbed
SAMPLE DESCRIPTION: Brown Silt, Organic smell and texture noted (visual / manual classification)
TYPE OF SAMPLE: Shelby Tube

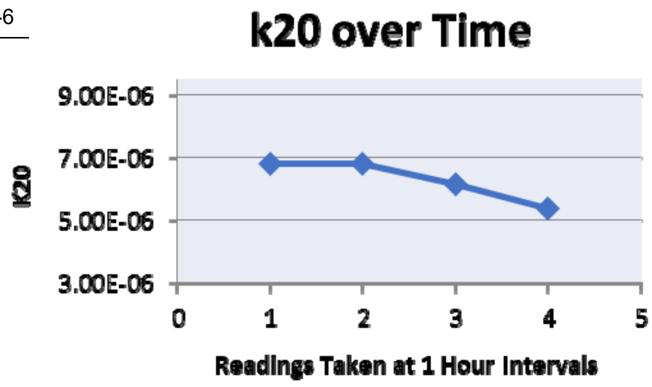
SAMPLE DIMENSIONS - INITIAL
DIAMETER (IN): 2.806
HEIGHT (IN): 3.010
AREA (SQ IN): 6.185
DRY UNIT WEIGHT (PCF): 41.5
WATER CONTENT (%): 104.6

TYPE OF PERMEANT: De-Aired Water
MAXIMUM BACK PRESSURE USED (PSI): 60.0 psi
MAXIMUM EFFECTIVE CONSOLIDATION STRESS: 2.0 psi
MINIMUM EFFECTIVE CONSOLIDATION STRESS: 1.0 psi
RANGE OF HYDRAULIC GRADIENT: 7.216 – 9.466

SAMPLE DIMENSIONS - FINAL
DIAMETER (IN): 2.802
HEIGHT (IN): 3.009
AREA (SQ IN): 6.166
DRY UNIT WEIGHT (PCF): 39.6
WATER CONTENT (%): 119.4
SATURATION: 100% *

AVERAGE HYDRAULIC CONDUCTIVITY (CM/SEC): 6.28×10^{-6}

REMARKS: *Assumed Specific Gravity - 2.65



REPORT BY:

REVIEWED BY: Timothy J. Lauderbach

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MTC
mtc-test.com 800.968.8378

MTC PROJECT NO.: 211257
DATE: 7/8/2021
SAMPLE ID: TW-21-012D 36-38

Shelby Tube Extrusion Photo Log

BOTTOM DEPTH: 38.05 ft LENGTH: 2.05 ft TOP DEPTH: 36.00 ft

4 1 4 2 3

MATERIAL DESCRIPTION/CLASSIFICATION:

1. Brown Silt with organic smell and texture from 36.10 to 38.05 ft
2. Contact beween Brown Silt and Brown Fine Sand at 36.10 ft
3. Brown Fine Sand from 36.00 to 36.10 ft - pocket pen reading of 0.75tsf at 36.10 ft
4. Brown Silt pocket pen reading of 1.50tsf at 36.50 ft, 37.00 ft, 37.50 ft, and 37.85 ft

Comments: Extrusion of sample was normal. Bottom 0.15 ft of the sample was damaged.

Appendix A-6

Groundwater Analytical Data

Appendix A-6
July 2021 Groundwater Analytical Data
D.E. Karn Generating Facility
Consumers Energy

			Location	TW-21-009	TW-21-010	TW-21-011D	TW-21-011I	TW-21-011S	TW-21-012D	TW-21-012I	TW-21-012S	TW-21-013
			Date	7/07/2021	7/07/2021	7/06/2021	7/06/2021	7/06/2021	7/06/2021	7/06/2021	7/06/2021	7/06/2021
			Sample Type	N	N	N	N	N	N	N	N	N
Parameter	Units	Chronic-Based Mixing Zone GSI Criteria	Acute-Based Mixing Zone GSI Criteria									
Effective Date		06/25/2018	06/25/2018									
Exceedance Key		**Bold**	No Exceed									
General Parameters												
Alkalinity, bicarbonate, as CaCO3	ug/l	N/A	N/A	188000	247000	932000	286000	462000	773000	370000	283000	483000
Alkalinity, carbonate, as CaCO3	ug/l	N/A	N/A	< 10000 U	< 10000 U	< 10000 U	< 10000 U	< 10000 U	< 10000 U	< 10000 U	< 10000 U	< 10000 U
Alkalinity, total, as CaCO3	ug/l	N/A	N/A	188000	247000	932000	286000	462000	773000	370000	283000	483000
Carbon, total organic	ug/l	N/A	N/A	4000	2900	33000	4400	3200	22000	7000	6300	8400
Chloride	ug/l	N/A	N/A	86700	62100	687000	74200	51700	1050000	45700	2820	65100
Nitrogen, ammonia, as N	ug/l	N/A	N/A	2020	2550	55800	7180	5090	42500	7440	977	15600
Nitrogen, nitrate, as N	ug/l	N/A	N/A	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	227	< 100 U	< 100 U
Nitrogen, nitrite, as N	ug/l	N/A	N/A	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U	< 100 U
Solids, total dissolved	ug/l	N/A	N/A	921000	836000	2130000	520000	1060000	2620000	712000	412000	650000
Sulfate, as SO4	ug/l	N/A	N/A	304000	257000	14300	46300	222000	2360	161000	74800	18000
Sulfide, as S^{2-}	ug/l	N/A	N/A	< 40 U	< 40 U	< 40 U	70	< 40 U	< 40 U	< 40 U	< 40 U	< 40 U
Dissolved Metals												
Arsenic	ug/l	**100**	680	**336**	**548**	5	**255**	**123**	6	**277**	**569**	**108**
Iron	ug/l	N/A	N/A	94	117	168	139	88	141	79	59	94
Manganese	ug/l	N/A	N/A	341	338	553	192	882	572	301	323	389
Total Metals												
Arsenic	ug/l	**100**	680	**367**	**518**	17	**246**	**261**	17	**266**	**596**	**113**
Boron	ug/l	44000	69000	7170	4900	120	4580	8700	125	2680	1270	9360
Calcium	ug/l	N/A	N/A	166000	154000	206000	76400	226000	189000	112000	90800	131000
Iron	ug/l	N/A	N/A	4820	226	14500	451	2260	8290	762	737	1210
Magnesium	ug/l	N/A	N/A	30800	26700	68400	18200	40800	65700	27200	22200	28800
Manganese	ug/l	N/A	N/A	364	355	530	194	904	561	315	313	402
Potassium	ug/l	N/A	N/A	7420	7790	5930	4800	8000	3890	4110	9180	6880
Selenium	ug/l	55	120	5	1	--	2	2	5	2	< 1 U	2
Sodium	ug/l	N/A	N/A	37800	45100	461000	73600	28800	654000	84200	9170	47900

LEGEND

Site-specific mixing zone Groundwater Surface Water Interface Criteria shown for arsenic, boron, and selenium are from the Michigan Department of Environmental Quality approval letter dated December, 23, 2015.

Footnotes

N Sample Type: Normal
U The analyte was analyzed for, but was not detected
N/A Mixing zone-based GSI criteria have not been developed

Appendix A-7

Low-Flow Sampling Logs

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-11D
Sample ID: TW-21-11D
Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED	Is cement pad in good repair?	[✓ YES] NO NA REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED	Is protective casing locked and in good repair?	[✓ YES] NO NA REMEDIED
Standing water present?	YES [✓ NO] REMEDIED	Is inner cap in place and properly sealing well?	[✓ YES] NO NA REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED	Is well casing in visibly good repair?	[✓ YES] NO NA REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/6/21 Time: 1045

Top of Casing Elevation:
Depth to Water: 20.61
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO 52.35 (after sampling)

WELL PURGING

Purge Method: [✓ PERISTALIC] BLADDER OTHER

Date: 7/6/21 Start Time: 1050

Measured Well Depth: 52.35 Screen Length: 5 feet Depth to Screen Midpoint: 49.85

Time	Water Level (feet)	Turb. (NTU) ~~Drawdown (feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1057	20.96	—	350	—	—	—	—	—
1101	20.91	—	250	—	—	—	—	—
1106	20.93	11.4	250	7.54	13.6	3635	-64.5	0.07
1111	20.93	7.71	250	7.38	14.1	3663	-87.2	0.37
1117	20.93	(7.75) ~~7.75~~	250	7.22	14.2	3684	-99.2	0.24
1122	20.94	7.74	250	7.17	14.1	3695	-101.5	0.21
1129	20.94	7.76	250	7.17	13.9	3736	-101.6	0.17
1132	20.93	7.79	250	7.17	14.2	3739	-102.0	0.17
1139	20.93	7.70	250	7.18	14.0	3744	-105.3	0.15
1144	20.92	7.65	250	7.28	13.9	3759	-114.5	0.14
1155	20.92	7.59	250	7.28	14.0	3755	-121.2	0.13
		Stabilization Criteria:		+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading	Mark if Recalibrated
pH:		S.U.	✓
Specific Cond.:		mS/cm	✓
Eh:		mV	✓
Dissolved Oxygen:		mg/L	✓

SAMPLE COLLECTION

Time: 1205
Appearance of Sample: clear, no odor
Sample Duplicate ?: no
Sample Method: Grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot. & diss. Metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions + Nitrates
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, [✓ NaOH], H2SO4	TDS, AK
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, H2SO4	sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADDa
Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: consumers
LOCATION: DE Karn

Monitoring Location: TW-21-11I
Sample ID: TW-21-11I
Well Type: 2" PVC

INSPECTION

Label on well? [✓ YES] NO REMEDIED
Is reference mark visible? [✓ YES] NO REMEDIED
Standing water present? YES [✓ NO] REMEDIED
Indication of surface runoff in well? YES [✓ NO] REMEDIED
Repair Notes:

Is cement pad in good repair? [✓ YES] NO NA REMEDIED
Is protective casing locked and in good repair? [✓ YES] NO NA REMEDIED
Is inner cap in place and properly sealing well? [✓ YES] NO NA REMEDIED
Is well casing in visibly good repair? [✓ YES] NO NA REMEDIED

STATIC WATER LEVEL

Date: 7/6/21 Time: 1222

Top of Casing Elevation:
Depth to Water: 20.50
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALTIC] BLADDER OTHER
Date: 7/6/21 Start Time: 1222

Measured Well Depth: 35.32
Screen Length: 5 feet
Depth to Screen Midpoint:

Time	Water Level (feet)	Turb (NTU) ~~Drawdown~~ ~~(feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1225	20.58	—	275	—	—	—	—	—
1232	20.58	8.65	275	8.48	13.2	905	-95.5	0.24
1237	20.59	10.8	275	8.68	13.2	005	-115.2	0.17
1248	20.59	6.01	275	8.62	12.9	920	-133.3	0.12
1253	20.59	5.30	277	8.64	13.0	922	-139.4	0.10
1300	20.58	4.34	275	8.68	13.1	921	-146.1	0.10
1304	20.58	4.27	275	8.72	13.1	927	-148.9	0.09
1309	20.59		275	8.73	13.3	931	-150.5	0.09
Stabilization Criteria:				+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading		Mark if Recalibrated
pH:	—	—	S.U.	
Specific Cond.:	—	—	mS/cm	
Eh:	—	—	mV	
Dissolved Oxygen:	—	—	mg/L	

SAMPLE COLLECTION

Time: 1310
Appearance of Sample: clear no odor
Sample Duplicate ?: no
Sample Method: low flow/grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions, TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alkalinity

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADDa
Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-11S
Sample ID: TW-21-11S
Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED	Is cement pad in good repair?	[✓ YES] NO NA	REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED	Is protective casing locked and in good repair?	[✓ YES] NO NA	REMEDIED
Standing water present?	YES [✓ NO] REMEDIED	Is inner cap in place and properly sealing well?	[✓ YES] NO NA	REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED	Is well casing in visibly good repair?	[✓ YES] NO NA	REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/6/21 Time: 1337

Top of Casing Elevation:
Depth to Water: 20.70
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALIC] BLADDER OTHER
Date: 7/6/21 Start Time: 1337

Measured Well Depth: 27.56 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	Turb. (NTU) ~~Brawdown (feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1346	20.75	37.1	200	7.59	14.4	1399	-76.5	1.47
1351	20.76	18.1	200	8.17	14.1	1412	-88.6	0.34
1401	20.75	6.96	200	8.19	14.5	1440	-102.0	0.17
1405	20.75	5.93	200	8.25	14.4	1449	-105.5	0.15
1409	20.76	6.75	200	8.25	14.3	1451	-108.7	0.12
1415	20.75	3.56	200	8.33	14.4	1451	-111.9	0.12
1418	20.75	2.73	200	8.34	14.5	1462	-114.8	0.11
1421	20.75	3.65	200	8.36	14.5	1455	-116.3	0.10
		Stabilization Criteria:		+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK	Standard (conc.)	Reading	Mark if Recalibrated
pH:	—	— S.U.	
Specific Cond.:	—	— mS/cm	
Eh:	—	— mV	
Dissolved Oxygen:	—	— mg/L	

SAMPLE COLLECTION

Time: 1425
Appearance of Sample: Clear, no odor
Sample Duplicate ?: —
Sample Method: Grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot. + Dis metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions, TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alkalinity

SAMPLING PERSONNEL

Name (SIGNATURE): ADD2
Chain of Custody No.
Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-012D
Sample ID: TW-21-012D
Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED	Is cement pad in good repair?	[✓ YES] NO NA REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED	Is protective casing locked and in good repair?	[✓ YES] NO NA REMEDIED
Standing water present?	YES [✓ NO] REMEDIED	Is inner cap in place and properly sealing well?	[✓ YES] NO NA REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED	Is well casing in visibly good repair?	[✓ YES] NO NA REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/6/21 Time: 1456

Top of Casing Elevation:
Depth to Water: 19.05
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALIC] BLADDER OTHER

Date: 7/6/21 Start Time: 1457

Measured Well Depth: 54.78 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	~~Drawdown (feet)~~ Turbidity (NTU)	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1501	19.09	—	300	—	—	—	—	—
1505	19.10	53.6	300	7.94	13.3	4342	-79.0	0.43
1511	19.08	92.1	300	7.91	13.1	4340	-85.1	0.24
1517	19.08	83.7	300	8.02	13.3	4325	-88.2	0.17
1522	19.08	68.4	300	8.14	13.4	4328	-89.2	0.15
1528	19.08	50.9	300	8.20	13.3	4333	-89.4	0.14
1543	19.09	29.3	300	8.23	13.3	4385	-92.7	0.11
1548	19.09	17.0	300	8.14	13.3	4410	-93.5	0.11
1553	19.09	9.16	300	8.01	13.3	4426	-93.9	0.11
1557	19.10	4.40	300	7.90	13.0	4423	-94.8	0.10
1601	19.10	4.24	300	7.91	13.2	4435	-96.0	0.10
1605	19.10	4.13	300	7.94	13.1	4440	-96.6	0.10
Total Volume Purged (gal):		Stabilization Criteria:		+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK	Standard (conc.)	Reading	Mark if Recalibrated
pH:	—	— S.U.	
Specific Cond.:	—	— mS/cm	
Eh:	—	— mV	
Dissolved Oxygen:	—	— mg/L	

SAMPLE COLLECTION

Time: 1610
Appearance of Sample: Clear, no odor
Sample Duplicate ?:
Sample Method: Grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis Metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions, TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alkalinity

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADD2 Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-012I
Sample ID: TW-21-012I
Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED		Is cement pad in good repair?	[✓ YES] NO NA	REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED		Is protective casing locked and in good repair?	[✓ YES] NO NA	REMEDIED
Standing water present?	YES [✓ NO] REMEDIED		Is inner cap in place and properly sealing well?	[✓ YES] NO NA	REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED		Is well casing in visibly good repair?	[✓ YES] NO NA	REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/6/21 Time: 1624

Top of Casing Elevation:
Depth to Water: 19.61
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALIC] BLADDER OTHER
Date: 7/16/21 Start Time: 1626

Measured Well Depth: 36.62 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	Turb (NTU) ~~Drawdown (feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1631	19.70	—	300	—	—	—	—	—
1635	19.73	~~NM~~ 10.7	300	7.96	12.4	1037	-69.1	2.28
1642	19.71	6.39	300	7.80	12.2	1125	-79.9	0.17
1647	19.72	5.49	300	7.80	12.2	1136	-90.6	0.14
1650	19.71	4.57	300	7.78	12.3	1140	-98.1	0.14
1657	19.72	4.25	300	7.78	12.2	1146	-109.3	0.11
1701	19.72	3.88	300	7.79	12.2	1140	-113.8	0.11
		Stabilization Criteria:		+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading	Mark if Recalibrated
pH:	—	— S.U.	
Specific Cond.:	—	— mS/cm	
Eh:	—	— mV	
Dissolved Oxygen:	—	— mg/L	

SAMPLE COLLECTION

Time: 1705
Appearance of Sample: Clear, no odor
Sample Duplicate ?: —
Sample Method: grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions + TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alk

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADD2 Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-0125
Sample ID: TW-21-0125
Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED	Is cement pad in good repair?	[✓ YES] NO NA REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED	Is protective casing locked and in good repair?	[✓ YES] NO NA REMEDIED
Standing water present?	YES [✓ NO] REMEDIED	Is inner cap in place and properly sealing well?	[✓ YES] NO NA REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED	Is well casing in visibly good repair?	[✓ YES] NO NA REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/6/21 Time: 1717

Top of Casing Elevation:
Depth to Water: 1947
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALIC] BLADDER OTHER
Date: 7/6/21 Start Time: 1717

Measured Well Depth: 27,83 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	Turb (NTU) ~~Drawdown~~ ~~(feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1723	19.52	—	260	—	—	—	—	—
1729	19.52	3.67	260	8.17	12.3	667	-114.9	0.44
1735	19.53	2.84	260	8.18	12.1	870	-121.1	0.27
1739	19.53	2.35	260	8.13	12.1	670	-126.7	0.21
1743	1952	1.78	260	8.04	12.0	670	-129.2	0.18

Stabilization Criteria: +/- 0.2 Units; +/- 0.02 mS/cm (+/- 0.02 mMho/cm); +/- 20 mV; +/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading	Mark if Recalibrated
pH:	—	— S.U.	
Specific Cond.:	—	— mS/cm	
Eh:	—	— mV	
Dissolved Oxygen:	—	— mg/L	

SAMPLE COLLECTION

Time: 1750
Appearance of Sample: clear, no odor
Sample Duplicate ?: no
Sample Method: Grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	~~None~~, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis. Metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, ~~HNO3~~, NaOH, H2SO4	Anions + TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alk

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADeà
Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-013
Sample ID: TW-21-013
Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED	Is cement pad in good repair?	[✓ YES] NO NA REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED	Is protective casing locked and in good repair?	[✓ YES] NO NA REMEDIED
Standing water present?	YES [✓ NO] REMEDIED	Is inner cap in place and properly sealing well?	[✓ YES] NO NA REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED	Is well casing in visibly good repair?	[✓ YES] NO NA REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/6/21 Time: 1815

Top of Casing Elevation:
Depth to Water: 21.71
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALIC] BLADDER OTHER
Date: 7/6/21 Start Time: 1816

Measured Well Depth: 36.52 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	Turb (NTU) ~~Drawdown (feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
1620	21.75	—	200	—	—	—	—	—
1624	21.76	21.7	250	7.57	13.2	1119	-97.3	0.64
1630	21.76	16.1	250	7.84	13.3	1115	-121.1	0.23
1636	21.76	11.3	250	7.71	13.1	1110	-125.8	0.23
1640	21.75	7.21	250	7.94	13.2	1111	-133.8	0.27
1646	21.76	4.98	250	8.03	13.1	1113	-138.7	0.20
1650	21.76	4.31	250	8.08	13.0	1114	-141.8	0.16
1653	21.77	2.95	250	8.18	13.0	1114	-143.6	0.15
		Stabilization Criteria:		+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading	Mark if Recalibrated
pH:	—	— S.U.	
Specific Cond.:	—	— mS/cm	
Eh:	—	— mV	
Dissolved Oxygen:	—	— mg/L	

SAMPLE COLLECTION

Time: 1855
Appearance of Sample: Clear none
Sample Duplicate ?: —
Sample Method: —

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions + TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfide
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alk

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADDZ
Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers

LOCATION: DE karn landfill

Monitoring Location: TW-21-009

Sample ID: TW-21-009

Well Type: 2" PVC

INSPECTION

Label on well?	[✓ YES] NO REMEDIED	Is cement pad in good repair?	[✓ YES] NO NA REMEDIED
Is reference mark visible?	[✓ YES] NO REMEDIED	Is protective casing locked and in good repair?	[✓ YES] NO NA REMEDIED
Standing water present?	YES [✓ NO] REMEDIED	Is inner cap in place and properly sealing well?	[✓ YES] NO NA REMEDIED
Indication of surface runoff in well?	YES [✓ NO] REMEDIED	Is well casing in visibly good repair?	[✓ YES] NO NA REMEDIED

Repair Notes:

STATIC WATER LEVEL

Date: 7/7/21 Time: 724

Top of Casing Elevation:

Depth to Water: 20.29

Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER

Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALTIC] BLADDER OTHER______

Date: 7/7/21 Start Time: 725

Measured Well Depth: 27.90 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	Turb (NTU) ~~Drawdown (feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (µS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
750	20.35	—	250	—	—	—	—	—
756	20.35	3.63	250	8.95	11.8	1178	-48.8	0.46
802	20.35	2.33	250	8.71	11.9	1188	-72.9	0.21
808	20.35	3.54	250	8.22	11.9	1182	-85.9	0.21
818	20.35	3.32	250	8.23	12.0	1236	-73.3	0.27
823	20.35	2.10	250	8.22	12.0	1222	-75.4	0.19
827	20.34	1.71	250	8.30	12.1	1215	-80.7	0.16
Stabilization Criteria:				+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):________

FIELD ANALYSIS

Time:

Temperature: ______ deg. C

pH: ______ S.U.

Specific Conductance: ______ mS/cm

ORP: ______ mV

Dissolved Oxygen: ______ mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading	Mark if Recalibrated
pH:	7/10	7.09/10.28 S.U.	X
Specific Cond.:	1409	1346 mS/cm	X
(ORP) Eh:	237.5	235.1 mV	
Dissolved Oxygen:	—	— mg/L	X
Turb.	10	10.5	

SAMPLE COLLECTION

Time: 835

Appearance of Sample: clear, no odor

Sample Duplicate ?:

Sample Method:

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	____ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis Metals
	____ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions + TDS
	____ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	____ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfate
	____ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	____ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Alk

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADDA

Name (SIGNATURE):

Low-Flow Sampling Form

CLIENT: Consumers
LOCATION: DE Karn

Monitoring Location: TW-21-010
Sample ID: TW-21-010
Well Type: 2" PVC

INSPECTION

Label on well? [✓ YES] NO REMEDIED
Is reference mark visible? [✓ YES] NO REMEDIED
Standing water present? YES [✓ NO] REMEDIED
Indication of surface runoff in well? YES [✓ NO] REMEDIED
Repair Notes:

Is cement pad in good repair? [✓ YES] NO NA REMEDIED
Is protective casing locked and in good repair? [✓ YES] NO NA REMEDIED
Is inner cap in place and properly sealing well? [✓ YES] NO NA REMEDIED
Is well casing in visibly good repair? [✓ YES] NO NA REMEDIED

STATIC WATER LEVEL

Date: 7/7/21 Time: 912

Top of Casing Elevation:
Depth to Water: 19.87
Elevation of Water:

Measured with: [✓ ELECTRONIC TAPE] CHALKED TAPE OTHER
Well depth verified? [✓ YES] NO

WELL PURGING

Purge Method: [✓ PERISTALTIC] BLADDER OTHER
Date: 7/7/21 Start Time: 914

Measured Well Depth: 28.02 Screen Length: 5 feet Depth to Screen Midpoint:

Time	Water Level (feet)	Turb (NTU) ~~Drawdown (feet)~~	Pumping Rate (ml/min)	pH (S.U.)	Temp (°C)	Spec Conductance (MS/cm)	Oxygen/Reduction (m/V)	Diss Oxy (mg/l)
920	19.94	19.2	250	9.13	12.1	1155	-67.3	0.33
945	19.94	7.54	260	8.28	12.0	1165	-73.9	0.40
949	19.94	3.98	250	8.43	12.0	1162	-96.5	0.21
957	19.94	3.00	250	8.62	11.9	1154	-119.2	0.17
1061	19.94	1.85	250	8.63	12.0	1154	-122.7	0.16
1006	19.94	1.93	250	8.68	11.9	1154	-129.1	0.15
		Stabilization Criteria:		+/- 0.2 Units		+/- 0.02 mS/cm (+/- 0.02 mMho/cm)	+/- 20 mV	+/- 0.2 mg/L

Total Volume Purged (gal):

FIELD ANALYSIS

Time:
Temperature: deg. C
pH: S.U.
Specific Conductance: mS/cm
ORP: mV
Dissolved Oxygen: mg/L

CALIBRATION CHECK

	Standard (conc.)	Reading	Mark if Recalibrated
pH:	7, 10	7.14, 10.02 S.U.	
Specific Cond.:	—	— mS/cm	
Eh:	—	— mV	
Dissolved Oxygen:	—	— mg/L	

SAMPLE COLLECTION

Time: 1010
Appearance of Sample: Clear, no odor
Sample Duplicate ?: —
Sample Method: Grab

NO./BOTTLES:	SIZE:	TYPE:	FILTERED:	PRESERVATIVE:	PARAMETER:
	ml	glass plastic	yes [✓ no]	None, HCl, [✓ HNO3], NaOH, H2SO4	Tot + Dis Metals
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	Anions + TDS
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, NaOH, [✓ H2SO4]	Ammonia
	ml	glass plastic	yes [✓ no]	None, HCl, HNO3, [✓ NaOH], H2SO4	Sulfate
	ml	glass plastic	yes [✓ no]	None, [✓ HCl], HNO3, NaOH, H2SO4	TOC
	ml	glass plastic	yes [✓ no]	[✓ None], HCl, HNO3, NaOH, H2SO4	ALK

SAMPLING PERSONNEL

Chain of Custody No.

Name (SIGNATURE): ADDa,
Name (SIGNATURE):

Appendix A-8

Groundwater Lab Report

Consumers Energy
Count on Us®
Laboratory Services
A CENTURY OF EXCELLENCE

135 W. Trail St.
Jackson, MI 49201
phone 517-788-1251
fax 517-788-2533

To: HDRegister, P22-521

From: EBlaj, T-258

Date: July 27, 2021

Subject: DE KARN PRB – GROUNDWATER – 2021 Q3

CC: CDBatts, Karn/Weadock

Mike Ellis, PE
Barr Engineering Co.
3005 Boardwalk Drive, Suite 100
Ann Arbor, MI 48108

Chemistry Project: 21-0819R

Barr Engineering conducted groundwater monitoring at the DE Karn solid waste disposal area on 07/06/2021 and 7/07/2021. The samples were received for analysis by the Chemistry department of Laboratory Services on 07/07/2021 and 7/08/2021.

Samples for Total Sulfide have been subcontracted to Merit Laboratories, Inc. and the results are listed under the analyst initials "Merit". Samples for Total Organic Carbon have been subcontracted to Brighton Analytical, LLC, and the results are listed under the analyst initials "BAL". Please note that the subcontracted work is not reported under the CE laboratory scope of accreditation.

The report that follows presents the results of the requested analytical testing; the results apply only to the samples as received. All samples have been analyzed in accordance with the 2016 TNI Standard and the applicable A2LA accreditation scope for Laboratory Services. Any exceptions to applicable test method criteria and standard compliance are noted in the Case Narrative, or flagged with applicable qualifiers in the analytical results section.

Reviewed and approved by:

Digitally signed
by Emil Blaj
Date: 2021.08.12
09:29:45 -04'00'

Emil Blaj
Sr. Technical Analyst
Project Lead

ilac-MRA
A2LA
ACCREDITED
Certificate #1097.04

Testing performed in accordance with the A2LA scope of accredidation specified in the listed certificate.
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CASE NARRATIVE

I. Sample Receipt

All samples were received within hold time and in good conditions, except as noted below and in the attached Sample Log-In Shipment Inspection Form. Identification of all samples included in the work order/project is provided in the sample summary section. All sample preservation and temperature upon receipt was verified by the sample custodian and confirmed to meet method requirements.

NOTE: Samples for dissolved metals were not field filtered; a sample aliquoted was taken from the Total Dissolved Solids container upon receipt at the laboratory, filtered through a 0.45 µm disposable filter, and preserved with Nitric Acid.

II. Methodology

Unless otherwise indicated, sample preparation and analysis was performed in accordance with the corresponding test methods from "Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100); SW-846, "Test Methods for Evaluating Solid Waste – Physical/Chemical Methods", USEPA (latest revisions), and Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF, 22nd Edition, 2012.

III. Results/Quality Control

Analytical results for this report are presented by laboratory sample ID, container, & aliquot number. Results for the field blanks, field duplicates, and recoveries of the field matrix spike & matrix spike duplicate samples are included in the results section; all other quality control data is listed in the Quality Control Summary associated with the particular test method, as appropriate. Unless specifically noted in the case narrative, all method quality control requirements have been met. If any results are qualified, the corresponding data flags/qualifiers are listed on the last page of the results section. Any additional information on method performance, when applicable, is presented in this section of the case narrative. When data flags are not needed, the qualifiers text box on the last page is left blank, and a statement confirms that no exceptions occurred.

DEFINITIONS / QUALIFIERS

The following qualifiers and/or acronyms are used in the report, where applicable:

Acronym	Description
RL	Reporting Limit
ND	Result not detected or below Reporting Limit
NT	Non TNI analyte
LCS	Laboratory Control Sample
LRB	Laboratory Reagent Blank (also referred to as Method Blank)
DUP	Duplicate
MS	Matrix Spike
MSD	Matrix Spike Duplicate
RPD	Relative Percent Difference
MDL	Method Detection Limit
PQL	Practical Quantitation Limit

TDL	Target Detection Limit
SM	Standard Methods Compendium

Qualifier	Description
*	Generic data flag, applicable description added in the corresponding notes section
B	The analyte was detected in the LRB at a level which is significant relative to sample result
D	Reporting limit elevated due to dilution
E	Estimated due to result exceeding the linear range of the analyzer
H	The maximum recommended hold time was exceeded
I	Dilution required due to matrix interference; reporting limit elevated
J	Estimated due to result found above MDL but below PQL (or RL)
K	Reporting limit raised due to matrix interference
M	The precision for duplicate analysis was not met; RPD outside acceptance criteria
N	Non-homogeneous sample made analysis questionable
PI	Possible interference may have affected the accuracy of the laboratory result
Q	Matrix Spike or Matrix Spike Duplicate recovery outside acceptance criteria
R	Result confirmed by new sample preparation and reanalysis
X	Other notation required; comment listed in sample notes and/or case narrative

Work Order Sample Summary

Customer Name: Karn/Weadock Complex
Work Order ID: Karn GW Samples from BARR
Date Received: 7/8/2021
Chemistry Project: 21-0819

Sample #	Field Sample ID	Matrix	Sample Date	Site
21-0819-01	TW-21-11D	Groundwater	07/06/2021 12:05 PM	DEK Solid Waste Disposal Area
21-0819-02	TW-21-11I	Groundwater	07/06/2021 01:10 PM	DEK Solid Waste Disposal Area
21-0819-03	TW-21-11S	Groundwater	07/06/2021 02:25 PM	DEK Solid Waste Disposal Area
21-0819-04	TW-21-012D	Groundwater	07/06/2021 04:10 PM	DEK Solid Waste Disposal Area
21-0819-05	TW-21-012I	Groundwater	07/06/2021 05:05 PM	DEK Solid Waste Disposal Area
21-0819-06	TW-21-012S	Groundwater	07/06/2021 05:50 PM	DEK Solid Waste Disposal Area
21-0819-07	TW-21-013	Groundwater	07/06/2021 06:55 PM	DEK Solid Waste Disposal Area
21-0819-08	TW-21-009	Groundwater	07/07/2021 08:35 AM	DEK Solid Waste Disposal Area
21-0819-09	TW-21-010	Groundwater	07/07/2021 10:10 AM	DEK Solid Waste Disposal Area

Analytical Report

Report Date: 07/27/21
08/12/21R

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-11D**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-01	Collect Time:	12:05 PM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-01-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	17		ug/L	1	07/21/2021	AB21-0720-04
Boron	120		ug/L	20	07/20/2021	AB21-0720-04
Calcium	206000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	14500		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	68400		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	530		ug/L	5	07/21/2021	AB21-0720-04
Potassium	5930		ug/L	100	07/22/2021	AB21-0720-04
Selenium	2		ug/L	1	07/21/2021	AB21-0720-04R
Sodium	461000		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-01-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	5		ug/L	1	07/21/2021	AB21-0720-05
Iron	168		ug/L	20	07/21/2021	AB21-0720-05
Manganese	553		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-01-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	55800		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-01-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	2130		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-01-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-01-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	687000		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	14300		ug/L	1000	07/07/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-01-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-11D**
Lab Sample ID: 21-0819-01
Matrix: Groundwater

Laboratory Project: **21-0819**
Collect Date: 07/06/2021
Collect Time: 12:05 PM

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-01-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	33000		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-01-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	932000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	932000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-11I**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-02	Collect Time:	01:10 PM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-02-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	246		ug/L	1	07/21/2021	AB21-0720-04
Boron	4580		ug/L	20	07/20/2021	AB21-0720-04
Calcium	76400		ug/L	1000	07/22/2021	AB21-0720-04
Iron	451		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	18200		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	194		ug/L	5	07/21/2021	AB21-0720-04
Potassium	4800		ug/L	100	07/22/2021	AB21-0720-04
Selenium	2		ug/L	1	07/21/2021	AB21-0720-04
Sodium	73600		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-02-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	255		ug/L	1	07/21/2021	AB21-0720-05
Iron	139		ug/L	20	07/21/2021	AB21-0720-05
Manganese	192		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-02-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	7180		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-02-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	520		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-02-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-02-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	74200		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	46300		ug/L	1000	07/07/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-02-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	70		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-11I**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-02	Collect Time:	01:10 PM
Matrix:	Groundwater		

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-02-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	4400		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-02-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	286000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	286000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-11S**
Lab Sample ID: 21-0819-03
Matrix: Groundwater

Laboratory Project: **21-0819**
Collect Date: 07/06/2021
Collect Time: 02:25 PM

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-03-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	261		ug/L	1	07/21/2021	AB21-0720-04
Boron	8700		ug/L	20	07/20/2021	AB21-0720-04
Calcium	226000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	2260		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	40800		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	904		ug/L	5	07/21/2021	AB21-0720-04
Potassium	8000		ug/L	100	07/22/2021	AB21-0720-04
Selenium	2		ug/L	1	07/21/2021	AB21-0720-04
Sodium	28800		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-03-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	123		ug/L	1	07/21/2021	AB21-0720-05
Iron	88		ug/L	20	07/21/2021	AB21-0720-05
Manganese	882		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-03-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	5090		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-03-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	1060		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-03-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-03-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	51700		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	222000		ug/L	1000	07/20/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-03-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-11S**
Lab Sample ID: 21-0819-03
Matrix: Groundwater

Laboratory Project: **21-0819**
Collect Date: 07/06/2021
Collect Time: 02:25 PM

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-03-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	3200		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-03-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	462000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	462000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-012D**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-04	Collect Time:	04:10 PM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-04-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	17		ug/L	1	07/21/2021	AB21-0720-04
Boron	125		ug/L	20	07/20/2021	AB21-0720-04
Calcium	189000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	8290		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	65700		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	561		ug/L	5	07/21/2021	AB21-0720-04
Potassium	3890		ug/L	100	07/22/2021	AB21-0720-04
Selenium	5		ug/L	1	07/21/2021	AB21-0720-04
Sodium	654000		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-04-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	6		ug/L	1	07/21/2021	AB21-0720-05
Iron	141		ug/L	20	07/21/2021	AB21-0720-05
Manganese	572		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-04-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	42500		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-04-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	2620		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-04-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-04-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	1050000		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	2360		ug/L	1000	07/07/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-04-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-012D**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-04	Collect Time:	04:10 PM
Matrix:	Groundwater		

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-04-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	22000		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-04-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	773000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	773000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

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Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-012I**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-05	Collect Time:	05:05 PM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-05-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	266		ug/L	1	07/21/2021	AB21-0720-04
Boron	2680		ug/L	20	07/20/2021	AB21-0720-04
Calcium	112000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	762		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	27200		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	315		ug/L	5	07/21/2021	AB21-0720-04
Potassium	4110		ug/L	100	07/22/2021	AB21-0720-04
Selenium	2		ug/L	1	07/21/2021	AB21-0720-04
Sodium	84200		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-05-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	277		ug/L	1	07/21/2021	AB21-0720-05
Iron	79		ug/L	20	07/21/2021	AB21-0720-05
Manganese	301		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-05-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	7440		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-05-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	712		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-05-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	227		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-05-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	45700		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	161000		ug/L	1000	07/20/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-05-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-012I**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-05	Collect Time:	05:05 PM
Matrix:	Groundwater		

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-05-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	7000		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-05-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	370000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	370000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-012S**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-06	Collect Time:	05:50 PM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-06-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	596		ug/L	1	07/21/2021	AB21-0720-04
Boron	1270		ug/L	20	07/20/2021	AB21-0720-04
Calcium	90800		ug/L	1000	07/22/2021	AB21-0720-04
Iron	737		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	22200		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	313		ug/L	5	07/21/2021	AB21-0720-04
Potassium	9180		ug/L	100	07/22/2021	AB21-0720-04
Selenium	ND		ug/L	1	07/21/2021	AB21-0720-04
Sodium	9170		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-06-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	569		ug/L	1	07/21/2021	AB21-0720-05
Iron	59		ug/L	20	07/21/2021	AB21-0720-05
Manganese	323		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-06-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	977		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-06-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	412		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-06-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-06-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	2820		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	74800		ug/L	1000	07/07/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-06-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-012S**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-06	Collect Time:	05:50 PM
Matrix:	Groundwater		

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-06-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	6300		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-06-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	283000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	283000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-013**
Lab Sample ID: 21-0819-07
Matrix: Groundwater

Laboratory Project: **21-0819**
Collect Date: 07/06/2021
Collect Time: 06:55 PM

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-07-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	113		ug/L	1	07/21/2021	AB21-0720-04
Boron	9360		ug/L	20	07/20/2021	AB21-0720-04
Calcium	131000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	1210		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	28800		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	402		ug/L	5	07/21/2021	AB21-0720-04
Potassium	6880		ug/L	100	07/22/2021	AB21-0720-04
Selenium	2		ug/L	1	07/21/2021	AB21-0720-04
Sodium	47900		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-07-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	108		ug/L	1	07/21/2021	AB21-0720-05
Iron	94		ug/L	20	07/21/2021	AB21-0720-05
Manganese	389		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-07-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	15600		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-07-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	650		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-07-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-07-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	65100		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	18000		ug/L	1000	07/07/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-07-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-013**	Collect Date:	07/06/2021
Lab Sample ID:	21-0819-07	Collect Time:	06:55 PM
Matrix:	Groundwater		

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-07-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	8400		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-07-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	483000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	483000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-009**	Collect Date:	07/07/2021
Lab Sample ID:	21-0819-08	Collect Time:	08:35 AM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-08-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	367		ug/L	1	07/21/2021	AB21-0720-04
Boron	7170		ug/L	20	07/20/2021	AB21-0720-04
Calcium	166000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	4820		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	30800		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	364		ug/L	5	07/21/2021	AB21-0720-04
Potassium	7420		ug/L	100	07/22/2021	AB21-0720-04
Selenium	5		ug/L	1	07/20/2021	AB21-0720-04
Sodium	37800		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-08-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	336		ug/L	1	07/21/2021	AB21-0720-05
Iron	94		ug/L	20	07/21/2021	AB21-0720-05
Manganese	341		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-08-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	2020		ug/L	25	07/15/2021	AB21-0712-12

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-08-C04-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	921		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-08-C04-A02 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/07/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/07/2021	AB21-0708-06

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-08-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	86700		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	304000		ug/L	1000	07/20/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-08-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-009**
Lab Sample ID: 21-0819-08
Matrix: Groundwater

Laboratory Project: **21-0819**
Collect Date: 07/07/2021
Collect Time: 08:35 AM

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-08-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	4000		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-08-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	188000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	188000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Sample Site:	**DEK Solid Waste Disposal Area (392503)**	Laboratory Project:	**21-0819**
Field Sample ID:	**TW-21-010**	Collect Date:	07/07/2021
Lab Sample ID:	21-0819-09	Collect Time:	10:10 AM
Matrix:	Groundwater		

GSI Total Metals by EPA 6020A, Extended List

Aliquot: 21-0819-09-C01-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	518		ug/L	1	07/21/2021	AB21-0720-04
Boron	4900		ug/L	20	07/20/2021	AB21-0720-04
Calcium	154000		ug/L	1000	07/22/2021	AB21-0720-04
Iron	226		ug/L	20	07/21/2021	AB21-0720-04
Magnesium	26700		ug/L	1000	07/22/2021	AB21-0720-04
Manganese	355		ug/L	5	07/21/2021	AB21-0720-04
Potassium	7790		ug/L	100	07/22/2021	AB21-0720-04
Selenium	1		ug/L	1	07/21/2021	AB21-0720-04
Sodium	45100		ug/L	1000	07/22/2021	AB21-0720-04

GSI Dissolved Metals by EPA 6020A, Extended List

Aliquot: 21-0819-09-C02-A01 **Analyst: EB**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Arsenic	548		ug/L	1	07/21/2021	AB21-0720-05
Iron	117		ug/L	20	07/21/2021	AB21-0720-05
Manganese	338		ug/L	5	07/21/2021	AB21-0720-05

Nitrogen-Ammonia by SM4500NH3(h), Groundwater HL

Aliquot: 21-0819-09-C03-A01 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Ammonia	2550		ug/L	25	07/15/2021	AB21-0712-12

Anions by EPA 300.0 Aqueous, NO2, NO3

Aliquot: 21-0819-09-C04-A01 **Analyst: DMW**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Nitrate	ND		ug/L	100	07/08/2021	AB21-0708-06
Nitrite	ND		ug/L	100	07/08/2021	AB21-0708-06

Total Dissolved Solids by SM 2540C

Aliquot: 21-0819-09-C04-A02 **Analyst: CLH**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Dissolved Solids	836		mg/L	10	07/08/2021	AB21-0708-03

Anions by EPA 300.0 Aqueous, Cl, SO4

Aliquot: 21-0819-09-C04-A03 **Analyst: TMR**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Chloride	62100		ug/L	1000	07/20/2021	AB21-0720-08
Sulfate	257000		ug/L	1000	07/20/2021	AB21-0720-08

Sulfide, Total by SM 4500 S2D

Aliquot: 21-0819-09-C05-A01 **Analyst: Merit**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Sulfide	ND		ug/L	40	07/11/2021	AB21-0714-04

Analytical Report

Report Date: 07/27/21

Sample Site: **DEK Solid Waste Disposal Area (392503)**
Field Sample ID: **TW-21-010**
Lab Sample ID: 21-0819-09
Matrix: Groundwater

Laboratory Project: **21-0819**
Collect Date: 07/07/2021
Collect Time: 10:10 AM

Total Organic Carbon by SM 5310B, Aqueous

Aliquot: 21-0819-09-C06-A01 **Analyst: BAL**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Total Organic Carbon	2900		ug/L	1000	07/14/2021	AB21-0723-10

Alkalinity by SM 2320B

Aliquot: 21-0819-09-C07-A01 **Analyst: DLS**

Parameter(s)	Result	Flag	Units	RL	Analysis Date	Tracking #
Alkalinity Total	247000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Bicarbonate	247000		ug/L	10000	07/19/2021	AB21-0719-03
Alkalinity Carbonate	ND		ug/L	10000	07/19/2021	AB21-0719-03

Analytical Report

Report Date: 07/27/21

Data Qualifiers	Exception Summary
	No exceptions occured.

CONSUMERS ENERGY	Chemistry Department General Standard Operating Procedure	PROC CHEM-1.2.01 PAGE 1 OF 2 REVISION 3 ATTACHMENT A

TITLE: SAMPLE LOG-IN – SHIPMENT INSPECTION FORM

Project Log-In Number: 21-0819

Inspection Date: 07-07-21 **Inspection By:** LMO

Sample Origin/Project Name: DE Karn PRB

Shipment Delivered By: Enter the type of shipment carrier.

Pony ___ FedEx ___ UPS ___ USPS ___ Airborne ___

Other/[✓ Hand Carry] (whom) CET

Tracking Number: ___ Shipping Form Attached: Yes ___ No ___

Shipping Containers: Enter the type and number of shipping containers received.

Cooler ✓ Cardboard Box ___ Custom Case ___ Envelope/Mailer ___

Loose/Unpackaged Containers ___ Other ___

Condition of Shipment: Enter the as-received condition of the shipment container.

Damaged Shipment Observed: None ✓ Dented ___ Leaking ___

Other ___

Shipment Security: Enter if any of the shipping containers were opened before receipt.

Shipping Containers Received: Opened ___ Sealed ✓

Enclosed Documents: Enter the type of documents enclosed with the shipment.

CoC ✓ Work Request ___ Air Data Sheet ___ Other ___

Temperature of Containers: Measure the temperature of several sample containers.

As-Received Temperature Range 2.4 - 5.1 °C Samples Received on Ice: Yes ✓ No ___

M&TE # and Expiration 015402 6-03-22

Number and Type of Containers: Enter the total number of sample containers received.

Container Type	Water	Soil	Other	Broken	Leaking
VOA (40mL or 60mL)	16				
Quart/Liter (g/p)	8				
9-oz (amber glass jar)					
2-oz (amber glass)					
125 mL (plastic)	32~~0~~ LMO 7-7-21				
24 mL vial (glass)					
500 mL (plastic)					
Other 250 ml	9				

~~Pg 2 of~~ LMO 7-7-21

Pg 1 of 2

TITLE: SAMPLE LOG-IN – SHIPMENT INSPECTION FORM

Container Damage List or Exception Report (required if leaking, damaged or exception containers are found)

Project Log-In Number: 21-0819

Inspection Date: 07-07-21 **Inspection By:** LMO

Sample Container Damage Listing: List all sample containers that were found to be broken, leaking, missing sample labels or are not accounted for on the CoC.

Sample/Container ID	Damage/Exception Report
0 LMO 7-7-21 ~~21-1809~~	
21-0819-01	extra 250 mL bottle was collected
All - CO2	samples were not filtered for dissolved
	LMO 7-7-21 ~~so~~ metals in the field. Lab filtered
	samples upon receipt

Barr Engineering Co. Chain of Custody

Sample Origination State
☐ CO ☒ MI ☐ MN ☐ MO ☐ ND ☐ TX ☐ UT ☐ WI ☐ Other: ______

COC Number: **№ 588768**
COC 1 of 1

REPORT TO	INVOICE TO
Company: Barr Engineering	Company: Same
Address: 3005 Boardwalk Dr.	Address:
Address: St. # 100, Ann Ar	Address:
Name: Mike Ellis	Name:
email: MEllis@Barr.com	email:
Copy to: BarrDM@barr.com	P.O.
Project Name: DE Karn PRB	Barr Project No: 22091016.01 400 100

Analysis Requested — Water | AD

Matrix Code:
GW = Groundwater
SW = Surface Water
WW = Waste Water
DW = Drinking Water
S = Soil/Solid
SD = Sediment
O = Other

Preservative Code:
A = None
B = HCl
C = HNO_3
D = H_2SO_4
E = NaOH
F = MeOH
G = $NaHSO_4$
H = $Na_2S_2O_3$
I = Ascorbic Acid
J = Zn Acetate
K = Other

Location	Sample Depth Start	Stop	Unit (m./ft. or in.)	Collection Date (mm/dd/yyyy)	Collection Time (hh:mm)	Matrix Code	Perform MS/MSD Y / [✓ N]	Total Number Of Containers	Tot. metals	Dissolved metals	Anions	TDS	TOC	Nitrate/Nitrite	Alkalinity (tot, bi, car)	sulfate/sulfide				% Solids	
Preservative Code																					
Field Filtered Y/[✓ N]									N	N	N	N	N	N	N	N					
1. TW-21-11D 21-0819	-01			07/06/2021	1205	GW			X	X	X	X	X	X	X	X					No samples field filtered
2. TW-21-11I	-02				1310																
3. TW-21-11S	-03				1425																
4. TW-21-012D	-04				1610																
5. TW-21-012I	-05				1705																
6. TW-21-012S	-06				1750																
7. TW-21-013	-07			↓	1855																
8. TW-21-009	-08			07/07/2021	835																
9.						↓															
10.																					

BARR USE ONLY	
Sampled by:	ADD2
Barr Proj. Manager:	MJE
Barr DQ Manager:	DLB
Lab Name:	Trail Street
Lab Location:	Jackson, MI

Relinquished by:	On Ice?	Date	Time	Received by:	Date	Time
	[✓ Y] N	7-7-21	0853			
	[✓ Y] N	7-7-21	1325		7-7-21	1325

Samples Shipped VIA: ☐ Ground Courier ☐ Air Carrier ☐ Sampler ☐ Other: ______

Air Bill Number:

Requested Due Date:
☐ Standard Turn Around Time
☐ Rush ______ (mm/dd/yyyy)

Lab WO: 21-0819 Temperature on Receipt (°C): Custody Seal Intact? ☐ Y ☐ N ☐ None

Distribution - **White-Original:** Accompanies Shipment to Laboratory; **Yellow Copy:** Include in Field Documents; **Scan and email:** a copy to BarrDM@barr.com for tracking and filing procedures

CONSUMERS ENERGY

Chemistry Department

General Standard Operating Procedure

PROC CHEM-1.2.01
PAGE 1 OF 2
REVISION 3
ATTACHMENT A

TITLE: SAMPLE LOG-IN – SHIPMENT INSPECTION FORM

Project Log-In Number: 21.0819

Inspection Date: 7.8.21 **Inspection By:** dmw

Sample Origin/Project Name: ____

Shipment Delivered By: Enter the type of shipment carrier.

Pony ____ FedEx ____ UPS ____ USPS ____ Airborne ____

Other/[✓ Hand Carry] (whom) DMW

Tracking Number: ____ Shipping Form Attached: Yes ____ No ____

Shipping Containers: Enter the type and number of shipping containers received.

Cooler X Cardboard Box ____ Custom Case ____ Envelope/Mailer ____

Loose/Unpackaged Containers ____ Other ____

Condition of Shipment: Enter the as-received condition of the shipment container.

Damaged Shipment Observed: None X Dented ____ Leaking ____

Other ____

Shipment Security: Enter if any of the shipping containers were opened before receipt.

Shipping Containers Received: Opened ____ Sealed X

Enclosed Documents: Enter the type of documents enclosed with the shipment.

CoC X Work Request ____ Air Data Sheet ____ Other ____

Temperature of Containers: Measure the temperature of several sample containers.

As-Received Temperature Range 4.3-5.6°C Samples Received on Ice: Yes ✓ No ____

M&TE # and Expiration 015402 6.3.22

Number and Type of Containers: Enter the total number of sample containers received.

pH paper
0.0-14.0
Cat. no. 13-640-508
lot: 222420
Exp: 8.1.23

Container Type	Water	Soil	Other	Broken	Leaking
VOA (40mL or 60mL)	2				
Quart/Liter (g/p)	1				
9-oz (amber glass jar)					
2-oz (amber glass)					
125 mL (plastic)	4				
24 mL vial (glass)					
500 mL (plastic)					
Other 250 ml plastic	1				

TITLE: SAMPLE LOG-IN – SHIPMENT INSPECTION FORM

Container Damage List or Exception Report (required if leaking, damaged or exception containers are found)

Project Log-In Number: 21-0819

Inspection Date: 7.8.21 **Inspection By:** dmw

Sample Container Damage Listing: List all sample containers that were found to be broken, leaking, missing sample labels or are not accounted for on the CoC.

Sample/Container ID	Damage/Exception Report
21-0819-09 C02	Sample was not filtered for dissolved metals in
	the field. Lab filtered sample upon ~~Arrival~~ dmw 7.8.21 receipt

Barr Engineering Co. Chain of Custody

Sample Origination State
☐ CO ☒ MI ☐ MN ☐ MO ☐ ND ☐ TX ☐ UT ☐ WI ☐ Other: ______

COC Number: **№ 588769**
COC 1 of 1

REPORT TO	INVOICE TO
Company: Barr Engineering	Company:
Address: 3005 Boardwalk Dr.	Address: Same
Address: Suite # 100, Ann Arbor, MI	Address:
Name: Mike Ellis	Name:
email: MEllis @ barr.com	email:
Copy to: BarrDM@barr.com	P.O.
Project Name: Karn PBB	Barr Project No: 22091016.01 400100

Matrix Code:
GW = Groundwater
SW = Surface Water
WW = Waste Water
DW = Drinking Water
S = Soil/Solid
SD = Sediment
O = Other

Preservative Code:
A = None
B = HCl
C = HNO_3
D = H_2SO_4
E = NaOH
F = MeOH
G = $NaHSO_4$
H = $Na_2S_2O_3$
I = Ascorbic Acid
J = Zn Acetate
K = Other

Location	Sample Depth Start	Sample Depth Stop	Unit (m./ft. or in.)	Collection Date (mm/dd/yyyy)	Collection Time (hh:mm)	Matrix Code	Perform MS/MSD Y / N	Total Number Of Containers	Water: Tot Metals	Water: Dis Metals	Water: Anions	Water: TDS	Water: TOC	Water: Nitrate / Nitrite	Soil: Alkalinity (tot, bi, car)	Soil: Sulfate / Sulfide	Soil	Soil	Soil	% Solids	
																					Preservative Code
									N												Field Filtered Y/[✓ N]
1. TW-21-010 21-0819-09				7/07/2021	10:10	GW	N	8	X	X	X	X	X	X	X	X					Not field filtered
2.																					
3.																					
4.																					
5.																					
6.																					
7.																					
8.																					
9.																					
10.																					

BARR USE ONLY
Sampled by: ADD2
Barr Proj. Manager: MJE
Barr DQ Manager: DLB
Lab Name: Trail Street
Lab Location: Jackson, MI

Relinquished by	On Ice?	Date	Time	Received by	Date	Time
Relinquished by:	[✓ Y] N	7/8/21	805	Received by:	7-8-21	0808
Relinquished by:	Y N			Received by:		

Samples Shipped VIA: ☐ Ground Courier ☐ Air Carrier ☐ Sampler ☐ Other: ______
Air Bill Number:

Requested Due Date:
☐ Standard Turn Around Time
☐ Rush ______ (mm/dd/yyyy)

Lab WO: 21-0819 Temperature on Receipt (°C): 4.3 Custody Seal Intact? ☐ Y ☐ N ☐ None

Distribution - **White-Original:** Accompanies Shipment to Laboratory; **Yellow Copy:** Include in Field Documents; **Scan and email:** a copy to BarrDM@barr.com for tracking and filing procedures

H:RLG\STDFORMS\Chain of Custody Form 2015 RLG Rev. 01/30/2020

Merit
Laboratories, Inc.

Analytical Laboratory Report

Report ID: S26059.01(01)
Generated on 07/12/2021

Report to

Attention: Emil Blaj
Consumers Energy Company
135 West Trail Street
Jackson, MI 49201

Phone: D:517-788-5888 C:517-684-9467 FAX:
Email: emil.blaj@cmsenergy.com

Report produced by

Merit Laboratories, Inc.
2680 East Lansing Drive
East Lansing, MI 48823

Phone: (517) 332-0167 FAX: (517) 332-6333

Contacts for report questions:
John Laverty (johnlaverty@meritlabs.com)
Barbara Ball (bball@meritlabs.com)

Report Summary

Lab Sample ID(s): S26059.01-S26059.09
Project: 21-0819 PR21070814
Collected Date(s): 07/07/2021 - 07/08/2021
Submitted Date/Time: 07/09/2021 14:06
Sampled by: Unknown
P.O. #: 4400096639

Table of Contents

Maya Murshak

Maya Murshak
Technical Director

General Report Notes

Analytical results relate only to the samples tested, in the condition received by the laboratory.

Methods may be modified for improved performance.

Results reported on a dry weight basis where applicable.

'Not detected' indicates that parameter was not found at a level equal to or greater than the reporting limit (RL).

40 CFR Part 136 Table II Required Containers, Preservation Techniques and Holding Times for the Clean Water Act specify that samples for acrolein and acrylonitrile need to be preserved at a pH in the range of 4 to 5 or if not preserved, analyzed within 3 days of sampling.

QA/QC corresponding to this analytical report is a separate document with the same Merit ID reference and is available upon request.

Full accreditation certificates are available upon request. Starred (*) analytes are not NELAP accredited.

Samples are held by the lab for 30 days from the final report date unless a written request to hold longer is provided by the client.

Report shall not be reproduced except in full, without the written approval of Merit Laboratories, Inc.

Limits for drinking water samples, are listed as the MCL Limits (Maximum Contaminant Level Concentrations)

PFAS requirement: Section 9.3.8 of U.S. EPA Method 537.1 states "If the method analyte(s) found in the Field Sample is present in the FRB at a concentration greater than 1/3 the MRL, then all samples collected with that FRB are invalid and must be recollected and reanalyzed."

Samples submitted without an accompanying FRB may not be acceptable for compliance purposes.

Report Narrative

There is no additional narrative for this analytical report

Analytical Laboratory Report

Laboratory Certifications

Authority	Certification ID
Michigan DEQ	#9956
DOD ELAP/ISO 17025	#69699
WBENC	#2005110032
Ohio VAP	#CL0002
Indiana DOH	#C-MI-07
New York NELAC	#11814
North Carolina DENR	#680
North Carolina DOH	#26702
Alaska CSLAP	#17-001
Pennsylvania DEP	#68-05884

Qualifier Descriptions

Qualifier	Description
!	Result is outside of stated limit criteria
B	Compound also found in associated method blank
E	Concentration exceeds calibration range
F	Analysis run outside of holding time
G	Estimated result due to extraction run outside of holding time
H	Sample submitted and run outside of holding time
I	Matrix interference with internal standard
J	Estimated value less than reporting limit, but greater than MDL
L	Elevated reporting limit due to low sample amount
M	Result reported to MDL not RDL
O	Analysis performed by outside laboratory. See attached report.
R	Preliminary result
S	Surrogate recovery outside of control limits
T	No correction for total solids
X	Elevated reporting limit due to matrix interference
Y	Elevated reporting limit due to high target concentration
b	Value detected less than reporting limit, but greater than MDL
e	Reported value estimated due to interference
j	Analyte also found in associated method blank
p	Benzo(b)Fluoranthene and Benzo(k)Fluoranthene integrated as one peak.
x	Preserved from bulk sample

Glossary of Abbreviations

Abbreviation	Description
RL/RDL	Reporting Limit
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
SW	EPA SW 846 (Soil and Wastewater) Methods
E	EPA Methods
SM	Standard Methods
LN	Linear
BR	Branched

Method Summary

Method	Version
SM4500-S2 D	Standard Method 4450 S2 D 2011

Sample Summary (9 samples)

Sample ID	Sample Tag	Matrix	Collected Date/Time
S26059.01	TW-21-11D (21-0819-01)	Groundwater	07/07/21 12:05
S26059.02	TW-21-11I (21-0819-02)	Groundwater	07/07/21 13:10
S26059.03	TW-21-11S (21-0819-03)	Groundwater	07/07/21 14:25
S26059.04	TW-21-012D (21-0819-04)	Groundwater	07/07/21 16:10
S26059.05	TW-21-012I (21-0819-05)	Groundwater	07/07/21 17:05
S26059.06	TW-21-012S (21-0819-06)	Groundwater	07/07/21 17:50
S26059.07	TW-21-013 (21-0819-07)	Groundwater	07/07/21 18:55
S26059.08	TW-21-009 (21-0819-08)	Groundwater	07/08/21 08:35
S26059.09	TW-21-010 (21-0819-09)	Groundwater	07/08/21 10:10

Analytical Laboratory Report

Lab Sample ID: S26059.01
Sample Tag: TW-21-11D (21-0819-01)
Collected Date/Time: 07/07/2021 12:05
Matrix: Groundwater
COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:36, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.02

Sample Tag: TW-21-11I (21-0819-02)

Collected Date/Time: 07/07/2021 13:10

Matrix: Groundwater

COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:38, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	0.07	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.03
Sample Tag: TW-21-11S (21-0819-03)
Collected Date/Time: 07/07/2021 14:25
Matrix: Groundwater
COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:46, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.04

Sample Tag: TW-21-012D (21-0819-04)

Collected Date/Time: 07/07/2021 16:10

Matrix: Groundwater

COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:48, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.05
Sample Tag: TW-21-012I (21-0819-05)
Collected Date/Time: 07/07/2021 17:05
Matrix: Groundwater
COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:50, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.06
Sample Tag: TW-21-012S (21-0819-06)
Collected Date/Time: 07/07/2021 17:50
Matrix: Groundwater
COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:52, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.07
Sample Tag: TW-21-013 (21-0819-07)
Collected Date/Time: 07/07/2021 18:55
Matrix: Groundwater
COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:54, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Lab Sample ID: S26059.08

Sample Tag: TW-21-009 (21-0819-08)

Collected Date/Time: 07/08/2021 08:35

Matrix: Groundwater

COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:56, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Analytical Laboratory Report

Lab Sample ID: S26059.09

Sample Tag: TW-21-010 (21-0819-09)

Collected Date/Time: 07/08/2021 10:10

Matrix: Groundwater

COC Reference:

Sample Containers

#	Type	Preservative(s)	Refrigerated?	Arrival Temp. (C)	Thermometer #
1	125ml Plastic	NaOH	Yes	5.0	IR

Inorganics

Method: SM4500-S2 D, Run Date: 07/11/21 08:58, Analyst: JDP

Parameter	Result	RL	MDL	Units	Dilution	CAS#	Flags
Sulfide	Not detected	0.04	0.010	mg/L	2	18496-25-8	

Merit Laboratories Login Checklist

Lab Set ID: S26059

Client: CONSUMERS (Consumers Energy)

Project: 21-0819 PR21070814

Submitted: 07/09/2021 14:06 Login User: SRS

Attention: Emil Blaj

Address: Consumers Energy Company
135 West Trail Street
Jackson, MI 49201

Phone: D:517-788-5888 FAX:

Email: emil.blaj@cmsenergy.com

Selection	Description	Note
Sample Receiving		
01. ☒ Yes ☐ No ☐ N/A	Samples are received at 4C +/- 2C Thermometer #	IR 5.0
02. ☒ Yes ☐ No ☐ N/A	Received on ice/ cooling process begun	
03. ☐ Yes ☒ No ☐ N/A	Samples shipped	
04. ☐ Yes ☒ No ☐ N/A	Samples left in 24 hr. drop box	
05. ☐ Yes ☐ No ☒ N/A	Are there custody seals/tape or is the drop box locked	
Chain of Custody		
06. ☒ Yes ☐ No ☐ N/A	COC adequately filled out	
07. ☒ Yes ☐ No ☐ N/A	COC signed and relinquished to the lab	
08. ☒ Yes ☐ No ☐ N/A	Sample tag on bottles match COC	
09. ☐ Yes ☒ No ☐ N/A	Subcontracting needed? Subcontacted to:	
Preservation		
10. ☒ Yes ☐ No ☐ N/A	Do sample have correct chemical preservation	
11. ☒ Yes ☐ No ☐ N/A	Completed pH checks on preserved samples? (no VOAs)	
12. ☐ Yes ☒ No ☐ N/A	Did any samples need to be preserved in the lab?	
Bottle Conditions		
13. ☒ Yes ☐ No ☐ N/A	All bottles intact	
14. ☒ Yes ☐ No ☐ N/A	Appropriate analytical bottles are used	
15. ☐ Yes ☒ No ☐ N/A	Merit bottles used	
16. ☒ Yes ☐ No ☐ N/A	Sufficient sample volume received	
17. ☐ Yes ☒ No ☐ N/A	Samples require laboratory filtration	
18. ☒ Yes ☐ No ☐ N/A	Samples submitted within holding time	
19. ☐ Yes ☐ No ☒ N/A	Do water VOC or TOX bottles contain headspace	

Corrective action for all exceptions is to call the client and to notify the project manager.

Client Review By: ________________________________ Date:_______________

Merit Laboratories Bottle Preservation Check

Lab Set ID: S26059 Submitted: 07/09/2021 14:06

Client: CONSUMERS (Consumers Energy)

Project: 21-0819 PR21070814

Attention: Emil Blaj
Address: Consumers Energy Company
135 West Trail Street
Jackson, MI 49201

Initial Preservation Check: 07/09/2021 14:19 SRS

Preservation Recheck (E200.8): N/A

Phone: D:517-788-5888 FAX:
Email: emil.blaj@cmsenergy.com

Sample ID	Bottle / Preservation	pH (Orig)	Add ml	pH (New)	Notes
S26059.01	125ml Plastic NaOH	>12			
S26059.02	125ml Plastic NaOH	>12			
S26059.03	125ml Plastic NaOH	>12			
S26059.04	125ml Plastic NaOH	>12			
S26059.05	125ml Plastic NaOH	>12			
S26059.06	125ml Plastic NaOH	>12			
S26059.07	125ml Plastic NaOH	>12			
S26059.08	125ml Plastic NaOH	>12			
S26059.09	125ml Plastic NaOH	>12			

Merit
Laboratories, Inc.

2680 East Lansing Dr., East Lansing, MI 48823
Phone (517) 332-0167 Fax (517) 332-4034
www.meritlabs.com

C.O.C. PAGE # 1 OF 1

CHAIN OF CUSTODY RECORD

REPORT TO

CONTACT NAME Emil Blaj
COMPANY Consumers Energy
ADDRESS 135 W. Trail Street
CITY Jackson STATE MI ZIP CODE 49201
PHONE NO. 517-788-5888 FAX NO. 517-788-2533 P.O. NO. 4400096639
E-MAIL ADDRESS emil.blaj@cmsenergy.com QUOTE NO.

INVOICE TO

CONTACT NAME ☒ SAME
COMPANY
ADDRESS
CITY STATE ZIP CODE
PHONE NO. E-MAIL ADDRESS

PROJECT NO./NAME 21-0819 PR21070814
SAMPLER(S) - PLEASE PRINT/SIGN NAME N/A

TURNAROUND TIME REQUIRED ☐ 1 DAY ☐ 2 DAYS ☐ 3 DAYS ☒ STANDARD ☐ OTHER

DELIVERABLES REQUIRED ☐ STD ☒ LEVEL II ☐ LEVEL III ☐ LEVEL IV ☐ EDD ☐ OTHER

MATRIX CODE: GW=GROUNDWATER WW=WASTEWATER S=SOIL L=LIQUID SD=SOLID SL=SLUDGE DW=DRINKING WATER O=OIL WP=WIPE A=AIR W=WASTE

ANALYSIS (ATTACH LIST IF MORE SPACE IS REQUIRED)

Certifications
☐ OHIO VAP ☐ Drinking Water
☐ DoD ☐ NPDES

Project Locations
☐ Detroit ☐ New York
☐ Other

MERIT LAB NO. FOR LAB USE ONLY	YEAR		SAMPLE TAG IDENTIFICATION-DESCRIPTION	MATRIX	# OF BOTTLES	# Containers & Preservatives							Total Sulfide									Special Instructions
	DATE	TIME				NONE	HCl	HNO_3	H_2SO_4	NaOH	MeOH	OTHER										
210059.01	7/~~6~~7/2021	1205	TW-21-11D (21-0819-01)	GW	1					1			✓									preserved with NaOH/ZnAcetate
.02	7/~~6~~7/2021	1310	TW-21-11I (21-0819-02)	GW	1					1			✓									"
.03	7/~~6~~7/2021	1425	TW-21-11S (21-0819-03)	GW	1					1			✓									"
.04	7/~~6~~7/2021	1610	TW-21-012D (21-0819-04)	GW	1					1			✓									"
.05	7/~~6~~7/2021	1705	TW-21-012I (21-0819-05)	GW	1					1			✓									"
.06	7/~~6~~7/2021	1750	TW-21-012S (21-0819-06)	GW	1					1			✓									"
.07	7/~~6~~7/2021	1855	TW-21-013 (21-0819-07)	GW	1					1			✓									"
.08	7/~~7~~8/2021	0835	TW-21-009 (21-0819-08)	GW	1					1			✓									"
.09	7/~~7~~8/2021	1010	TW-21-010 (21-0819-09)	GW	1					1			✓									"

EB 07-09-202

RELINQUISHED BY: SIGNATURE/ORGANIZATION CONSUMERS ENERGY ☐ Sampler DATE 07-09-21 TIME 1406
RECEIVED BY: SIGNATURE/ORGANIZATION DATE 7/9/21 TIME 1406
RELINQUISHED BY: SIGNATURE/ORGANIZATION DATE TIME
RECEIVED BY: SIGNATURE/ORGANIZATION DATE TIME

RELINQUISHED BY: SIGNATURE/ORGANIZATION DATE TIME
RECEIVED BY: SIGNATURE/ORGANIZATION DATE TIME
SEAL NO. SEAL INTACT YES ☐ NO ☐ INITIALS
SEAL NO. SEAL INTACT YES ☐ NO ☐ INITIALS
NOTES:
TEMP. ON ARRIVAL 5.0

PLEASE NOTE: SIGNING ACKNOWLEDGES ADHERENCE TO MERIT'S SAMPLE ACCEPTANCE POLICY ON REVERSE SIDE

BA Brighton Analytical L.L.C. ™

2105 Pless Drive Brighton, Michigan 48114 Phone (810)229-7575 Fax (810)229-8650 E-mail bai-brighton@sbcglobal.net

July 21, 2021

Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

Subject: DE Karn
21-0819

Dear Mr. Blaj :

Thank you for making Brighton Analytical, L.L.C. your laboratory of choice. Attached are the results for the samples submitted on 07/14/2021 for the above mentioned project. NELAP/TNI Accredited Analysis and EGLE Drinking Water Certified Analysis will be identified in their respective reporting formats. Hard copies can be supplied at your request for a fee of $20.00 per copy.

The invoice for this project will be emailed separately. If you have any questions concerning the data or invoice, please don't hesitate to contact our office. We welcome your comments and suggestions to improve our quality systems. Please reference Brighton Analytical, L.L.C. Project ID 75866 when calling or emailing. We thank you for this opportunity to partner with you on this project and hope to work with you again in the future.

Sincerely,
Brighton Analytical, L.L.C.

EGLE
Environment, Great Lakes, and Energy

NELAP RECOGNIZED TNI ACCREDITATION BODY

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/06/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:

Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01052**
Project Number: **21-0819**
Sample ID: **21-0819-01 TW-21-11D**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**33000**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/06/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:
Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01053**
Project Number: **21-0819**
Sample ID: **21-0819-02 TW-21-11I**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**4400**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/06/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:

Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01054**
Project Number: **21-0819**
Sample ID: **21-0819-03 TW-21-11S**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**3200**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/06/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:
Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01055**
Project Number: **21-0819**
Sample ID: **21-0819-04 TW-21-12D**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**22000**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/06/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:

Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**

Project Name: **DE Karn**

BA Sample ID: **CP01056**

Project Number: **21-0819**

Sample ID: **21-0819-05 TW-21-12D**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**7000**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/06/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:
Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01057**
Project Number: **21-0819**
Sample ID: **21-0819-06 TW-21-12S**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**6300**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date:	07/06/2021
Submit Date:	07/14/2021
Report Date:	07/21/2021

To:

Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**

Project Name: **DE Karn**

BA Sample ID: **CP01058**

Project Number: **21-0819**

Sample ID: **21-0819-07 TW-21-013**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**8400**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/07/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:
Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01059**
Project Number: **21-0819**
Sample ID: **21-0819-08 TW-21-009**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**4000**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

Brighton Analytical LLC
2105 Pless Drive
Brighton, Michigan 48114
Phone: (810)229-7575 (810)229-8650
e-mail:bai-brighton@sbcglobal.net
EGLE Certified #9404
NELAC Accredited #176507

Sample Date: 07/07/2021
Submit Date: 07/14/2021
Report Date: 07/21/2021

To:
Consumers Energy Company
135 W. Trail St.
Jackson, MI 49201

BA Report Number: **75866**
Project Name: **DE Karn**
BA Sample ID: **CP01060**
Project Number: **21-0819**
Sample ID: **21-0819-09 TW-21-010**

Parameters	Result	Units	DL	Method Reference	Analyst	Analysis Date
Organic Analysis						
Total Organic Carbon	**2900**	ug/L	1000	SM5310B	RG	07/21/2021

DL=Reported detection limit for analytical method requested. Some compounds require special analytical methods to achieve EGLE designated target detection limits (TDL).

Released by

Date 7/21/2021

CHAIN OF CUSTODY

75866

CONSUMERS ENERGY COMPANY – LABORATORY SERVICES

135 WEST TRAIL ST., JACKSON, MI 49201 • (517) 788-1251 • FAX (517) 788-2533

SAMPLING SITE: DE Karn

PROJECT NUMBER: 21-0819

SAMPLING TEAM: BARR

DATE SHIPPED:

SITE SKETCHED ATTACHED? CIRCLE ONE: YES NO

ANALYSIS REQUESTED

Page 1 of 1

SEND REPORT TO: Emil.Blaj@cmsenergy.com

PHONE: 517-788-5888

CE CONTROL #	SAMPLE DATE	SAMPLE TIME	SAMPLE MATRIX	SAMPLE DESCRIPTION / LOCATION	DEPTH (ft)	# OF CONTAINERS	TOC								REMARKS
21-0819-01	7/06/2021	1205	GW	TW-21-11D		1	X								C83 1052
-02	7/06/2021	1310	GW	TW-21-11I		1	X								53
-03	7/06/2021	1425	GW	TW-21-11S		1	X								54
-04	7/06/2021	1610	GW	TW-21-012D		1	X								55
-05	7/06/2021	1705	GW	TW-21-012D		1	X								56
-06	7/06/2021	1750	GW	TW-21-012S		1	X								57
-07	7/06/2021	1855	GW	TW-21-013		1	X								58
-08	7/07/2021	0835	GW	TW-21-009		1	X								59
-09	7/07/2021	1010	GW	TW-21-010		1	X								60

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
	7-14-21 0812	

RELINQUISHED BY: (SIGNATURE)	DATE/TIME:	RECEIVED BY: (SIGNATURE)

COMMENTS

Procurement # PR21070817

ORIGINAL TO LAB COPY TO CUSTOMER

Brighton
Analytical
L.L.C.

BRIGHTON ANALYTICAL, LLC

QUALITY ASSURANCE/QUALITY CONTROL

REPRESENTATIVE BATCH QUALITY CONTROL

Accuracy & Precision

Analyst: RG

Parameter: TOC/DOC

Analysis Date: 7/21/2021

Method Reference: EPA 415.1/SM5310B/9060

SPIKE - ACCURACY

Laboratory ID	Spike level PPB	Background PPB	Recoveries (%)	Acceptable Range (%)	Method Blank Concentration
CP01676	TV=10000	3300	92/93	80 - 120	ND

Laboratory ID	Observed A PPB	Observed B PPB	RPD (%)	Acceptable Range(%)
CP01676	12500	12600	0.80	≤20

MISCELLANEOUS

	Standard ID #	%Recoveries
Independent Secondary Reference Material:	#4295	97
Method Standard (Lab. Control Spike):	#3046.4	103

COMMENTS:

Appendix A-9

FS Remedial Response Area Groundwater Analytical Data

Appendix A-9
FS Remedial Response Area Groundwater Analytical Data
D.E. Karn Generating Facility
Consumers Energy

Location			MW-08	MW-10	MW-12	MW-14
Sample Type			N	N	N	N
Parameter		Units				
General Parameters						
Alkalinity, bicarbonate, as CaCO3		ug/l	389000	547000	462000	392000
Alkalinity, carbonate, as CaCO3		ug/l	--	--	--	--
Alkalinity, total, as CaCO3		ug/l	389000	547000	462000	392000
Carbon, total organic		ug/l	2500	3900	3800	3100
Chloride		ug/l	54400	69400	65900	29000
Nitrogen, ammonia, as N		ug/l	1260	1780	1200	1120
Nitrogen, nitrate, as N		ug/l	<100U	<100U	<100U	250
Nitrogen, nitrite, as N		ug/l	<100U	<100U	<100U	<100U
Solids, total dissolved		ug/l	1260000	891000	1270000	1620000
Sulfate, as SO4		ug/l	333000	54900	201000	1220000
Sulfide, as S^{2-}		ug/l	<40U	<40U	<40U	<40U
Dissolved Metals						
Arsenic		ug/l	94	770	261	55
Iron		ug/l	6620	4200	2040	323
Manganese		ug/l	311	205	682	1200
Total Metals						
Arsenic		ug/l	84	589	384	47
Boron		ug/l	4130	5210	3030	1300
Calcium		ug/l	191000	159000	179000	366000
Iron		ug/l	9150	2780	2900	245
Magnesium		ug/l	35900	41800	34500	145000
Manganese		ug/l	273	214	642	1100
Potassium		ug/l	13300	12200	10300	15300
Selenium		ug/l	2	--	2	8
Sodium		ug/l	46500	57200	51100	43700
Field Parameters						
pH		s.u.	7.12	7.29	7.28	6.96
Oxidation Reduction Potential		mV	-104.5	-106.1	-92.3	95
Conductivity		mS/sec	1521	1358	1506	2660

Groundwater analytical data are from sampling events in August 2020, October 2020, and July 2021. For each location, the most recent data available for each parameter is shown.

Footnotes

N Sample Type: Normal
U The analyte was analyzed for, but was not detected.

Collection Date

Collection Date
July 2021
October 2020
August 2020

Appendix A-10

FS Remedial Response Area Soil Analytica Data

Appendix A-10
FS Remedial Response Area Soil Analytical Data
D.E. Karn Generating Facility Consumers
Energy Company

Location		**DEK-SB-20001**	**DEK-SB-20002**	**DEK-SB-20003**	**DEK-SB-20004**	**DEK-SB-20005**	**DEK-SB-20006**	**DEK-SB-20007**	**DEK-SB-20008**	**DEK-SB-20009**	**DEK-SB-20010**
Date		**7/14/2020**	**7/14/2020**	**7/14/2020**	**7/14/2020**	**7/15/2020**	**7/15/2020**	**7/15/2020**	**7/15/2020**	**7/15/2020**	**7/15/2020**
Depth		**22 - 25 ft**	**21 - 23 ft**	**15 - 17 ft**	**17 - 19 ft**	**19 - 21 ft**	**11 - 13 ft**	**14 - 16 ft**	**17 - 19 ft**	**15 - 17 ft**	**9 - 12 ft**
Sample Type		**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Parameter	Units										
General Parameters											
Biochemical Oxygen Demand (5-day)	mg/l	< 20.0 U	< 20.0 U	**24.0**	< 20.0 U	< 20.0 U	< 20.0 U	< 20.0 U	< 20.0 U	< 20.0 U	< 20.0 U
Carbon, total organic	mg/kg	**2160**	**2230**	**3580**	**1430**	**3100**	**2040**	**1980**	**2650**	**2410**	**2210**
Chemical Oxygen Demand	mg/l	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U	< 10.0 U
Moisture	%	**14.4**	**19.5**	**20.0**	**13.3**	**16.8**	**10.8**	**20.7**	**14.3**	**12.3**	**16.8**
pH	pH units	**8.1 H**	**7.9 H**	**8.1 H**	**8.3 H**	**8.5 H**	**8.5 H**	**8.5 H**	**8.3 H**	**8.1 H**	**8.3 H**
Redox (oxidation potential)	mV	**370**	**345**	**378**	**375**	**395**	**479**	**456**	**452**	**428**	**443**
Solids, percent	%	**85.6**	**80.5**	**80.0**	**86.7**	**83.2**	**89.2**	**79.3**	**85.7**	**87.7**	**83.2**
Metals											
Arsenic	mg/kg	**4.65**	**7.02**	**9.81**	**3.89**	**9.81**	**16.6**	**12.8**	**6.10**	**2.76**	**3.84**
Iron	mg/kg	**2780**	**2830**	**5180**	**2620**	**3750**	**3690**	**7010**	**3280**	**5420**	**4210**

LEGEND

Detections are presented in **bold**.

Footnotes

N Sample Type: Normal

H Recommended sample preservation, extraction, or analysis

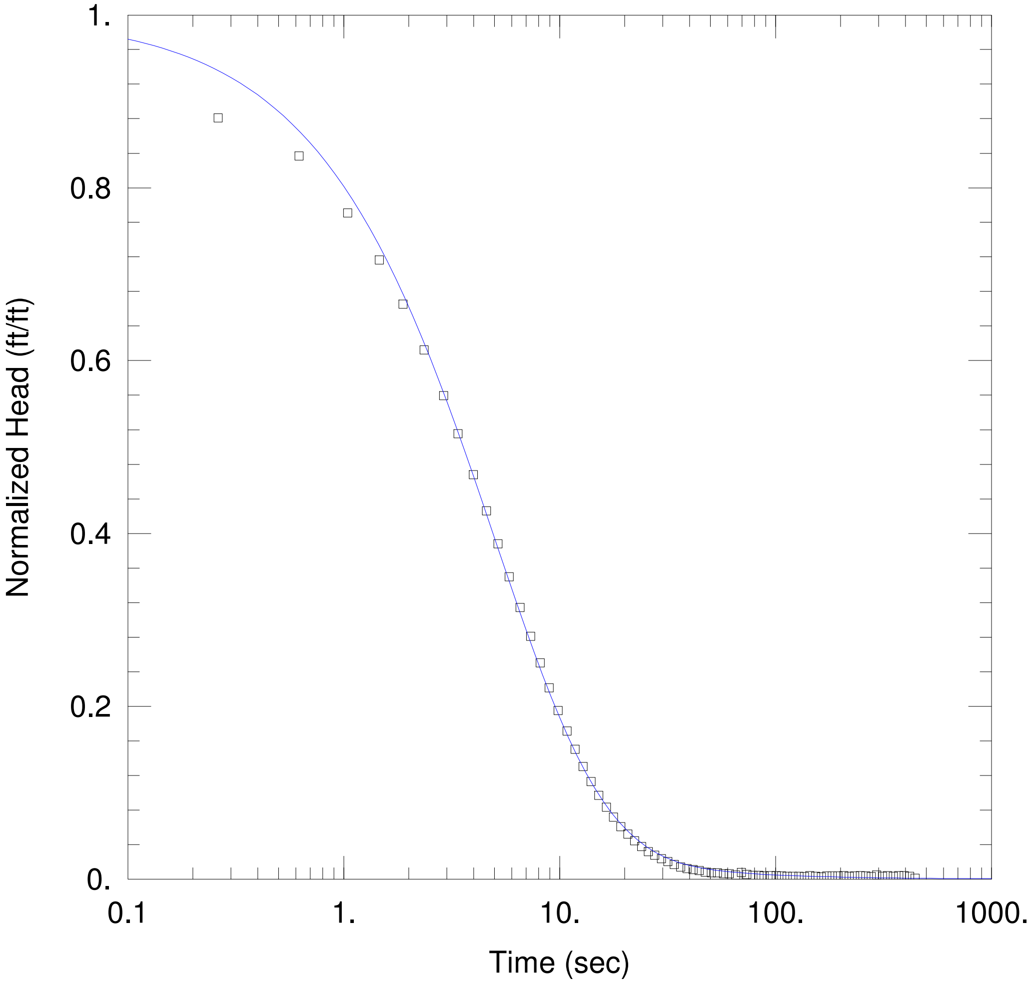
U The analyte was analyzed for, but was not detected.

Appendix B

Slug Testing and Pumping Tests

Appendix B-1

Slug Tests



TW-21-010

PROJECT INFORMATION

Company: Barr Engineering
Client: Consumers Energy
Project: 22091016.01
Location: DE Karn Landfill
Test Date: 7/7/2021

AQUIFER DATA

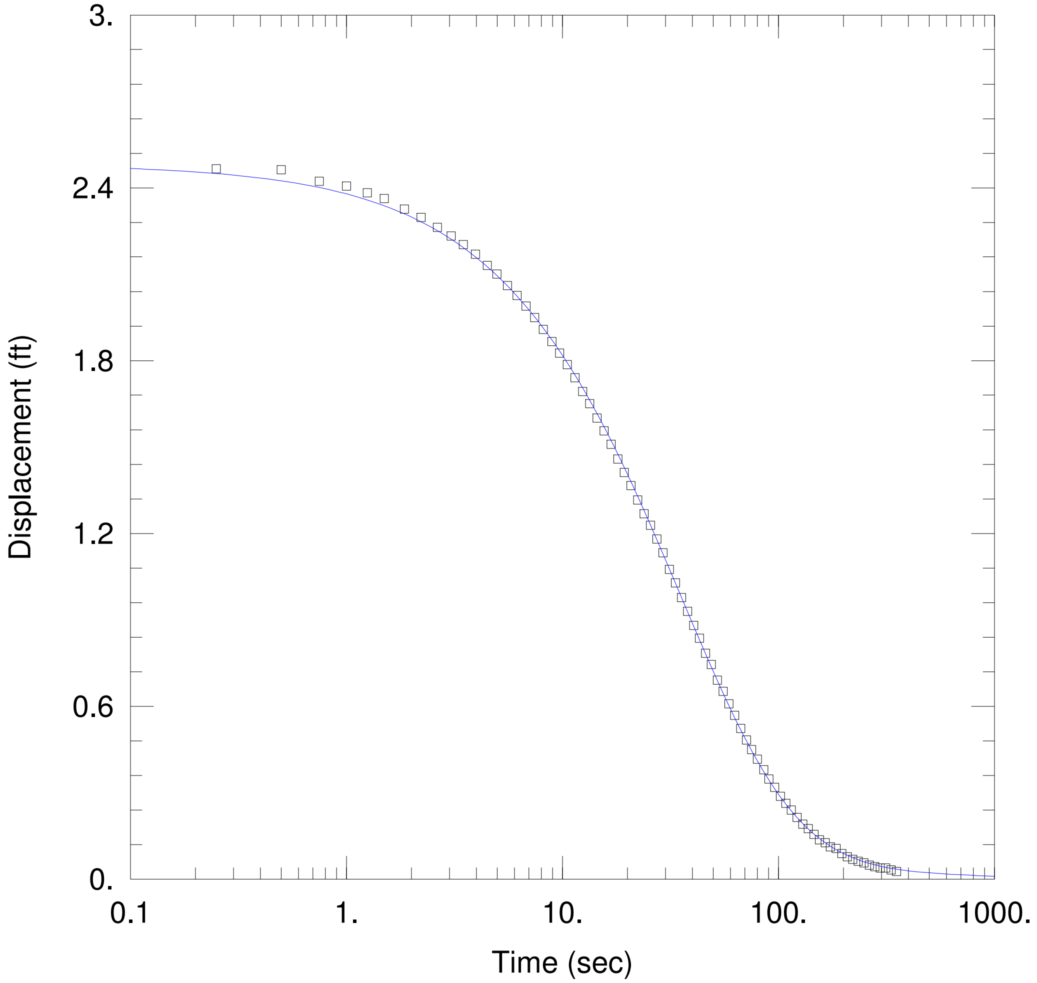
Saturated Thickness: 10.32 ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (TW-21-010)

Initial Displacement: 2.423 ft
Static Water Column Height: 8.32 ft
Total Well Penetration Depth: 8.32 ft
Screen Length: 5. ft
Casing Radius: 0.09296 ft
Well Radius: 0.1667 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 454.5 ft^2/day
S = 3.131E-6



TW-21-011D

PROJECT INFORMATION

Company: Barr Engineering
Client: Consumers Energy
Project: 22091016.01
Location: DE Karn Landfill
Test Date: 7/7/2021

AQUIFER DATA

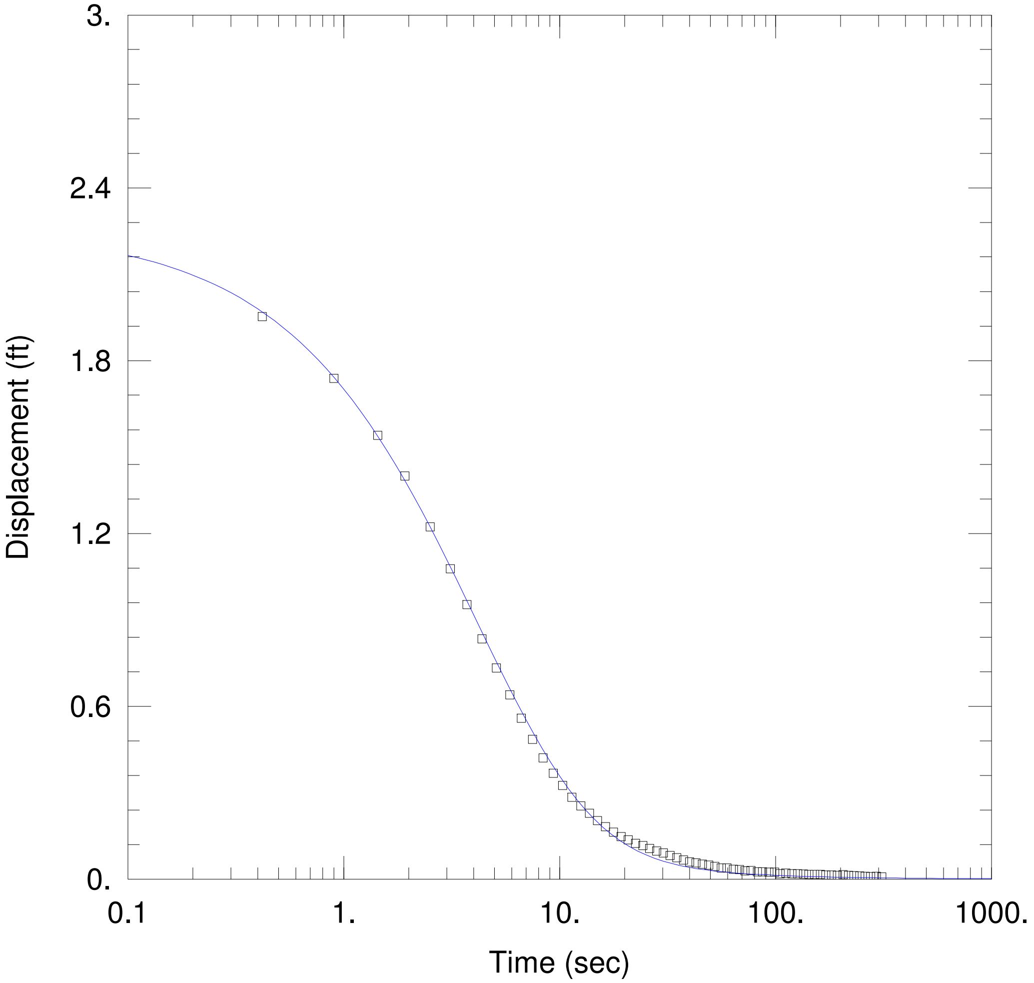
Saturated Thickness: 25. ft	Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (TW-21-011D)

Initial Displacement: 2.483 ft	Static Water Column Height: 32.13 ft
Total Well Penetration Depth: 6. ft	Screen Length: 5. ft
Casing Radius: 0.0887 ft	Well Radius: 0.1667 ft

SOLUTION

Aquifer Model: Confined	Solution Method: Cooper-Bredehoeft-Papadopulos
T = 47.26 ft^2/day	S = 2.802E-5



TW-21-011S

PROJECT INFORMATION

Company: Barr Engineering
Client: Consumers Energy
Project: 22091016.01
Location: DE Karn Landfill
Test Date: 7/7/2021

AQUIFER DATA

Saturated Thickness: 15.74 ft
Anisotropy Ratio (Kz/Kr): 1.

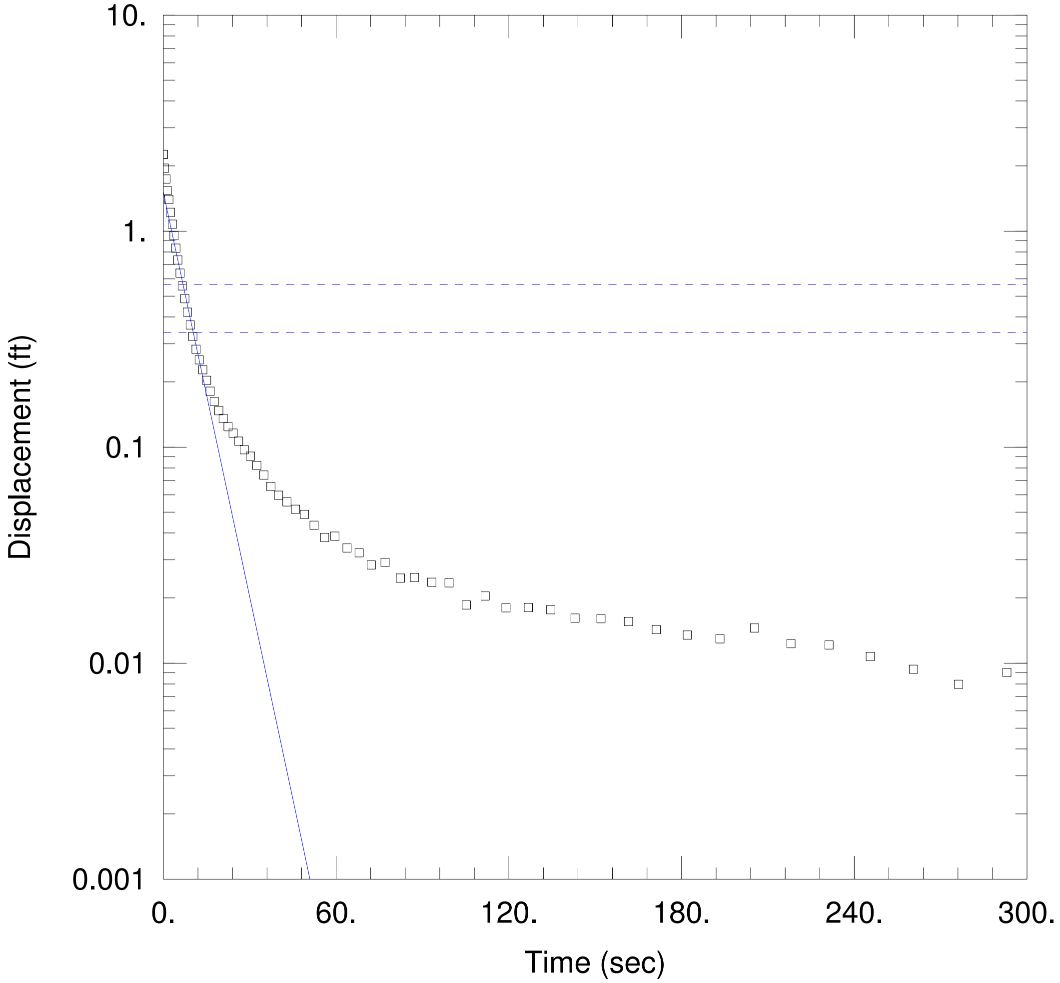
WELL DATA (TW-21-011S)

Initial Displacement: 2.26 ft
Total Well Penetration Depth: 7.24 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 7.24 ft
Screen Length: 5. ft
Well Radius: 0.1667 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 292.4 ft^2/day
S = 0.0001419



TW-21-011S

PROJECT INFORMATION

Company: Barr Engineering
Client: Consumers Energy
Project: 22091016.01
Location: DE Karn Landfill
Test Date: 7/7/2021

AQUIFER DATA

Saturated Thickness: 15.74 ft
Anisotropy Ratio (Kz/Kr): 1.

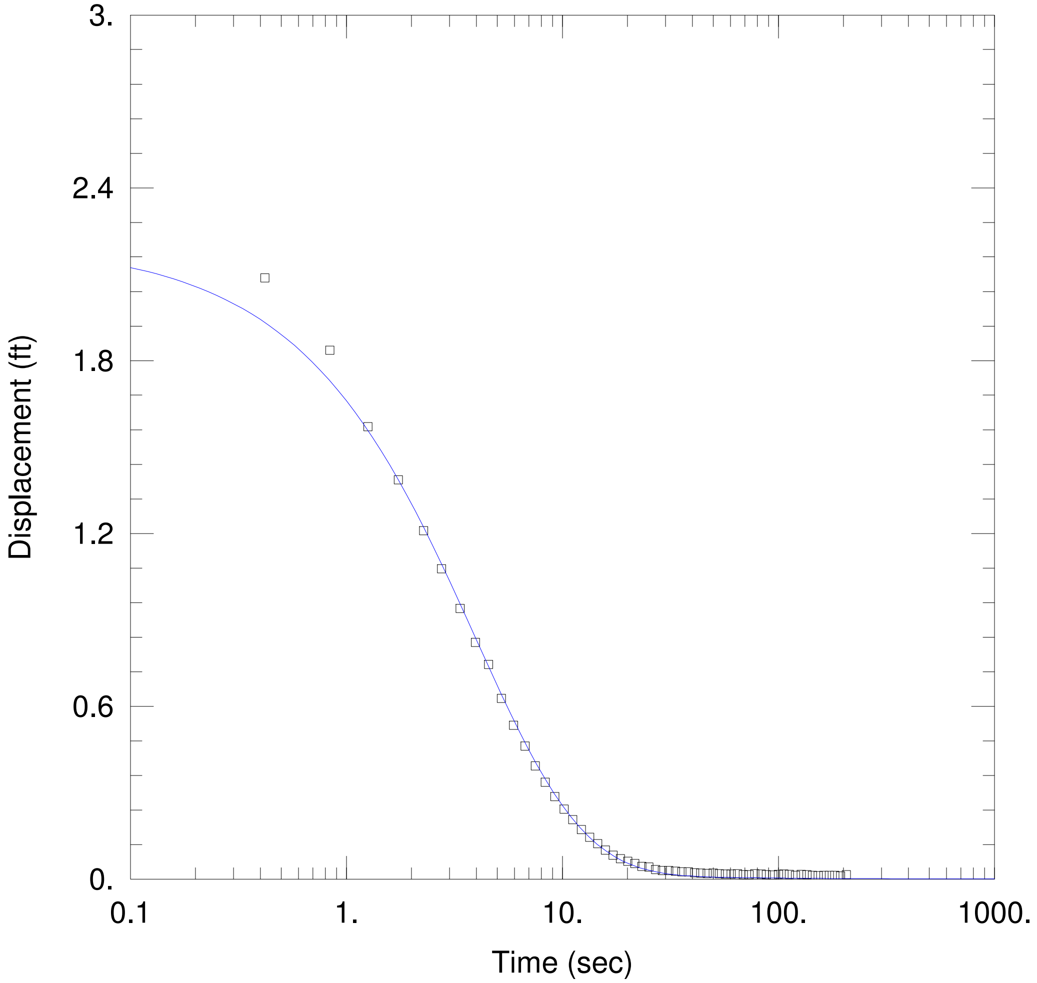
WELL DATA (TW-21-011S)

Initial Displacement: 2.26 ft
Static Water Column Height: 7.24 ft
Total Well Penetration Depth: 7.24 ft
Screen Length: 5. ft
Casing Radius: 0.08333 ft
Well Radius: 0.1667 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 29.35 ft/day
y0 = 1.506 ft



TW-21-012D

PROJECT INFORMATION

Company: Barr Engineering
Client: Consumers Energy
Project: 22091016.01
Location: DE Karn Landfill
Test Date: 7/7/2021

AQUIFER DATA

Saturated Thickness: 25. ft

WELL DATA (TW-21-012D)

Initial Displacement: 2.216 ft
Total Well Penetration Depth: 8. ft
Casing Radius: 0.09261 ft

Static Water Column Height: 36.03 ft
Screen Length: 5. ft
Well Radius: 0.1667 ft

SOLUTION

Aquifer Model: Confined

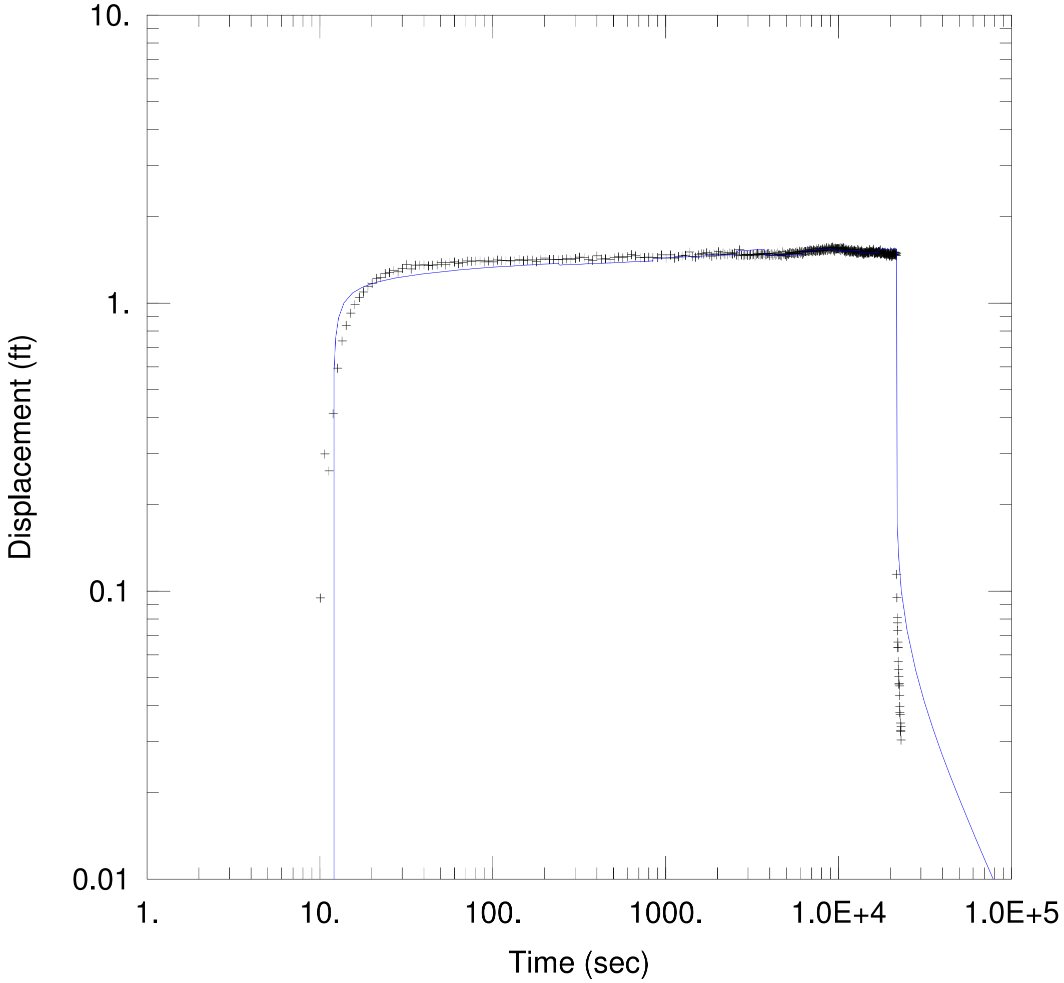
Solution Method: KGS Model

Kr = 52.66 ft/day
Kz/Kr = 1.

Ss = 8.056E-5 ft^{-1}

Appendix B-2

Pumping Test



PUMPING TEST AT TW-21-012D

PROJECT INFORMATION

Company: Barr Eng Co.
Client: Consumers Energy Company
Project: 22091016.01
Location: Essexville, MI
Test Well: TW-21-012D
Test Date: 7/14/2021

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
TW-21-012D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
+ TW-21-012D	0	0

SOLUTION

Aquifer Model: Leaky

Solution Method: Hantush-Jacob

T = 1381. ft^2/day
r/B = 0.0001465
b = 25. ft

S = 0.0184
Kz/Kr = 1.

Data Set: P:\Ann Arbor\22 MI\09\22091015 DE Karn Corrective Action\WorkFiles\PRB Additional Extent Evaluation
Title: Pumping Test at TW-21-012D
Date: 09/03/21
Time: 13:44:47

PROJECT INFORMATION

Company: Barr Eng Co.
Client: Consumers Energy Company
Project: 22091016.01
Location: Essexville, MI
Test Date: 7/14/2021
Test Well: TW-21-012D

AQUIFER DATA

Saturated Thickness: 25. ft
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 8. ft
Aquitard Thickness (b"): 1. ft

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: TW-21-012D

X Location: 0. ft
Y Location: 0. ft

Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft

Partially Penetrating Well
Depth to Top of Screen: 3. ft
Depth to Bottom of Screen: 8. ft

No. of pumping periods: 12

Pumping Period Data

Time (sec)	Rate (gal/min)	Time (sec)	Rate (gal/min)
12.	3.339	6180.	3.401
60.	3.339	9660.	3.339
240.	3.289	1.314E+4	3.261
840.	3.363	1.686E+4	3.344
2580.	3.476	2.046E+4	3.341
3720.	3.304	2.168E+4	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: TW-21-012D

X Location: 0. ft
Y Location: 0. ft

Radial distance from TW-21-012D: 0. ft

Partially Penetrating Well
Depth to Top of Screen: 3. ft
Depth to Bottom of Screen: 8. ft

No. of Observations: 480

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.251	-0.00303	8688.	1.536

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.501	-0.00449	8748.	1.556
0.751	-0.00917	8808.	1.543
1.001	0.00301	8868.	1.545
1.251	-0.00486	8928.	1.54
1.501	-0.00812	8988.	1.527
1.751	-0.0004	9048.	1.537
2.001	-0.00828	9108.	1.559
2.251	-0.00516	9168.	1.543
2.501	-0.0035	9228.	1.567
2.751	-0.00585	9288.	1.562
3.001	-0.00684	9348.	1.544
3.251	-0.0001	9408.	1.532
3.501	-0.00326	9468.	1.548
3.751	-0.00266	9528.	1.517
4.001	0.00127	9588.	1.554
4.251	-0.00139	9648.	1.542
4.501	-0.00554	9708.	1.547
4.751	0.00203	9768.	1.541
5.001	-0.00692	9828.	1.548
5.251	-0.00123	9888.	1.548
5.501	-0.00025	9948.	1.542
5.751	-0.00115	1.001E+4	1.546
6.001	-0.00025	1.007E+4	1.547
6.361	0.00036	1.013E+4	1.535
6.721	-0.00606	1.019E+4	1.551
7.141	0.00021	1.025E+4	1.56
7.561	-0.00721	1.031E+4	1.525
7.98	0.00431	1.037E+4	1.542
8.461	-0.00493	1.043E+4	1.551
9.001	0.00149	1.049E+4	1.553
9.48	0.00272	1.055E+4	1.534
10.08	0.09468	1.061E+4	1.542
10.68	0.2997	1.067E+4	1.551
11.28	0.2616	1.073E+4	1.557
11.94	0.4134	1.079E+4	1.523
12.66	0.5937	1.085E+4	1.514
13.44	0.7391	1.091E+4	1.542
14.22	0.8379	1.097E+4	1.504
15.06	0.9232	1.103E+4	1.526
15.96	0.9881	1.109E+4	1.539
16.92	1.045	1.115E+4	1.513
17.88	1.093	1.121E+4	1.523
18.96	1.145	1.127E+4	1.526
20.1	1.17	1.133E+4	1.515
21.3	1.218	1.139E+4	1.519
22.56	1.228	1.145E+4	1.523
23.88	1.268	1.151E+4	1.536
25.32	1.276	1.157E+4	1.503
26.82	1.3	1.163E+4	1.51
28.38	1.285	1.169E+4	1.505
30.06	1.319	1.175E+4	1.51
31.86	1.361	1.181E+4	1.523
33.72	1.312	1.187E+4	1.507
35.76	1.353	1.193E+4	1.534
37.86	1.354	1.199E+4	1.528
40.08	1.358	1.205E+4	1.513
42.48	1.346	1.211E+4	1.509
45.	1.355	1.217E+4	1.522
47.64	1.357	1.223E+4	1.505
50.46	1.382	1.229E+4	1.512
53.46	1.359	1.235E+4	1.516
56.64	1.382	1.241E+4	1.526
60.	1.389	1.247E+4	1.524
63.6	1.371	1.253E+4	1.509
67.2	1.382	1.259E+4	1.513
71.4	1.401	1.265E+4	1.49
75.6	1.395	1.271E+4	1.513

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
79.8	1.399	1.277E+4	1.495
84.6	1.402	1.283E+4	1.494
90.	1.39	1.289E+4	1.535
94.8	1.398	1.295E+4	1.492
100.8	1.39	1.301E+4	1.508
106.8	1.411	1.307E+4	1.493
112.8	1.402	1.313E+4	1.529
119.4	1.409	1.319E+4	1.5
126.6	1.399	1.325E+4	1.504
134.4	1.403	1.331E+4	1.511
142.2	1.418	1.337E+4	1.508
150.6	1.404	1.343E+4	1.5
159.6	1.411	1.349E+4	1.517
169.2	1.411	1.355E+4	1.526
178.8	1.394	1.361E+4	1.507
189.6	1.414	1.367E+4	1.499
201.	1.432	1.373E+4	1.506
213.	1.419	1.379E+4	1.492
225.6	1.416	1.385E+4	1.486
238.8	1.415	1.391E+4	1.499
253.2	1.418	1.397E+4	1.477
268.2	1.425	1.403E+4	1.502
283.8	1.416	1.409E+4	1.499
300.6	1.43	1.415E+4	1.486
318.6	1.445	1.421E+4	1.502
337.2	1.439	1.427E+4	1.498
357.6	1.414	1.433E+4	1.5
378.6	1.407	1.439E+4	1.494
400.8	1.459	1.445E+4	1.493
424.8	1.42	1.451E+4	1.515
450.	1.424	1.457E+4	1.512
476.4	1.418	1.463E+4	1.489
504.6	1.434	1.469E+4	1.511
534.6	1.446	1.475E+4	1.495
566.4	1.438	1.481E+4	1.506
600.	1.449	1.487E+4	1.493
636.	1.473	1.493E+4	1.497
672.	1.46	1.499E+4	1.497
714.	1.436	1.505E+4	1.506
756.	1.441	1.511E+4	1.498
798.	1.443	1.517E+4	1.534
846.	1.44	1.523E+4	1.519
900.	1.439	1.529E+4	1.504
948.	1.468	1.535E+4	1.506
1008.	1.431	1.541E+4	1.513
1068.	1.468	1.547E+4	1.512
1128.	1.433	1.553E+4	1.506
1188.	1.45	1.559E+4	1.508
1248.	1.46	1.565E+4	1.506
1308.	1.465	1.571E+4	1.518
1368.	1.505	1.577E+4	1.502
1428.	1.449	1.583E+4	1.5
1488.	1.443	1.589E+4	1.515
1548.	1.47	1.595E+4	1.541
1608.	1.483	1.601E+4	1.518
1668.	1.481	1.607E+4	1.495
1728.	1.497	1.613E+4	1.484
1788.	1.474	1.619E+4	1.494
1848.	1.453	1.625E+4	1.492
1908.	1.481	1.631E+4	1.495
1968.	1.47	1.637E+4	1.494
2028.	1.509	1.643E+4	1.496
2088.	1.469	1.649E+4	1.513
2148.	1.491	1.655E+4	1.51
2208.	1.478	1.661E+4	1.509
2268.	1.475	1.667E+4	1.5
2328.	1.497	1.673E+4	1.484

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
2388.	1.484	1.679E+4	1.501
2448.	1.48	1.685E+4	1.493
2508.	1.492	1.691E+4	1.502
2568.	1.468	1.697E+4	1.511
2628.	1.457	1.703E+4	1.502
2688.	1.531	1.709E+4	1.512
2748.	1.468	1.715E+4	1.499
2808.	1.464	1.721E+4	1.501
2868.	1.47	1.727E+4	1.517
2928.	1.477	1.733E+4	1.51
2989.	1.467	1.739E+4	1.498
3048.	1.463	1.745E+4	1.478
3108.	1.475	1.751E+4	1.53
3168.	1.468	1.757E+4	1.485
3228.	1.478	1.763E+4	1.488
3288.	1.46	1.769E+4	1.491
3348.	1.477	1.775E+4	1.494
3408.	1.489	1.781E+4	1.484
3468.	1.473	1.787E+4	1.493
3528.	1.471	1.793E+4	1.495
3588.	1.481	1.799E+4	1.505
3648.	1.472	1.805E+4	1.504
3708.	1.488	1.811E+4	1.495
3768.	1.471	1.817E+4	1.489
3828.	1.474	1.823E+4	1.493
3888.	1.484	1.829E+4	1.495
3948.	1.487	1.835E+4	1.491
4008.	1.461	1.841E+4	1.485
4068.	1.487	1.847E+4	1.5
4128.	1.481	1.853E+4	1.478
4188.	1.464	1.859E+4	1.502
4248.	1.485	1.865E+4	1.485
4308.	1.466	1.871E+4	1.495
4368.	1.476	1.877E+4	1.483
4428.	1.497	1.883E+4	1.491
4488.	1.471	1.889E+4	1.487
4548.	1.472	1.895E+4	1.484
4608.	1.465	1.901E+4	1.458
4668.	1.458	1.907E+4	1.479
4728.	1.508	1.913E+4	1.498
4788.	1.48	1.919E+4	1.499
4848.	1.482	1.925E+4	1.484
4908.	1.476	1.931E+4	1.477
4968.	1.475	1.937E+4	1.487
5028.	1.456	1.943E+4	1.477
5088.	1.487	1.949E+4	1.489
5148.	1.479	1.955E+4	1.494
5208.	1.498	1.961E+4	1.476
5268.	1.499	1.967E+4	1.46
5328.	1.485	1.973E+4	1.474
5388.	1.49	1.979E+4	1.459
5448.	1.498	1.985E+4	1.471
5508.	1.488	1.991E+4	1.47
5568.	1.481	1.997E+4	1.491
5628.	1.5	2.003E+4	1.507
5688.	1.488	2.009E+4	1.474
5748.	1.508	2.015E+4	1.492
5808.	1.487	2.021E+4	1.475
5868.	1.485	2.027E+4	1.498
5928.	1.507	2.033E+4	1.45
5988.	1.515	2.039E+4	1.455
6048.	1.492	2.045E+4	1.481
6108.	1.509	2.051E+4	1.462
6168.	1.516	2.057E+4	1.478
6228.	1.476	2.063E+4	1.486
6288.	1.497	2.069E+4	1.472
6348.	1.513	2.075E+4	1.482

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
6408.	1.511	2.081E+4	1.472
6468.	1.51	2.087E+4	1.501
6528.	1.508	2.093E+4	1.483
6588.	1.516	2.099E+4	1.474
6648.	1.525	2.105E+4	1.502
6708.	1.512	2.111E+4	1.481
6768.	1.534	2.117E+4	1.475
6828.	1.515	2.123E+4	1.495
6888.	1.528	2.129E+4	1.477
6948.	1.526	2.135E+4	1.48
7008.	1.52	2.141E+4	1.467
7068.	1.507	2.147E+4	1.499
7128.	1.514	2.153E+4	1.481
7188.	1.532	2.159E+4	1.46
7248.	1.521	2.165E+4	1.485
7308.	1.523	2.171E+4	0.1145
7368.	1.51	2.177E+4	0.09478
7428.	1.542	2.183E+4	0.08081
7488.	1.521	2.189E+4	0.07755
7548.	1.523	2.195E+4	0.07299
7608.	1.518	2.201E+4	0.06374
7668.	1.547	2.207E+4	0.06647
7728.	1.528	2.213E+4	0.06369
7788.	1.512	2.219E+4	0.057
7848.	1.535	2.225E+4	0.05341
7908.	1.524	2.231E+4	0.04757
7968.	1.521	2.237E+4	0.05062
8028.	1.531	2.243E+4	0.04765
8088.	1.541	2.249E+4	0.04682
8148.	1.533	2.255E+4	0.04334
8208.	1.521	2.261E+4	0.03977
8268.	1.552	2.267E+4	0.03787
8328.	1.531	2.273E+4	0.03723
8388.	1.541	2.279E+4	0.03485
8448.	1.523	2.285E+4	0.03273
8508.	1.559	2.291E+4	0.03249
8568.	1.555	2.297E+4	0.03381
8628.	1.524	2.303E+4	0.03038

SOLUTION

Pumping Test
Aquifer Model: Leaky
Solution Method: Hantush-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	1381.	ft^2/day
S	0.0184	
r/B	0.0001465	
Kz/Kr	1.	
b	25.	ft

K = T/b = 55.24 ft/day (0.01949 cm/sec)
Ss = S/b = 0.0007361 1/ft
K'/b' = 4.94E-8 sec^{-1}
K' = 0.03415 ft/day

AUTOMATIC ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	Std. Error	Approx. C.I.	t-Ratio	
T	1381.	6.381	+/- 12.54	216.4	ft^2/day

S	0.0184	0.002876	+/- 0.00565	6.4	
r/B	0.0001465	not estimated			
Kz/Kr	1.	not estimated			
b	25.	not estimated			ft

C.I. is approximate 95% confidence interval for parameter
t-ratio = estimate/std. error
No estimation window

K = T/b = 55.24 ft/day (0.01949 cm/sec)
Ss = S/b = 0.0007361 1/ft
K'/b' = 4.94E-8 sec^{-1}
K' = 0.03415 ft/day

Parameter Correlations

	T	S
T	1.00	-0.92
S	-0.92	1.00

Residual Statistics

for weighted residuals

Sum of Squares . . . . . . 1.374 ft^2
Variance . . . . 0.002874 ft^2
Std. Deviation . . . . 0.05361 ft
Mean . . . . -0.001011 ft
No. of Residuals 480
No. of Estimates 2

Appendix C

Groundwater Flow Model Files

Model input and output files are enclosed on a separate compressed (i.e., .zip) file. Tables C1, C2, and C3 in this document summarize and describe the calibration, Feasibility Study predictive simulation, and Feasibility Study Addendum predictive simulation model files, respectively. Predictive simulation files use the calibrated parameter values unless specified otherwise.

Table C1 Calibration Model Files

Calibration Model Files: FS_modflow_calib_files.zip	
File Name	**Description**
Simulation Calling 2010, 2016, and 2019 Conditions	
mfsim.nam	Simulation file used by MODFLOW 6
de_karn_2010.ims	MODFLOW 6 input file - Iterative Model Solution (IMS6) Package
mfsim.lst	ASCII output file for simulation
2010 Conditions	
de_karn_2010.nam	Name file used by MODFLOW 6
de_karn_2010.tdis	MODFLOW 6 input file – Temporal Discretization (TDIS) Package
de_karn_2010.lst	ASCII output file
de_karn_2010.dis	MODFLOW 6 input file - Structured Discretization (DIS) Package
de_karn_2010.ic6	MODFLOW 6 input file – Initial Conditions (IC6) Package
de_karn_2010.oc6	MODFLOW 6 input file – Output Control (OC6) Package
de_karn_2010.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
de_karn_2010.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2010.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2010_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2010.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2010_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_2010.ghb	MODFLOW 6 input file – General-Head Boundary (GHB) Package
de_karn_2010.rch	MODFLOW 6 input file – Recharge (RCH) Package
de_karn_2010_initial.hds	MODFLOW 6 binary input file – Initial Heads
de_karn_2010.dis.grb	MODFLOW 6 binary output file – Binary Grid File
de_karn_2010.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_2010.hds	MODFLOW 6 binary output file – Heads
de_karn_2010_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_2010_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
2016 Conditions	
de_karn_2016.nam	Name file used by MODFLOW 6
de_karn_2016.tdis	MODFLOW 6 input file – Temporal Discretization (TDIS) Package
de_karn_2016.lst	ASCII output file
de_karn_2016.dis	MODFLOW 6 input file - Structured Discretization (DIS) Package
de_karn_2016.ic6	MODFLOW 6 input file – Initial Conditions (IC6) Package
de_karn_2016.oc6	MODFLOW 6 input file – Output Control (OC6) Package
de_karn_2016.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
de_karn_2016.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2016.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2016_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2016.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2016_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_2016.ghb	MODFLOW 6 input file – General-Head Boundary (GHB) Package
de_karn_2016.rch	MODFLOW 6 input file – Recharge (RCH) Package
de_karn_2016_initial.hds	MODFLOW 6 binary input file – Initial Heads

de_karn_2016.dis.grb	MODFLOW 6 binary output file – Binary Grid File
de_karn_2016.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_2016.hds	MODFLOW 6 binary output file - Heads
de_karn_2016_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_2016_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
2019 Conditions	
de_karn_2019.nam	Name file used by MODFLOW 6
de_karn_2019.tdis	MODFLOW 6 input file – Temporal Discretization (TDIS) Package
de_karn_2019.lst	ASCII output file
de_karn_2019.dis	MODFLOW 6 input file - Structured Discretization (DIS) Package
de_karn_2019.ic6	MODFLOW 6 input file – Initial Conditions (IC6) Package
de_karn_2019.oc6	MODFLOW 6 input file – Output Control (OC6) Package
de_karn_2019.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_2019.ghb	MODFLOW 6 input file – General-Head Boundary (GHB) Package
de_karn_2019.wel	MODFLOW 6 input file – Well (WEL) Package
de_karn_2019_wel.obs	MODFLOW 6 input file – Observations file for WEL Package
de_karn_2019.rch	MODFLOW 6 input file – Recharge (RCH) Package
de_karn_2019_initial.hds	MODFLOW 6 binary input file – Initial Heads
de_karn_2019.dis.grb	MODFLOW 6 binary output file – Binary Grid File
de_karn_2019.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_2019.hds	MODFLOW 6 binary output file - Heads
de_karn_2019_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_2019_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
de_karn_2019_wel.obs.csv	MODFLOW 6 comma-separated values file – WEL Package observations

Table C2 Feasibility Study Predictive Simulation Model Files

Predictive Simulation Model Files: FS_modflow_pred_files.zip	
File Name	**Description**
Input Files for All Predictive Simulations	
de_karn_2019.ims	MODFLOW 6 input file - Iterative Model Solution (IMS6) Package
de_karn_2019.tdis	MODFLOW 6 input file – Temporal Discretization (TDIS) Package
de_karn_2019.dis	MODFLOW 6 input file - Structured Discretization (DIS) Package
de_karn_2019.ic6	MODFLOW 6 input file – Initial Conditions (IC6) Package
de_karn_2019.oc6	MODFLOW 6 input file – Output Control (OC6) Package
de_karn_2019.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
de_karn_2019.ghb	MODFLOW 6 input file – General-Head Boundary (GHB) Package
de_karn_2019.rch	MODFLOW 6 input file – Recharge (RCH) Package
de_karn_2019_initial.hds	MODFLOW 6 binary input file – Initial Heads
Output File for All Predictive Simulations	
de_karn_2019.dis.grb	MODFLOW 6 binary output file – Binary Grid File
Groundwater Extraction with Six Wells Scenario	
mfsim_existing_wells.nam	Simulation file used by MODFLOW 6

mfsim_existing_wells.lst	ASCII output file for simulation
de_karn_existing_wells.nam	Name file used by MODFLOW 6
de_karn_existing_wells.lst	ASCII output file
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_existing_wells.wel	MODFLOW 6 input file – Well (WEL) Package
de_karn_existing_wells_wel.obs	MODFLOW 6 input file – Observations File for WEL Package
de_karn_existing_wells.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_existing_wells.hds	MODFLOW 6 binary output file - Heads
de_karn_existing_wells_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_existing_wells_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
de_karn_existing_wells_wel.obs.csv	MODFLOW 6 comma-separated values file – WEL Package observations
Groundwater Extraction with Seven Wells Scenario	
mfsim_7new_wells.nam	Simulation file used by MODFLOW 6
mfsim_7new_wells.lst	ASCII output file for simulation
de_karn_7new_wells.nam	Name file used by MODFLOW 6
de_karn_7new_wells.lst	ASCII output file
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_7new_wells.wel	MODFLOW 6 input file – Well (WEL) Package
de_karn_7new_wells_well.obs	MODFLOW 6 input file – Observations File for WEL Package
de_karn_7new_wells.obs	MODFLOW 6 input file – Observations File for Model
de_karn_7new_wells.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_7new_wells.hds	MODFLOW 6 binary output file - Heads
de_karn_7new_wells_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_7new_wells_ddn.obs.csv	MODFLOW 6 comma-separated values file – Model observations
de_karn_7new_wells_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
de_karn_7new_wells_wel.obs.csv	MODFLOW 6 comma-separated values file – WEL Package observations
Groundwater Extraction with Seven Wells and a Low-Permeability Barrier Scenario	
mfsim_7new_wells_barrier.nam	Simulation file used by MODFLOW 6
mfsim_7new_wells_barrier.lst	ASCII output file for simulation
de_karn_7new_wells_barrier.nam	Name file used by MODFLOW 6
de_karn_7new_wells_barrier.lst	ASCII output file
de_karn_barrier_wall.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_7new_wells.wel	MODFLOW 6 input file – Well (WEL) Package
de_karn_7new_wells.obs	MODFLOW 6 input file – Observations File for WEL Package
de_karn_7new_wells.obs	MODFLOW 6 input file – Observations File for Model
de_karn_7new_wells_barrier.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows

de_karn_7new_wells_barrier.hds	MODFLOW 6 binary output file - Heads
de_karn_7new_wells_barrier_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_7new_wells_barrier_ddn.obs.csv	MODFLOW 6 comma-separated values file – Model observations
de_karn_7new_wells_barrier_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
de_karn_7new_wells_barrier_wel.obs.csv	MODFLOW 6 comma-separated values file – WEL Package observations
Groundwater Extraction with a Horizontal Well and a Low-Permeability Barrier Scenario	
mfsim_Hwell.nam	Simulation file used by MODFLOW 6
mfsim_Hwell.lst	ASCII output file for simulation
de_karn_Hwell.nam	Name file used by MODFLOW 6
de_karn_Hwell.lst	ASCII output file
de_karn_barrier_wall.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_Hwell.drn	MODFLOW 6 input file – Drain (DRN) Package
de_karn_Hwell_drn.obs	MODFLOW input file – Observations File for DRN Package
de_karn_Hwell.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_Hwell.hds	MODFLOW 6 binary output file - Heads
de_karn_Hwell_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_Hwell_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
de_karn_Hwell_drn.obs.csv	MODFLOW 6 comma-separated values file – DRN Package observations
Permeable Reactive Barrier with Half-length Low-Permeability Barriers Scenario	
mfsim_half_barrier_prb.nam	Simulation file used by MODFLOW 6
mfsim_half_barrier_prb.lst	ASCII output file for simulation
de_karn_half_barrier_prb.nam	Name file used by MODFLOW 6
de_karn_half_barrier_prb.lst	ASCII output file
de_karn_half_barrier_prb.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_half_barrier_prb.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_half_barrier_prb.hds	MODFLOW 6 binary output file - Heads
de_karn_half_barrier_prb_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_half_barrier_prb_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
Permeable Reactive Barrier with Extended Low-Permeability Barriers Scenario	
mfsim_ext_barrier_prb.nam	Simulation file used by MODFLOW 6
mfsim_ext_barrier_prb.lst	ASCII output file for simulation
de_karn_ext_barrier_prb.nam	Name file used by MODFLOW 6
de_karn_ext_barrier_prb.lst	ASCII output file
de_karn_ext_barrier_prb.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019_chd.obs	MODFLOW 6 input file – Observations File for CHD Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019_riv.obs	MODFLOW 6 input file – Observations File for RIV Package
de_karn_ext_barrier_prb.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows

de_karn_ext_barrier_prb.hds	MODFLOW 6 binary output file - Heads
de_karn_ext_barrier_prb_chd.obs.csv	MODFLOW 6 comma-separated values file – CHD Package observations
de_karn_ext_barrier_prb_riv.obs.csv	MODFLOW 6 comma-separated values file – RIV Package observations
Sensitivity Scenario – Groundwater Extraction with Seven Wells and High Saginaw Bay Water Level	
mfsim_7wells_high_bay.nam	Simulation file used by MODFLOW 6
mfsim_7wells_high_bay.lst	ASCII output file for simulation
de_karn_7wells_high_bay.nam	Name file used by MODFLOW 6
de_karn_7wells_high_bay.lst	ASCII output file
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_high_bay.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_high_bay.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_7new_wells.wel	MODFLOW 6 input file – Well (WEL) Package
de_karn_7new_wells_wel.obs	MODFLOW 6 input file – Observations File for WEL Package
de_karn_7new_wells.obs	MODFLOW 6 input file – Observations File for Model
de_karn_7wells_high_bay.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_7wells_high_bay.hds	MODFLOW 6 binary output file - Heads
de_karn_7wells_high_bay_ddn.obs.csv	MODFLOW 6 comma-separated values file – Model observations
de_karn_7wells_high_bay_wel.obs.csv	MODFLOW 6 comma-separated values file – WEL Package observations
Sensitivity Scenario – Groundwater Extraction with Seven Wells and Low Saginaw Bay Water Level	
mfsim_7wells_low_bay.nam	Simulation file used by MODFLOW 6
mfsim_7wells_low_bay.lst	ASCII output file for simulation
de_karn_7wells_low_bay.nam	Name file used by MODFLOW 6
de_karn_7wells_low_bay.lst	ASCII output file
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_low_bay.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_low_bay.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_7new_wells.wel	MODFLOW 6 input file – Well (WEL) Package
de_karn_7new_wells_wel.obs	MODFLOW 6 input file – Observations File for WEL Package
de_karn_7new_wells.obs	MODFLOW 6 input file – Observations File for Model
de_karn_7wells_low_bay.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_7wells_low_bay.hds	MODFLOW 6 binary output file - Heads
de_karn_7wells_low_bay_ddn.obs.csv	MODFLOW 6 comma-separated values file – Model observations
de_karn_7wells_low_bay_wel.obs.csv	MODFLOW 6 comma-separated values file – WEL Package observations
Sensitivity Scenario – Fully Permeable PRB and High Saginaw Bay Water Level	
mfsim_prb_high_bay.nam	Simulation file used by MODFLOW 6
mfsim_prb_high_bay.lst	ASCII output file for simulation
de_karn_prb_high_bay.nam	Name file used by MODFLOW 6
de_karn_prb_high_bay.lst	ASCII output file
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
de_karn_high_bay.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_high_bay.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_prb_high_bay.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_prb_high_bay.hds	MODFLOW 6 binary output file - Heads
Sensitivity Scenario – Fully Permeable PRB and Low Saginaw Bay Water Level	
mfsim_prb_low_bay.nam	Simulation file used by MODFLOW 6
mfsim_prb_low_bay.lst	ASCII output file for simulation
de_karn_prb_low_bay.nam	Name file used by MODFLOW 6
de_karn_prb_low_bay.lst	ASCII output file
de_karn_2019.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package

de_karn_low_bay.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_low_bay.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_prb_low_bay.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
de_karn_prb_low_bay.hds	MODFLOW 6 binary output file - Heads

Table C3 Feasibility Study Addendum Predictive Simulation Model Files

Predictive Simulation Model Files: FS_Addendum_modflow_pred_files.zip	
File Name	**Description**
Input Files for All Predictive Simulations	
de_karn_2019.ims	MODFLOW 6 input file - Iterative Model Solution (IMS6) Package
de_karn_pred.tdis	MODFLOW 6 input file – Temporal Discretization (TDIS) Package
de_karn_2019.dis	MODFLOW 6 input file - Structured Discretization (DIS) Package
de_karn_2019.ic6	MODFLOW 6 input file – Initial Conditions (IC6) Package
de_karn_2019.chd	MODFLOW 6 input file – Constant-Head (CHD) Package
de_karn_2019.riv	MODFLOW 6 input file – River (RIV) Package
de_karn_2019.ghb	MODFLOW 6 input file – General-Head Boundary (GHB) Package
de_karn_2019.rch	MODFLOW 6 input file – Recharge (RCH) Package
de_karn_2019_initial.hds	MODFLOW 6 binary input file – Initial Heads
Output File for All Predictive Simulations	
de_karn_2019.dis.grb	MODFLOW 6 binary output file – Binary Grid File
Existing Conditions Scenario	
mfsim_Scn0.nam	Simulation file used by MODFLOW 6
mfsim_Scn0.lst	ASCII output file for simulation
Karn_pred_Scn0.nam	Name file used by MODFLOW 6
Karn_pred_Scn0.lst	ASCII output file
Karn_pred_Scn1.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn1.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn0.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn0.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn0.hds	MODFLOW 6 binary output file - Heads
Partially Fouled PRB Keyed into Intermediate Silt/Clay Layer with Calibrated Upper Native Sand Hydraulic Conductivity Scenario	
mfsim_Scn1.nam	Simulation file used by MODFLOW 6
mfsim_Scn1.lst	ASCII output file for simulation
Karn_pred_Scn1.nam	Name file used by MODFLOW 6
Karn_pred_Scn1.lst	ASCII output file
Karn_pred_Scn1.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn1.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn1.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn1.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn1.hds	MODFLOW 6 binary output file - Heads
Initial Permeability PRB Keyed into Intermediate Silt/Clay Layer with Calibrated Upper Native Sand Hydraulic Conductivity Scenario	
mfsim_Scn1b.nam	Simulation file used by MODFLOW 6
mfsim_Scn1b.lst	ASCII output file for simulation
Karn_pred_Scn1b.nam	Name file used by MODFLOW 6
Karn_pred_Scn1b.lst	ASCII output file
Karn_pred_Scn1.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn1.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package

Karn_pred_Scn1_prb_highK.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn1b.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn1b.hds	MODFLOW 6 binary output file - Heads
Completely Fouled PRB Keyed into Intermediate Silt/Clay Layer with Calibrated Upper Native Sand Hydraulic Conductivity Scenario	
mfsim_Scn1a.nam	Simulation file used by MODFLOW 6
mfsim_Scn1a.lst	ASCII output file for simulation
Karn_pred_Scn1a.nam	Name file used by MODFLOW 6
Karn_pred_Scn1a.lst	ASCII output file
Karn_pred_Scn1.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn1.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn1_prb_lowK.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn1a.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn1a.hds	MODFLOW 6 binary output file - Heads
Partially Fouled PRB Keyed into Glacial Till with Calibrated Upper Native Sand Hydraulic Conductivity Scenario	
mfsim_Scn2.nam	Simulation file used by MODFLOW 6
mfsim_Scn2.lst	ASCII output file for simulation
Karn_pred_Scn2.nam	Name file used by MODFLOW 6
Karn_pred_Scn2.lst	ASCII output file
Karn_pred_Scn2.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn1.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn2.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn2.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn2.hds	MODFLOW 6 binary output file - Heads
Partially Fouled PRB Keyed into Intermediate Silt/Clay Layer with Upper Native Sand Hydraulic Conductivity from 2021 Slug Tests Scenario	
mfsim_Scn5.nam	Simulation file used by MODFLOW 6
mfsim_Scn5.lst	ASCII output file for simulation
Karn_pred_Scn5.nam	Name file used by MODFLOW 6
Karn_pred_Scn5.lst	ASCII output file
Karn_pred_Scn5.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn5.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn1.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn5.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn5.hds	MODFLOW 6 binary output file - Heads
Partially Fouled PRB Keyed into Glacial Till with Upper Native Sand Hydraulic Conductivity from 2021 Slug Tests Scenario	
mfsim_Scn6.nam	Simulation file used by MODFLOW 6
mfsim_Scn6.lst	ASCII output file for simulation
Karn_pred_Scn6.nam	Name file used by MODFLOW 6
Karn_pred_Scn6.lst	ASCII output file
Karn_pred_Scn6.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn5.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn2.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn6.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn6.hds	MODFLOW 6 binary output file - Heads
Partially Fouled PRB Keyed into Intermediate Silt/Clay Layer with Two Zones of Upper Native Sand Hydraulic Conductivity Scenario	
mfsim_Scn7.nam	Simulation file used by MODFLOW 6
mfsim_Scn7.lst	ASCII output file for simulation
Karn_pred_Scn7.nam	Name file used by MODFLOW 6

Karn_pred_Scn7.lst	ASCII output file
Karn_pred_Scn7.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn7.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn1.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn7.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn7.hds	MODFLOW 6 binary output file - Heads
Partially Fouled PRB Keyed into Glacial Till with Two Zones of Upper Native Sand Hydraulic Conductivity Scenario	
mfsim_Scn8.nam	Simulation file used by MODFLOW 6
mfsim_Scn8.lst	ASCII output file for simulation
Karn_pred_Scn8.nam	Name file used by MODFLOW 6
Karn_pred_Scn8.lst	ASCII output file
Karn_pred_Scn8.oc6	MODFLOW 6 input file – Output Control (OC6) Package
Karn_pred_Scn7.npf	MODFLOW 6 input file – Node Property Flow (NPF) Package
Karn_pred_Scn2.hfb	MODFLOW 6 input file – Horizontal Flow Barrier (HFB) Package
Karn_pred_Scn8.cbb	MODFLOW 6 binary output file – Cell-by-cell Flows
Karn_pred_Scn8.hds	MODFLOW 6 binary output file - Heads

Attachment D

Continuous Flow-Through Column Testing Summary

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BARR

Technical Memorandum

To: JR Register, Consumers Energy Company
From: Mike Ellis, PE and Christopher Miron, PE
Subject: D.E. Karn Zero-Valent Iron Continuous Flow-Through Column Testing
Date: December 14, 2021
Project: 22091015.01
c: Caleb Batts and Bradley Runkel, Consumers Energy Company;
Tom Boom and Katy Lindstrom, Barr Engineering Co.

1 Introduction

The purpose of this technical memorandum is to provide a summary of accelerated flow-through column testing (column testing) completed by Barr Engineering Co. (Barr) to further evaluate a zero-valent iron (ZVI) amended permeable reactive barrier (PRB) as a corrective action for mitigation of arsenic-impacted groundwater venting to Saginaw Bay potentially related to Consumer's Energy Company's (Consumers') closed 171-acre, Type III, low-hazard industrial landfill (Karn Landfill) in Essexville, Michigan. Results from batch testing conducted as part of the feasibility study (FS) (reference (1)) indicate that attenuation through direct contact with ZVI was an effective means to remove arsenic from impacted groundwater. Batch testing was completed to assess the efficacy of direct contact with ZVI to remove arsenic. Column testing was conducted to further assess the technology by more fully replicating conditions associated with full-scale implementation of a PRB, including using an actively supplied source of site groundwater to feed the columns.

2 Experimental Design and Overview

The following describes the experimental design parameters and how each were developed.

- **Test Duration.** The accelerated flow-through column testing was designed to mimic the equivalent number of pore water volume flushes a PRB would experience over a service life of 10 years. The number of pore water volume flushes a full-scale PRB would experience over 10 years was estimated based on the assumptions that a full-scale PRB would have a width of 1.5 feet, a porosity of 0.3, and the average groundwater velocity of 0.027 feet per day, which is based on the velocity predicted by Barr's groundwater modeling results in the area of installation (reference (1)). These assumptions suggest that a PRB of above-referenced characteristics would experience approximately 220 pore water volume exchanges during a 10-year service life. That number of pore water volume exchanges was used to establish the initial test duration (30 days) based on flow rate through the column.

  After a test duration representative of 10 years was completed, results did not show arsenic breakthrough, which is further described in the Results and Interpretation section, so the test was extended to a quantity of pore volume exchanges consistent with a 30-year PRB service life.

- **ZVI Amendment Rates.** ZVI amendment rates were based on results from batch testing (reference (1)) which suggested that, from a stoichiometric standpoint, a 1.5-foot thick PRB containing 30% ZVI by mass could reduce arsenic concentrations in groundwater by approximately 90% or more over a 45-year service life. Because the 30% ZVI content used in the batch testing was anticipated to maintain treatment effectiveness for a period longer than the post-closure period for the corrective action, a ZVI content of 30% was established as the high-end ZVI content for use in the column testing. Lesser ZVI contents of 5% and 15% were based on anticipated effectiveness at lower amendment rates and industry-standard amendment rates (references (2); (3)).

- **Target Empty Bed Contact Time (EBCT) and Column Flow Rate.** An EBCT of 9 hours was selected based on previous batch testing (reference (1)), which suggested a reaction time of less than 9 hours was adequate to achieve acceptable reductions in arsenic concentrations (i.e., concentrations of arsenic were 0 to 10 micrograms per liter [µg/L] after 9 hours).

- Selecting an EBCT of 9 hours established the flow rate based on the volume of the test columns. Consistent with design guidance for accelerated column tests design (reference (4)), replicating the number of pore water volume exchanges in a column study that would be realized in full-scale implementation, while passing groundwater at a faster rate through the column than what would occur in full-scale implementation, is an efficient means of evaluating the longevity of a reactive medium.

- **Column Sizing.** The general size of the columns was constrained to fit within an existing water treatment building to allow the test to operate in a climate-controlled environment over a period of several months. The final column size design was based on achieving an EBCT of 9 hours while allowing for a flow rate that was measurable and controllable within the experimental constraints (i.e., measuring and controlling the flow rate with needle valve on a rotameter).

- **ZVI Source.** Reactive ZVI media was 8/50 ZVI and was procured from Peerless Metal Power & Abrasives Company of Melvindale, Michigan. 8/50 ZVI is produced for use in environmental applications.

- **Aggregate Source.** Off-site sands used in the experimental columns (i.e., C2, C3, and C4) were Michigan Department of Transportation (MDOT) Class II sands obtained from a Stoneco stockpile in Ann Arbor, Michigan. MDOT Class II sands were selected because sands of this type are readily available throughout Michigan and are representative of materials anticipated to be suitable for a full-scale PRB installation.

3 Experimental Setup

The column test was conducted from December 1, 2020 through March 2, 2021, which allowed for a pore-volume throughput equivalent to approximately 30 years of service life of a full-scale PRB that is under consideration for use at the Karn Landfill.

The column test was conducted using four columns, designated C1 through C4. The columns were each four inches in diameter by approximately 54 inches high and constructed of solvent-welded polyvinyl chloride pipe. Each column was constructed with intermediate sampling ports located approximately one-third and two-thirds of the height of the column, referred to as the 33% and 66% sampling ports respectively, and an effluent sampling port. Groundwater from the existing groundwater extraction system was fed to the columns from the influent line in the existing on-site groundwater treatment building. Groundwater flow to each column was regulated through periodic adjustment of a needle valve on a dedicated rotameter. Treated groundwater was discharged to an on-site tank associated with the existing groundwater extraction and treatment system.

The control column, C1, contained site sands and was not amended with ZVI. The experimental columns C2, C3, and C4 contained MDOT Class II sand amended with ZVI at ZVI/sand mass ratios of 5%/95%, 15%/85%, and 30%/70%, respectively.

4 Sampling Protocols

Sampling was conducted throughout the test to assess the efficacy of arsenic removal and to assess other ramifications of ZVI treatment of extracted groundwater. More frequent sampling occurred during the first five weeks of the column test and less frequent sampling occurred for the remaining eight weeks. Generally, samples collected for laboratory analysis were analyzed for alkalinity, hardness, pH, sulfate, arsenic, calcium, iron, and magnesium, and select samples were analyzed for arsenic speciation. In addition to laboratory analyses, field parameters (dissolved oxygen, pH, oxidation reduction potential, specific conductance, temperature, turbidity, and pressure drop across the columns) were recorded during each event and a Hach® field test kit for arsenic was used to evaluate real-time arsenic concentrations, which allowed for timely results evaluation and adjustments to the experimental procedure based on real-time results.

One sample was collected from the source water immediately prior to bench testing for laboratory analysis. Sampling protocols for the first five weeks included collecting samples from each sampling port (effluent and intermediate sampling ports) on all columns on a weekly basis. At each sampling event, a sample was collected from each of three sample ports located at equal intervals along the column's treatment path (i.e., 33% of its length, 66% of its length, and the effluent).

During the remaining eight weeks of the test, sampling was conducted every-other week and was focused on column C2 (containing a 5%/95% ratio of ZVI/sand). Sampling was limited to this column because that amendment ratio was considered most probable for full-scale PRB implementation.

Solid-phase sampling for arsenic was conducted following completion of the test by splitting the columns into an influent, middle, and effluent sections, each weighing approximately 18-pounds (lb), and creating composite samples from those sections. Solid-phase samples were analyzed to evaluate the mass balance of arsenic in the column test system, and toxicity characteristic leaching procedure (TCLP) testing was performed on a composite sample from the media in each experimental column to evaluate if the spent media constitutes a hazardous waste based on the toxicity characteristic.

5 Results and Interpretation

A summary of field data collected during the test is summarized in Table 1 and a photolog of the column test is attached as Exhibit A.

5.1 Dissolved-Phase Sampling Results

Results of effluent sampling from C2, C3, and C4 showed that total and dissolved arsenic concentrations were consistently less than the site-specific chronic mixing zone-based groundwater-surface water interface (GSI) criterion of 100 µg/L for the duration of the test. Dissolved arsenic was not detected in a vast majority of effluent samples from C2, C3, and C4, and the detections of dissolved arsenic in effluent samples from C2, C3, and C4 were from samples collected from C2. Detections of dissolved arsenic in samples from the C2 effluent were estimated detections based on the sample not meeting laboratory quality control criteria or the result being between the laboratory's detection and quantitation limits. Total arsenic was detected in select samples collected from the effluent of C2, C3, and C4, but results were less than 10 µg/L, which is more than an order of magnitude lower than the GSI criterion of 100 µg/L.A comparison of analytical results to GSI criteria is included in Table 2.1 through Table 2.4.

Influent dissolved arsenic concentrations varied over the duration of the experiment from 69 µg/L to 760 µg/L. Figure 1 shows the dissolved arsenic effluent concentrations over the duration of the column test as a percentage of the influent concentrations. Figure 1 indicates that C1 effluent arsenic concentrations were generally consistent with influent arsenic concentrations except for the December 29, 2020 sampling event where results from C1 effluent were nearly 300% greater than the influent arsenic concentrations. The difference between the C1 influent and effluent concentrations observed during this sampling event could be an effect of the variable influent arsenic concentrations between samples and recent variations in the influent concentrations not being realized at the effluent of C1 prior to the sampling event. Figure 1 also indicates that arsenic was well attenuated in columns C2, C3, and C4 which is exhibited by effluent concentrations from those columns being less than 2% of the influent arsenic concentrations throughout the duration of the test.

Arsenic was detected in every sampling event from the intermediate C1 sampling ports. Arsenic concentrations at the intermediate C1 sampling ports are generally consistent with concentrations at the C1 effluent and influent. Figure 2 summarizes dissolved arsenic concentrations in C1 as a percentage of the influent concentrations over the duration of the column test. The results indicate that the control column did not attenuate arsenic, and therefore, attenuation of arsenic in the experimental columns should be considered a result of the ZVI within those columns.

In columns containing ZVI, analytical results indicate that concentrations of total arsenic were similar to results for dissolved arsenic, suggesting that ZVI is effective at sequestering arsenic in both the dissolved and suspended phases. These results generally agree with the continuously stirred batch reactor experiment conducted as part of the FS (reference (1)).

Arsenic was not detected in samples collected from the intermediate sample ports of C3 and C4 aside from an estimated detected value observed in the sample collected from the 33% sample port of C3 on December 8, 2020. The arsenic concentrations in the C3 and C4 intermediate sample ports are not included on a figure for this reason. Arsenic was routinely detected in samples collected from the intermediate sample ports of C2, but results were not indicative of breakthrough, as arsenic results from the intermediate 33% sample port were higher during the test's early stages and generally decreased over the test duration with the exception of the March 2, 2021 sampling event.[1] Figure 3 summarizes dissolved arsenic concentrations in C2 as a percentage of the influent concentrations over the duration of the column test. Figure 3 shows that less than 30% of the influent arsenic concentration was detected at the 33% sample port throughout the duration of the test and that percentage decreased at the 66% and effluent sampling ports during each sampling event, with the effluent sample exhibiting non-detect values of dissolved arsenic during most sampling events. These results indicate that arsenic attenuation occurred throughout the length of the column, and in consideration with results from C3 and C4, indicates that arsenic attenuation is a function of the mass of ZVI that has contacted the impacted groundwater.

The concentration of aqueous-phase sulfate did not appear to be affected by flow through column C2, with similar concentrations in the influent and effluent. Reductions in sulfate concentration were observed in columns C3 and C4 during some sampling events. Further interpretation of aqueous-phase sulfate results is included in the solid-phase sampling results section because consideration of sulfate in both the aqueous and solid-phases is needed to assess the fate of sulfate within the experimental columns.

5.2 Solid-Phase Sampling Results

Following the tests conclusion, solid-phase sampling was conducted on the column media to approximate an arsenic mass-balance, for waste characterization purposes, to assess the fate of sulfate in the column test, and to assess carbonate-based fouling. The analytical results of solid-phase sampling are summarized in Table 3.

Solid-phase sampling results for arsenic were used along with aqueous phase results from column effluent sampling to evaluate the mass balance of arsenic in the column test system. A depiction of the arsenic mass-balance is shown on Figure 4. Mass balances for columns C1 and C3 are most nearly closed with respect to total influent arsenic (i.e., the total arsenic mass is within 15% of the expected total). Results from evaluating the arsenic mass balance for columns C2 and C4 show that sample results were further from closing the arsenic mass balance, despite effluent samples from both columns having arsenic concentrations below or near the detection limit for the duration of the test. The unclosed mass balances

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[1] The observed reduction in arsenic concentrations over the life of the column test is considered likely to be the result of entrained solids contained in earlier samples collected from this sampling port or some other, similar sampling anomaly.

of C2 and C4 are attributed to the variability of influent arsenic concentrations, the relative infrequency of sampling relative to test duration, and the limitations of solid-phase sampling methods. As shown in Table 2.1 through Table 2.4, influent dissolved arsenic concentrations varied by nearly an order of magnitude during the test (69 to 760 µg/L). The variability of the influent arsenic concentration means there is less confidence in the total influent arsenic mass calculated. Sample jars for the solid-phase sampling allowed for collection of approximately 1.5 lbs of material which is much less than the 18 lbs of material generated from each section of the column. It is possible that even with significant mixing in each internal section, sampling resulted in imprecise representation of the concentration of arsenic in each section due to the potentially heterogeneous distribution of arsenic on the column media. Despite the potential bias in these results, the mass balance indicates that most of the arsenic was captured by the experimental column media across all columns.

Analytical results from TCLP testing indicate that the column media did not constitute a hazardous waste based on the toxicity characteristic.

Solid-phase sulfur was sampled, and the results are summarized in Table 3. Solid-phase sulfur results from the column media indicate that sulfur-containing compounds were removed from groundwater as a result of contact with the ZVI, with sulfur concentrations in the column media consistently increasing with increasing ZVI content. The fate of sulfur-bearing compounds will be examined further in the detailed design phase.

Solid-phase samples were also collected to provide data that would be used to evaluate carbonate-based fouling during potential future geochemical evaluations. The following field observations related to fouling were noted:

- pressure increased at the system influent over time to maintain column flow rate and overcome increased pressure drop attributed to a reduction in available flow channels in the column media;
- during deconstruction, some sections of the experimental columns had been hardened into dark-colored, dense, cohesive material that was difficult to separate; and
- during deconstruction, influent screens of the experimental columns were observed to have a build-up of rust-colored deposits.

6 Conclusions

Experimental columns consistently removed arsenic to below site-specific chronic mixing zone-based concentration values of 100 µg/L for the duration of the test. The experimental column C2 had the lowest ZVI-to-sand mass ratio (5% to 95%) of the three columns evaluated during the testing and therefore, would represent the most cost-effective amendment ratio evaluated for use in a full-scale PRB. A ZVI-to-sand mass ratio of 5% to 95% is recommended for further evaluation in the detailed design phase.

Results from the column test suggest that the preliminary 10-year design life assumed in the FS was conservative, and a longer service life is reasonable to assume from the perspective of the PRB’s ability to reduce arsenic concentrations in groundwater to less than its site-specific chronic mixing zone-based GSI criterion. Based on literature and observations from the column testing, factors other than ZVI oxidation or passivation (e.g., fouling/decreased barrier permeability) may drive the lifespan of a full-scale PRB. Geochemical modeling, to be completed in final design, should be employed to assess these factors in detail.

Visual observations during column deconstruction indicated fouling occurred in the column media; however, flow through the column was maintained during testing. Fouling is partially attributable to the corrosion products of the ZVI spalling from the surface of the ZVI or forming in solution, along with adsorbed or co-precipitated arsenic. Retention of sulfur-bearing compounds in the ZVI also contributed to the visually observed fouling. Characterization of solids subsequent to the column testing confirmed the presence of arsenic removed from groundwater in the sand/ZVI matrix.

7 References

1. **Barr Engineering Co.** Feasibility Study: D.E. Karn Generating Facility. February 2021.

2. **Department of Earth and Environmental Sciences, University of Waterloo; AECOM.** Laboratory Testing of Reactive Media for Permeable Reactive Barriers to Treat Groundwater Affected by Coal Combustion Residual Leachate. s.l. : Electric Power Research Institute, Inc. (EPRI), 2017. Technical Report 3002010951.

3. **The Interstate Technology and Regulatory Council.** Permeable Reactive Barrier: Technology Update. June 2011.

4. **Battelle Memorial Institute.** Design Guidance for Application of Permeable Reactive Barriers for Groundwater Remediation. March 2000.

Attachments:

Table 1	Field Data
Table 2.1	Aqueous-Phase Analytical Data - Influent and C1
Table 2.2	Aqueous-Phase Analytical Data – Influent and C2
Table 2.3	Aqueous-Phase Analytical Data – Influent and C3
Table 2.4	Aqueous-Phase Analytical Data – Influent and C4
Table 3	Solid-Phase Sampling Analytical Data
Figure 1	Arsenic Concentrations Normalized to Influent Concentrations over Time
Figure 2	Column C1 Arsenic Concentrations Normalized to Influent Concentrations over Time
Figure 3	Column C2 Arsenic Concentrations Normalized to Influent Concentrations over Time
Figure 4	Arsenic Mass-Balance
Exhibit A	Photolog

Tables

Table 1
Field Data
D.E. Karn Generating Facility
Consumers Energy Company

		Location	INFL	INFL	INFL	INFL	INFL	INFL	INFL	INFL	INFL	INFL	INFL	INFL	INFL	C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL
		Date	12/08/2020	12/15/2020	12/22/2020	12/29/2020	1/05/2021	1/12/2021	1/19/2021	1/26/2021	2/02/2021	2/09/2021	2/17/2021	2/23/2021	3/02/2021	12/08/2020	12/15/2020	12/22/2020	12/29/2020	1/05/2021	1/12/2021	1/19/2021
		Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Units																				
Field Parameters																						
Arsenic (Hach Method)	Dissolved	ug/l	**70 -300**	**70 - 300**	**300 - 500**	**50 - 70**	**300**	**300**	**70 - 300**	**300 - 500**	**300 - 500**	**70 - 300**	**500+**	**300 - 500**	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	mg/l	**1.81**	**1.76**	**5.95**	**2.02**	**4.97**	**5.04**	**2.08**	**2.31**	**5.62**	**3.50**	**3.40**	**3.35**	**5.28**	**2.03**	**1.99**	**7.15**	**2.71**	**7.48**	**7.50**	**3.36**
pH	NA	pH units	**7.12**	**7.23**	**7.53**	**6.71**	**7.47**	**7.41**	--	**7.34**	**7.45**	**7.42**	**7.26**	**7.37**	**7.37**	**7.80**	**7.88**	**7.42**	**7.05**	**7.44**	**7.41**	--
Redox (oxidation potential)	NA	mV	**-98.2**	**-101.8**	**-105.0**	**-58.1**	**-51.2**	**72.6**	**-83.7**	**-104.3**	**-42.7**	**-60.8**	**-45.9**	**-77.3**	**-7.0**	**-72.5**	**-65.9**	**-84.0**	**-63.0**	**-50.5**	**-36.3**	**-110.4**
Specific conductance @ 25 ºC	NA	umhos/cm	**1077**	**1103**	**1255**	**1181**	**1245**	**1248**	**1207**	**1253**	**1370**	**899**	**1224**	**1193**	**1098**	**1106**	**995**	**1225**	**1358**	**1240**	**1252**	**661**
Temperature	NA	deg C	**12.1**	**12.8**	**12.0**	**16.2**	**13.3**	**11.8**	**17.3**	**14.2**	**12.0**	**10.9**	**11.3**	**16.3**	**15.6**	**15.7**	**15.3**	**14.2**	**14.5**	**14.5**	**13.5**	**17.3**
Turbidity	NA	NTU	**43.5**	**52.4**	**18.66**	**17.8**	**8.27**	**33.49**	**5.06**	**56.7**	**37.34**	**22.6**	**27.8**	**24.7**	**4.74**	**8.92**	**9.01**	**24.96**	**50.2**	**57.61**	**52.13**	**26.2**
Pressure - Arrival	NA	psi	--	--	--	--	--	--	--	--	--	**7.5**	**7.5**	**7.5**	**8.0**	**2**	**3**	**2**	**2.5**	**4.0**	**4.25**	**4.00**
Pressure - Departure	NA	psi	--	--	--	--	--	--	--	--	--	**7.5**	**7.5**	**7.5**	**8.0**	--	--	**2**	--	**4.2**	**4.25**	**4.25**

Table 1
Field Data
D.E. Karn Generating Facility
Consumers Energy Company

Location			C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL	C1-EFFL	C2-33	C2-33	C2-33	C2-33	C2-33	C2-33	C2-33	C2-33	C2-66	C2-66	C2-66	C2-66	C2-66	C2-66	C2-66
Date			1/26/2021	2/02/2021	2/09/2021	2/17/2021	2/23/2021	3/02/2021	1/05/2021	1/12/2021	1/19/2021	1/26/2021	2/02/2021	2/09/2021	2/17/2021	2/23/2021	1/05/2021	1/05/2021	1/19/2021	1/26/2021	2/02/2021	2/09/2021	2/17/2021
Sample Type			N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Units																					
Field Parameters																							
Arsenic (Hach Method)	Dissolved	ug/l	--	--	--	--	--	--	30 - 50	30 - 50	30 - 50	30 - 50	30	--	30 - 50	30 - 50	50 -70	50 -70	30 - 50	30 - 50	30	--	30 - 50
Dissolved oxygen	NA	mg/l	5.40	7.05	6.23	5.75	2.74	7.51	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
pH	NA	pH units	7.55	7.55	7.53	7.45	7.45	7.34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Redox (oxidation potential)	NA	mV	-98.6	-67.6	-113.8	-131.1	-105.5	-6.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Specific conductance @ 25 ºC	NA	umhos/cm	1235	1237	964	1195	1235	1129	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature	NA	deg C	16.0	17.9	15.9	16.0	16.9	17.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Turbidity	NA	NTU	25.8	35.71	18.2	69.3	21.3	55.04	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pressure - Arrival	NA	psi	4.00	3.5	3.5	5.0	4.5	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pressure - Departure	NA	psi	3.5	4.0	4.0	4.0	5.0	5.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 1
Field Data
D.E. Karn Generating Facility
Consumers Energy Company

		Location	C2-66	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C2-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL
		Date	2/23/2021	12/08/2020	12/15/2020	12/22/2020	12/29/2020	1/05/2021	1/12/2021	1/19/2021	1/26/2021	2/02/2021	2/09/2021	2/17/2021	2/23/2021	3/02/2021	12/08/2020	12/15/2020	12/22/2020	12/29/2020	1/05/2021	1/12/2021
		Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Units																				
Field Parameters																						
Arsenic (Hach Method)	Dissolved	ug/l	10 - 30	10	< 10	10 - 30	0 -10	10 - 30	10 - 30	10 - 30	10 - 30	10 - 30	10 - 30	10 - 30	10 - 30	--	--	--	--	--	--	--
Dissolved oxygen	NA	mg/l	--	2.84	2.01	6.38	5.09	7.52	6.54	2.39	4.81	6.53	4.39	3.75	2.93	6.57	1.82	1.68	6.89	5.12	7.77	7.89
pH	NA	pH units	--	7.62	7.71	7.32	7.29	7.45	7.39	--	7.92	7.46	7.73	7.42	7.63	7.30	7.96	7.84	8.36	7.63	8.59	8.30
Redox (oxidation potential)	NA	mV	--	-124.8	-117.8	-96.1	-80.9	-42.3	-68.6	-126.8	-117.3	-85.6	-103.5	-134.3	-127.1	0.2	-171.8	-180.2	144.0	-9.8	154.1	183.3
Specific conductance @ 25 ºC	NA	umhos/cm	--	523.9	501	1208	980	1079	1188	656	1189	1133	921	1077	1035	1045	871	792	811	574.2	689	801
Temperature	NA	deg C	--	16.6	15.0	14.0	13.0	14.0	12.9	17.9	18.9	17.5	14.6	16.9	16.0	16.5	15.6	15.2	13.3	13.1	14.6	12.7
Turbidity	NA	NTU	--	> 1000	55.6	164.7	229	99.68	199.79	145	242	133.51	126	72.8	109	127.44	75.3	70.1	69.51	39.8	30.96	69.88
Pressure - Arrival	NA	psi	--	2.5	2.5	1.5	2.5	3.8	4.25	4	4.5	3.25	4.0	5.5	5.5	6.5	3	2.5	2.2	2.5	4.5	4.25
Pressure - Departure	NA	psi	--	--	--	1.25	--	4	4.25	4	4	5.0	5.0	4.5	5.5	6.25	--	--	2	--	3	4.0

Table 1
Field Data
D.E. Karn Generating Facility
Consumers Energy Company

		Location	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C3-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL	C4-EFFL
		Date	1/19/2021	1/26/2021	2/02/2021	2/09/2021	2/17/2021	2/23/2021	3/02/2021	12/08/2020	12/15/2020	12/22/2020	12/29/2020	1/05/2021	1/12/2021	1/19/2021	1/26/2021	2/02/2021	2/09/2021	2/17/2021	2/23/2021	3/02/2021
		Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Total or Dissolved	Units																				
Field Parameters																						
Arsenic (Hach Method)	Dissolved	ug/l	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dissolved oxygen	NA	mg/l	2.34	4.33	6.33	3.41	2.08	0.31	7.38	2.78	2.65	7.31	4.26	6.20	7.28	3.16	5.34	8.16	3.08	3.10	0.25	7.64
pH	NA	pH units	--	7.53	7.63	8.74	7.56	7.68	7.22	8.35	8.01	7.49	7.55	9.09	8.54	--	8.26	7.89	9.11	7.60	8.17	7.02
Redox (oxidation potential)	NA	mV	-133.7	-88.3	-76.8	38.6	-154.7	-107.8	97.6	-138.8	-129.4	157.5	45.0	123.0	168.4	-83.7	-7.8	117.7	-7.6	-93.6	7.2	216.9
Specific conductance @ 25 ºC	NA	umhos/cm	860	999	941	443.9	938	894	929	43.9	58.3	885	607.3	625	821	409.8	801	664	228.7	837	749	933
Temperature	NA	deg C	18.1	16.9	17.0	15.8	17.5	15.7	15.8	15.1	14.9	13.9	15.7	16.8	14.8	18.3	16.7	16.0	15.7	17.1	15.7	15.6
Turbidity	NA	NTU	70.6	69.2	82.81	190	232	201	112.48	114	102	39.88	72.9	31.70	8.70	53.2	222.9	29.55	35.2	36.5	96.3	101.66
Pressure - Arrival	NA	psi	5	4	4.0	4.0	6.0	6.0	5.5	3.5	3	2.5	3.5	3.9	4.0	4.0	4.5	2.5	3.5	5.0	5.0	6.0
Pressure - Departure	NA	psi	5	4	4.0	4.0	4.5	5.5	3.75	--	--	2.5	--	4	4.0	4.5	4	4.5	5.0	5.0	5.5	1.5

Table 2.1
Aqueous-Phase Analytical Data - Influent and C1
D.E. Karn Generating Facility
Consumers Energy

		Parameter	**Alkalinity, total, as CaCO3**	**Hardness, as CaCO3**	**pH**	**Sulfate, as SO4**	**Arsenic**	**Calcium**	**Iron**	**Magnesium**	**Arsenic III**	**Arsenic inorganic**	**Arsenic V**
		Total or Dissolved	**NA**	**NA**	**NA**	**NA**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Total**	**Total**	**Total**
		Units	**ug/l**	**ug/l**	**pH units**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**
		Groundwater Surface Water Interface Criteria (1)			**6.5 - 9.0**		**100 (2)**						
Location	Date	Sample Type											
INFL	12/08/2020	N	340000	580000	8.0 H	240000	**430**	150000	3000	48000	181	458	278
INFL	12/15/2020	N	320000	550000	8.3 H	240000	**760**	140000	7200	43000	776	932	156
INFL	12/22/2020	N	320000	590000	8.2 H	260000	**590**	160000	4400	49000	641	727	86
INFL	12/29/2020	N	280000	580000	7.7	290000	**180**	150000	1300	48000	138 H	224	85.3
INFL	1/05/2021	N	290000	570000	8.3	270000	**270**	160000	1800	50000	219	267	48.8
INFL	1/19/2021	N	280000	520000	8.3	270000	**250**	150000	1900	48000	236	285	49.2
INFL	2/09/2021	N	310000	880000	8.2	270000	**120**	170000	1200	55000	113	345	231
INFL	3/02/2021	N	270000	1200000	8.0	240000	69	140000	390	45000	40.5	127	86.7
C1-33	12/08/2020	N	280000	620000	8.1 H	250000	**470**	160000	6500	51000	--	--	--
C1-33	12/15/2020	N	330000	560000	8.3 H	230000	**860**	140000	6900	43000	--	--	--
C1-33	12/22/2020	N	320000	580000	8.1 H	260000	**630**	160000	6600	49000	--	--	--
C1-33	12/29/2020	N	330000	610000	8.1	270000	**260**	150000	3900	49000	--	--	--
C1-33	1/05/2021	N	290000	580000	8.3	280000	**230**	150000	3800	48000	--	--	--
C1-33	3/02/2021	N	270000	1400000	8.0	230000	**120**	150000	1800	47000	--	--	--
C1-66	12/08/2020	N	330000	540000	8.0 H	240000	**460**	150000	3600	49000	--	--	--
C1-66	12/15/2020	N	320000	620000	8.3 H	240000	**550**	160000	5900	48000	--	--	--
C1-66	12/22/2020	N	320000	590000	8.2 H	260000	**710**	170000	6400	51000	--	--	--
C1-66	12/29/2020	N	340000	550000	8.1	260000	**410**	150000	4400	48000	--	--	--
C1-66	1/05/2021	N	300000	570000	8.3	270000	**290**	150000	2900	48000	--	--	--
C1-66	3/02/2021	N	280000	890000	8.0	230000	**140**	150000	2000	46000	--	--	--
C1-EFFL	12/08/2020	N	320000	580000	8.1 H	250000	**500**	150000	2000	49000	134	460	326
C1-EFFL	12/15/2020	N	320000	560000	8.3 H	240000	**460**	160000	3600	48000	434	637	203
C1-EFFL	12/22/2020	N	310000	580000	8.2 H	260000	**600**	160000	3800	49000	746	725	< 7.5
C1-EFFL	12/29/2020	N	330000	580000	7.8	280000	**530**	150000	5700	47000	286 H	622	336
C1-EFFL	1/05/2021	N	290000	580000	8.3	270000	**300**	160000	4100	50000	323	310	< 15.0 U
C1-EFFL	1/19/2021	N	270000	--	8.3	270000	**450**	160000	4600	51000	--	--	--
C1-EFFL	2/09/2021	N	340000	1300000	8.0	250000	**180**	160000	3200	52000	180	167	< 15.0 U
C1-EFFL	3/02/2021	N	260000	1100000	8.2	230000	**140**	140000	1300	45000	140	218	77.6

Footnotes

N Sample type: Normal

H Recommended sample preservation, extraction or analysis holding time was exceeded.

U The analyte was analyzed for, but was not detected.

(1) Groundwater surface water criteria as of 6/25/2018, with exceedances shown in bold text

(2) Site-specific mixing zone criteria

Table 2.2

Aqueous-Phase Analytical Data - Influent and C2

D.E. Karn Generating Facility

Consumers Energy

		Parameter	**Alkalinity, total, as CaCO3**	**Hardness, as CaCO3**	**pH**	**Sulfate, as SO4**	**Arsenic**	**Calcium**	**Iron**	**Magnesium**	**Arsenic III**	**Arsenic inorganic**	**Arsenic V**
		Total or Dissolved	**NA**	**NA**	**NA**	**NA**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Total**	**Total**	**Total**
		Units	**ug/l**	**ug/l**	**pH units**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**
		Groundwater Surface Water Interface Criteria (1)			**6.5 - 9.0**		**100 (2)**						
Location	Date	Sample Type											
INFL	12/08/2020	N	340000	580000	8.0 H	240000	**430**	150000	3000	48000	181	458	278
INFL	12/15/2020	N	320000	550000	8.3 H	240000	**760**	140000	7200	43000	776	932	156
INFL	12/22/2020	N	320000	590000	8.2 H	260000	**590**	160000	4400	49000	641	727	86
INFL	12/29/2020	N	280000	580000	7.7	290000	**180**	150000	1300	48000	138 H	224	85.3
INFL	1/05/2021	N	290000	570000	8.3	270000	**270**	160000	1800	50000	219	267	48.8
INFL	1/19/2021	N	280000	520000	8.3	270000	**250**	150000	1900	48000	236	285	49.2
INFL	2/09/2021	N	310000	880000	8.2	270000	**120**	170000	1200	55000	113	345	231
INFL	3/02/2021	N	270000	1200000	8.0	240000	69	140000	390	45000	40.5	127	86.7
C2-33	12/08/2020	N	290000	550000	8.0 H	250000	**110**	150000	26000	48000	--	--	--
C2-33	12/15/2020	N	300000	550000	8.1 H	240000	32	120000	19000	41000	--	--	--
C2-33	12/22/2020	N	320000	580000	8.1 H	260000	**160**	160000	14000	50000	--	--	--
C2-33	12/29/2020	N	310000	590000	8.0	280000	19	150000	10000	49000	--	--	--
C2-33	1/05/2021	N	270000	580000	8.2	270000	13	140000	11000	48000	--	--	--
C2-33	1/19/2021	N	280000	570000	8.2	260000	22	150000	11000	50000	--	--	--
C2-33	2/09/2021	N	270000	1100000	8.2	260000	4.3 J	150000	14000	53000	--	--	--
C2-33	3/02/2021	N	260000	1100000	8.0	230000	19	130000	9500	46000	--	--	--
C2-66	12/08/2020	N	270000	520000	8.0 H	240000	2.7 J	140000	25000	49000	--	--	--
C2-66	12/15/2020	N	260000	500000	8.2 H	230000	< 1.5 U	120000	10000	49000	--	--	--
C2-66	12/22/2020	N	300000	560000	8.2 H	260000	20	150000	12000	48000	--	--	--
C2-66	12/29/2020	N	260000	540000	8.1	280000	1.5 J	120000	4400	48000	--	--	--
C2-66	1/05/2021	N	260000	520000	8.3	270000	< 1.5 U	130000	7600	54000	--	--	--
C2-66	1/19/2021	N	250000	600000	8.2	260000	< 1.5 U	140000	8900	50000	--	--	--
C2-66	2/09/2021	N	290000	1200000	8.1	250000	< 1.5 U	140000	6900	59000	--	--	--
C2-66	3/02/2021	N	260000	880000	7.9	230000	2.3 J	120000	5300	46000	--	--	--
C2-EFFL	12/08/2020	N	250000	500000	8.1 H	240000	2.3 J	130000	16000	50000	1.28	1.28	< 0.500 U
C2-EFFL	12/15/2020	N	190000	440000	8.3 H	220000	< 1.5 U	100000	2400	43000	0.022 UB	0.550	0.550
C2-EFFL	12/22/2020	N	300000	570000	8.2 H	260000	3.4 J	140000	6600	47000	0.161	7.85	7.689
C2-EFFL	12/29/2020	N	190000	430000	8.1	270000	< 1.5 U	97000	3800	44000	< 1.50 UH	< 3.00 U	< 3.00 U
C2-EFFL	1/05/2021	N	220000	480000	8.3	260000	< 1.5 U	110000	3800	51000	1.30	< 7.50 U	< 7.50 U
C2-EFFL	1/19/2021	N	270000	550000	8.1	260000	< 1.5 U	140000	7100	50000	0.538	1.91	1.37
C2-EFFL	2/09/2021	N	260000	590000	8.1	230000	< 1.5 U	110000	2200	55000	0.647	< 1.50 U	< 1.50 U
C2-EFFL	3/02/2021	N	250000	1000000	8.0	220000	1.3 J	120000	4100	45000	2.18	3.12	0.938

Footnotes

N Sample type: Normal

H Recommended sample preservation, extraction or analysis holding time was exceeded.

J Estimated detected value. Either certain QC criteria were not met or the concentration is between the laboratory's detection and quanitation limits.

U The analyte was analyzed for, but was not detected.

UB The analyte was detected in one of the associated laboratory, equipment, field or trip blank samples and is considered non-detect at the concentration reported.

(1) Groundwater surface water criteria as of 6/25/2018, with exceedances shown in bold text

(2) Site-specific mixing zone criteria

Table 2.3
Aqueous-Phase Analytical Data - Influent and C3
D.E. Karn Generating Facility
Consumers Energy

		Parameter	Alkalinity, total, as CaCO3	Hardness, as CaCO3	pH	Sulfate, as SO4	Arsenic	Calcium	Iron	Magnesium	Arsenic III	Arsenic inorganic	Arsenic V
		Total or Dissolved	NA	NA	NA	NA	Dissolved	Dissolved	Dissolved	Dissolved	Total	Total	Total
		Units	ug/l	ug/l	pH units	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
		Groundwater Surface Water Interface Criteria (1)			6.5 - 9.0		100 (2)						
Location	Date	Sample Type											
INFL	12/08/2020	N	340000	580000	8.0 H	240000	**430**	150000	3000	48000	181	458	278
INFL	12/15/2020	N	320000	550000	8.3 H	240000	**760**	140000	7200	43000	776	932	156
INFL	12/22/2020	N	320000	590000	8.2 H	260000	**590**	160000	4400	49000	641	727	86
INFL	12/29/2020	N	280000	580000	7.7	290000	**180**	150000	1300	48000	138 H	224	85.3
INFL	1/05/2021	N	290000	570000	8.3	270000	**270**	160000	1800	50000	219	267	48.8
INFL	1/19/2021	N	280000	520000	8.3	270000	**250**	150000	1900	48000	236	285	49.2
INFL	2/09/2021	N	310000	880000	8.2	270000	**120**	170000	1200	55000	113	345	231
INFL	3/02/2021	N	270000	1200000	8.0	240000	69	140000	390	45000	40.5	127	86.7
C3-33	12/08/2020	N	260000	510000	8.0 H	240000	2.3 J	130000	36000	53000	--	--	--
C3-33	12/15/2020	N	200000	630000	8.4 H	230000	< 1.5 U	84000	2800	44000	--	--	--
C3-33	12/22/2020	N	270000	520000	8.2 H	260000	< 1.5 U	130000	12000	52000	--	--	--
C3-33	12/29/2020	N	280000	520000	7.8	290000	< 1.5 U	120000	8400	52000	--	--	--
C3-33	1/05/2021	N	260000	530000	8.1	280000	< 1.5 U	140000	13000	53000	--	--	--
C3-33	3/02/2021	N	260000	950000	7.9	220000	< 0.75 U	120000	10000	45000	--	--	--
C3-66	12/08/2020	N	210000	810000	8.1 H	240000	< 1.5 U	88000	13000	50000	--	--	--
C3-66	12/15/2020	N	130000	300000	8.4 H	210000	< 1.5 U	58000	110 J	35000	--	--	--
C3-66	12/22/2020	N	190000	420000	8.3 H	250000	< 1.5 U	83000	920	51000	--	--	--
C3-66	12/29/2020	N	160000	420000	8.4	260000	< 1.5 U	64000	< 52 U	52000	--	--	--
C3-66	1/05/2021	N	180000	400000	8.4	260000	< 1.5 U	78000	120 J	58000	--	--	--
C3-66	3/02/2021	N	240000	940000	7.9	220000	< 0.75 U	110000	6600	46000	--	--	--
C3-EFFL	12/08/2020	N	160000	360000	8.2 H	250000	< 1.5 U	71000	5800	46000	< 0.500 U	< 0.500 U	< 0.500 U
C3-EFFL	12/15/2020	N	98000	270000	8.3 H	140000	< 1.5 U	45000	52 J	29000	0.256	0.493	0.237
C3-EFFL	12/22/2020	N	110000	300000	8.5 H	210000	< 1.5 U	51000	< 52 U	49000	0.054	0.519	0.465
C3-EFFL	12/29/2020	N	56000	200000	8.3	160000	1.6 J	30000	79 J	29000	< 0.500 UH	0.781	0.781
C3-EFFL	1/05/2021	N	82000	220000	8.6	180000	< 1.5 U	30000	59 J	41000	< 0.500 U	< 0.500 U	0.499 J
C3-EFFL	1/19/2021	N	--	--	8.2	--	< 1.5 U	--	--	--	--	--	--
C3-EFFL	2/09/2021	N	--	--	--	--	< 1.5 U	--	--	--	--	--	--
C3-EFFL	3/02/2021	N	220000	1000000	8.0	210000	< 0.75 U	97000	1800	46000	< 0.500 U	< 0.500 U	0.369 J

Footnotes

N Sample type: Normal

H Recommended sample preservation, extraction or analysis holding time was exceeded.

J Estimated detected value. Either certain QC criteria were not met or the concentration is between the laboratory's detection and quanitation limits.

U The analyte was analyzed for, but was not detected.

(1) Groundwater surface water criteria as of 6/25/2018, with exceedances shown in bold text

(2) Site-specific mixing zone criteria

Table 2.4
Aqueous-Phase Analytical Data - Influent and C4
D.E. Karn Generating Facility
Consumers Energy

		Parameter	**Alkalinity, total, as CaCO3**	**Hardness, as CaCO3**	**pH**	**Sulfate, as SO4**	**Arsenic**	**Calcium**	**Iron**	**Magnesium**	**Arsenic III**	**Arsenic inorganic**	**Arsenic V**
		Total or Dissolved	**NA**	**NA**	**NA**	**NA**	**Dissolved**	**Dissolved**	**Dissolved**	**Dissolved**	**Total**	**Total**	**Total**
		Units	**ug/l**	**ug/l**	**pH units**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**	**ug/l**
		Groundwater Surface Water Interface Criteria (1)			**6.5 - 9.0**		**100 (2)**						
Location	Date	Sample Type											
INFL	12/08/2020	N	340000	580000	8.0 H	240000	**430**	150000	3000	48000	181	458	278
INFL	12/15/2020	N	320000	550000	8.3 H	240000	**760**	140000	7200	43000	776	932	156
INFL	12/22/2020	N	320000	590000	8.2 H	260000	**590**	160000	4400	49000	641	727	86
INFL	12/29/2020	N	280000	580000	7.7	290000	**180**	150000	1300	48000	138 H	224	85.3
INFL	1/05/2021	N	290000	570000	8.3	270000	**270**	160000	1800	50000	219	267	48.8
INFL	1/19/2021	N	280000	520000	8.3	270000	**250**	150000	1900	48000	236	285	49.2
INFL	2/09/2021	N	310000	880000	8.2	270000	**120**	170000	1200	55000	113	345	231
INFL	3/02/2021	N	270000	1200000	8.0	240000	69	140000	390	45000	40.5	127	86.7
C4-33	12/08/2020	N	250000	430000	8.0 H	240000	< 1.5 U	110000	22000	53000	--	--	--
C4-33	12/15/2020	N	180000	400000	8.4 H	230000	< 1.5 U	77000	1100	48000	--	--	--
C4-33	12/22/2020	N	220000	470000	8.2 H	250000	< 1.5 U	100000	7200	49000	--	--	--
C4-33	12/29/2020	N	230000	460000	8.3	280000	< 1.5 U	96000	490	58000	--	--	--
C4-33	1/05/2021	N	210000	470000	8.3	270000	< 1.5 U	100000	2300	57000	--	--	--
C4-33	3/02/2021	N	250000	1100000	8.0	220000	3.2 J	120000	7500	44000	--	--	--
C4-66	12/08/2020	N	190000	370000	8.2 H	250000	< 1.5 U	75000	8400	50000	--	--	--
C4-66	12/15/2020	N	110000	330000	8.2 H	240000	< 1.5 U	53000	110 J	36000	--	--	--
C4-66	12/22/2020	N	150000	380000	8.4 H	250000	< 1.5 U	77000	390 J	51000	--	--	--
C4-66	12/29/2020	N	59000	310000	8.6	260000	< 1.5 U	48000	77 J	39000	--	--	--
C4-66	1/05/2021	N	85000	290000	8.7	260000	< 1.5 U	45000	< 52 U	49000	--	--	--
C4-66	3/02/2021	N	220000	1000000	8.0	210000	< 0.75 U	110000	6600	44000	--	--	--
C4-EFFL	12/08/2020	N	140000	410000	8.2 H	250000	< 1.5 U	63000	5000	47000	1.65	1.65	< 0.500 U
C4-EFFL	12/15/2020	N	83000	290000	8.1 H	190000	< 1.5 U	46000	< 52 U	32000	0.059	0.490	0.431
C4-EFFL	12/22/2020	N	110000	350000	8.3 H	250000	< 1.5 U	64000	< 52 U	50000	< 0.028 UB	0.268	0.268
C4-EFFL	12/29/2020	N	24000	210000	7.1	190000	< 1.5 U	42000	< 52 U	23000	< 0.500 UH	< 0.500 U	< 0.500 U
C4-EFFL	1/05/2021	N	65000	200000	8.9	170000	< 1.5 U	24000	< 52 U	34000	< 0.500 U	0.666	0.666
C4-EFFL	1/19/2021	N	--	--	8.4	--	< 1.5 U	--	--	--	--	--	--
C4-EFFL	2/09/2021	N	--	--	--	--	< 1.5 U	--	--	--	--	--	--
C4-EFFL	3/02/2021	N	220000	620000	7.9	210000	< 0.75 U	100000	3000	45000	< 0.500 U	< 0.500 U	< 0.500 U

Footnotes

N Sample type: Normal

H Recommended sample preservation, extraction or analysis holding time was exceeded.

J Estimated detected value. Either certain QC criteria were not met or the concentration is between the laboratory's detection and quanitation limits.

U The analyte was analyzed for, but was not detected.

(1) Groundwater surface water criteria as of 6/25/2018, with exceedances shown in bold text

(2) Site-specific mixing zone criteria

Table 3
Solid-Phase Sampling Analytical Data
D.E. Karn Generating Facility
Consumers Energy

Footnotes

N Sample type: Normal

H Recommended sample preservation, extraction or analysis holding time was exceeded.

J Estimated detected value. Either certain QC criteria were not met or the concentration is between the laboratory's detection and quanitation limits.

U The analyte was analyzed for, but was not detected.

UB The analyte was detected in one of the associated laboratory, equipment, field or trip blank samples and is considered non-detect at the concentration reported by the laboratory.

	Location	C1- COMPOSITE	C2- COMPOSITE	C3- COMPOSITE	C4- COMPOSITE	C1- INFLUENT SECTION	C1- MIDDLE SECTION	C1- EFFLUENT SECTION	C2- INFLUENT SECTION	C2- MIDDLE SECTION	C2- EFFLUENT SECTION	C3- INFLUENT SECTION	C3- MIDDLE SECTION	C3- EFFLUENT SECTION	C4- INFLUENT SECTION
	Date	3/5/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021	3/05/2021
	Sample Type	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Parameter	Units														
General Parameters															
Carbon, total inorganic	ug/kg	--	--	--	--	**1200000**	--	--	**14000000**	--	--	**19000000**	--	--	**16000000**
Moisture	%	**7.3**	**4.3**	**5.2**	**5.0**	**13.4**	**7.3**	**3.9**	**5.6**	**4.6**	**4.4**	**7.0**	**7.1**	**5.0**	**6.4**
Solids, percent	%	**92.7**	**95.7**	**94.8**	**95.0**	**86.6**	**92.7**	**96.1**	**94.4**	**95.4**	**95.6**	**93.0**	**92.9**	**95.0**	**93.6**
Sulfur, as S	ug/kg	**100000**	**460000**	**650000**	**990000**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**
TCLP General Parameters															
Alkalinity, total, as CaCO3	ug/l	--	--	--	--	< 18000 UB	--	--	**69000**	--	--	**120000**	--	--	**150000**
Metals (Total)															
Arsenic	ug/kg	--	--	--	--	**2500**	**2600**	**2700**	**53000**	**21000**	**5200**	**130000**	**5800**	**15000**	**55000**
Calcium	ug/kg	--	--	--	--	**6000000**	--	--	**120000000**	--	--	**85000000**	--	--	**56000000**
Iron	ug/kg	--	--	--	--	**2500000**	--	--	**61000000**	--	--	**150000000**	--	--	**350000000**
Magnesium	ug/kg	--	--	--	--	**1900000**	--	--	**22000000**	--	--	**23000000**	--	--	**11000000**
Manganese	ug/kg	--	--	--	--	**38000**	--	--	**630000**	--	--	**1200000**	--	--	**2300000**
TCLP Metals															
Arsenic	mg/l	--	**0.0066 J**	< 0.081 U	< 0.0041 U	--	--	--	--	--	--	--	--	--	--
Barium	mg/l	--	**0.11 J**	**0.13 J**	**0.16 J**	--	--	--	--	--	--	--	--	--	--
Cadmium	mg/l	--	**0.00026 J**	< 0.00020 U	< 0.00020 U	--	--	--	--	--	--	--	--	--	--
Chromium	mg/l	--	< 0.00071 UB	< 0.013 U	< 0.00063 U	--	--	--	--	--	--	--	--	--	--
Lead	mg/l	--	< 0.0028 U	< 0.0028 U	< 0.0028 U	--	--	--	--	--	--	--	--	--	--
Mercury	mg/l	--	< 0.00013 U	< 0.00013 U	< 0.00013 U	--	--	--	--	--	--	--	--	--	--
Selenium	mg/l	--	< 0.0060 U	< 0.12 U	< 0.0081 UB	--	--	--	--	--	--	--	--	--	--
Silver	mg/l	--	< 0.00062 U	< 0.00062 U	< 0.00062 U	--	--	--	--	--	--	--	--	--	--

Table 3
Solid-Phase Sampling Analytical Data
D.E. Karn Generating Facility
Consumers Energy

	Location	C4-MIDDLE SECTION	C4-EFFLUENT SECTION	KARN-CLASS 2 MEDIA	KARN-SITE MEDIA
	Date	3/05/2021	3/05/2021	3/05/2021	3/05/2021
	Sample Type	N	N	N	N
Parameter	Units				
General Parameters					
Carbon, total inorganic	ug/kg	--	--	--	--
Moisture	%	**5.0**	**5.9**	**2.7**	**0.5**
Solids, percent	%	**95.0**	**94.1**	**97.3**	**99.5**
Sulfur, as S	ug/kg	**--**	**--**	**--**	**--**
TCLP General Parameters					
Alkalinity, total, as CaCO3	ug/l	--	--	--	--
Metals (Total)					
Arsenic	ug/kg	**19000**	**10000**	**2300**	**1600**
Calcium	ug/kg	--	--	--	--
Iron	ug/kg	--	--	--	--
Magnesium	ug/kg	--	--	--	--
Manganese	ug/kg	--	--	--	--
TCLP Metals					
Arsenic	mg/l	--	--	--	--
Barium	mg/l	--	--	--	--
Cadmium	mg/l	--	--	--	--
Chromium	mg/l	--	--	--	--
Lead	mg/l	--	--	--	--
Mercury	mg/l	--	--	--	--
Selenium	mg/l	--	--	--	--
Silver	mg/l	--	--	--	--

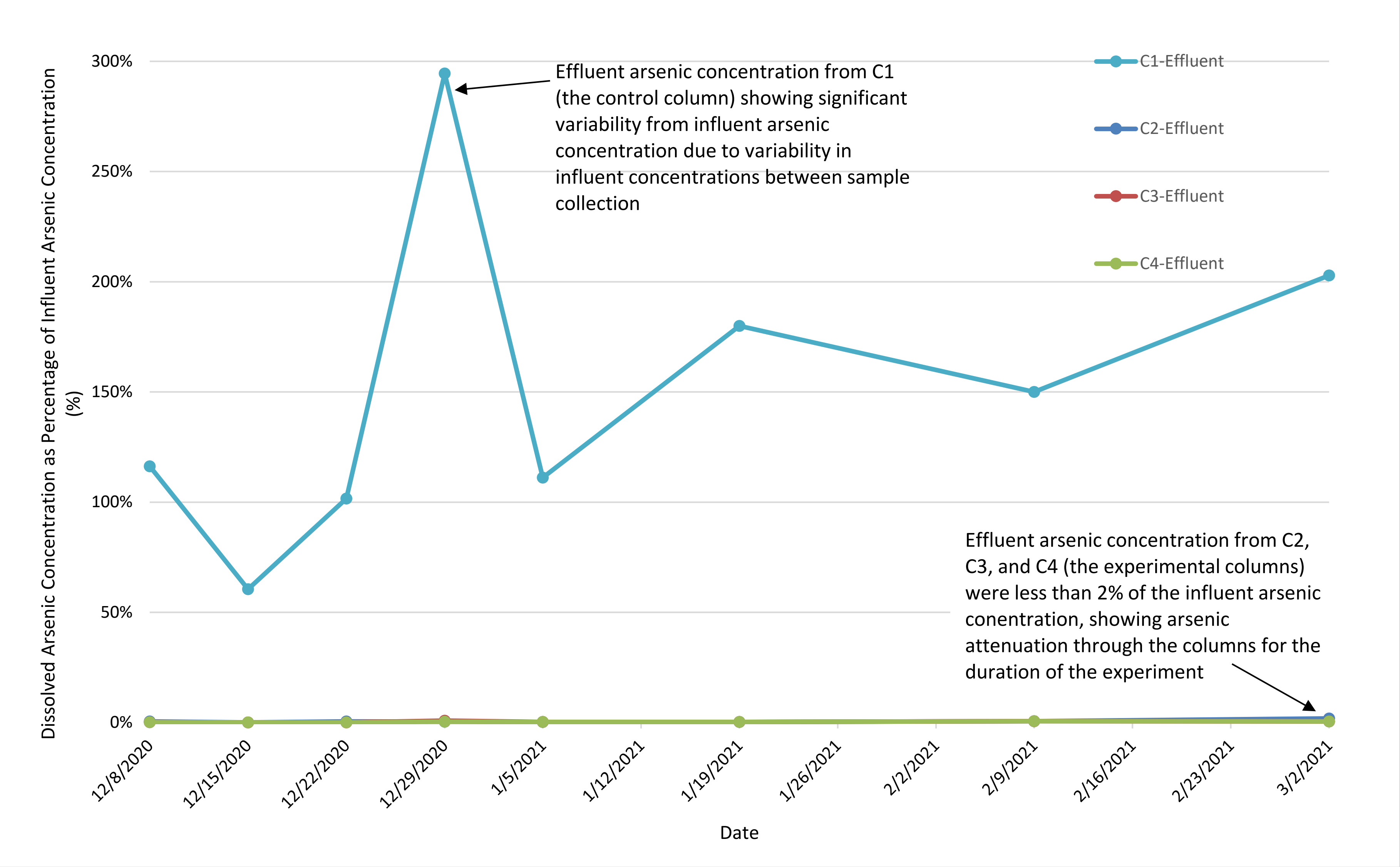
Figures

Figure 1

Arsenic Concentrations Normalized to Influent Concentrations over Time

D.E. Karn Generating Facility

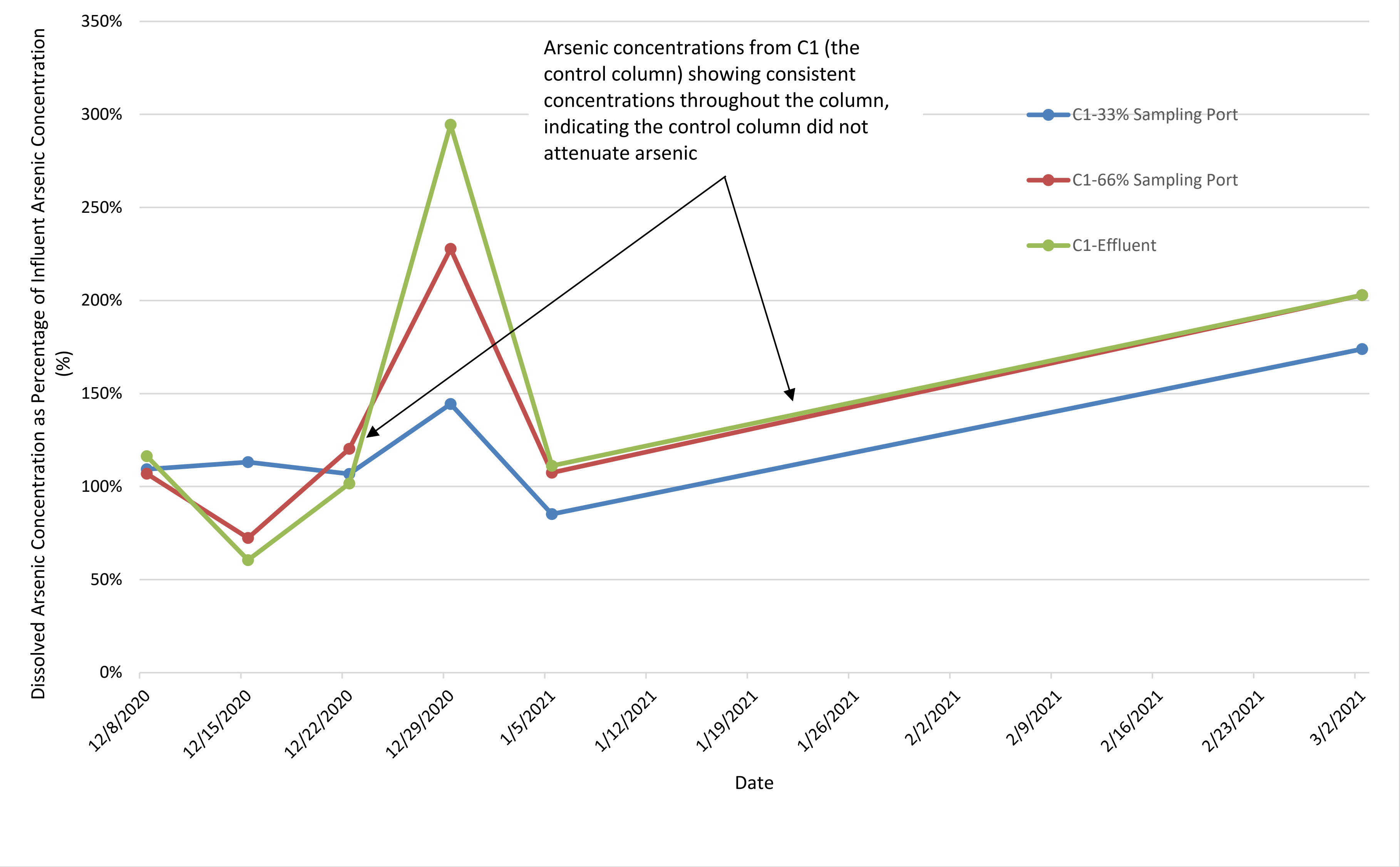
Consumers Energy



Effluent arsenic concentration from C1 (the control column) showing significant variability from influent arsenic concentration due to variability in influent concentrations between sample collection

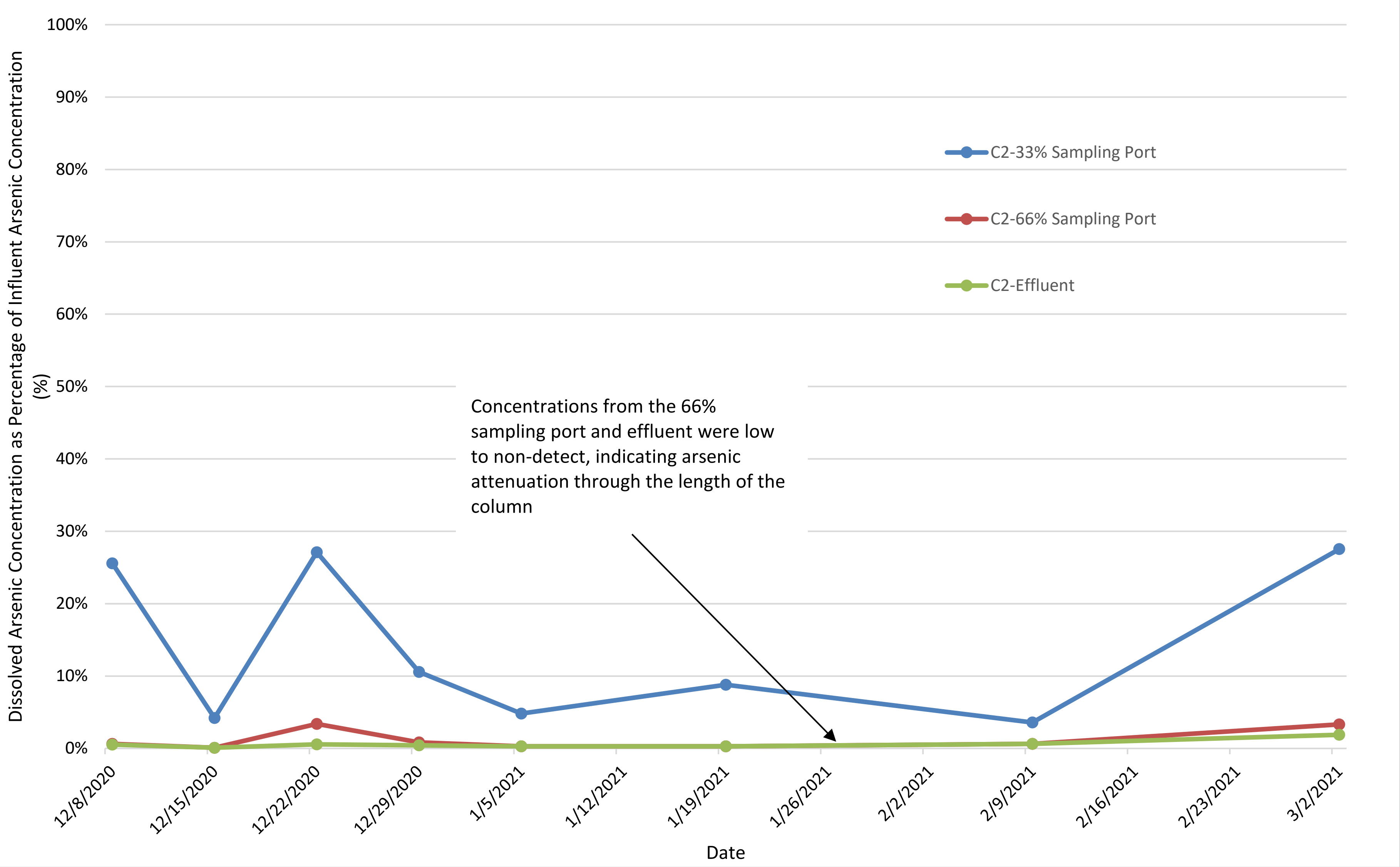
Effluent arsenic concentration from C2, C3, and C4 (the experimental columns) were less than 2% of the influent arsenic conentration, showing arsenic attenuation through the columns for the duration of the experiment

Figure 2
Column C1 Arsenic Concentrations Normalized to Influent Concentrations over Time D.E. Karn Generating Facility
Consumers Energy



Arsenic concentrations from C1 (the control column) showing consistent concentrations throughout the column, indicating the control column did not attenuate arsenic

Figure 3
Column C2 Arsenic Concentrations Normalized to Influent Concentrations over Time
D.E. Karn Generating Facility
Consumers Energy



Concentrations from the 66% sampling port and effluent were low to non-detect, indicating arsenic attenuation through the length of the column

Figure 4
Arsenic Mass-Balance
D.E. Karn Generating
Facility Consumers Energy

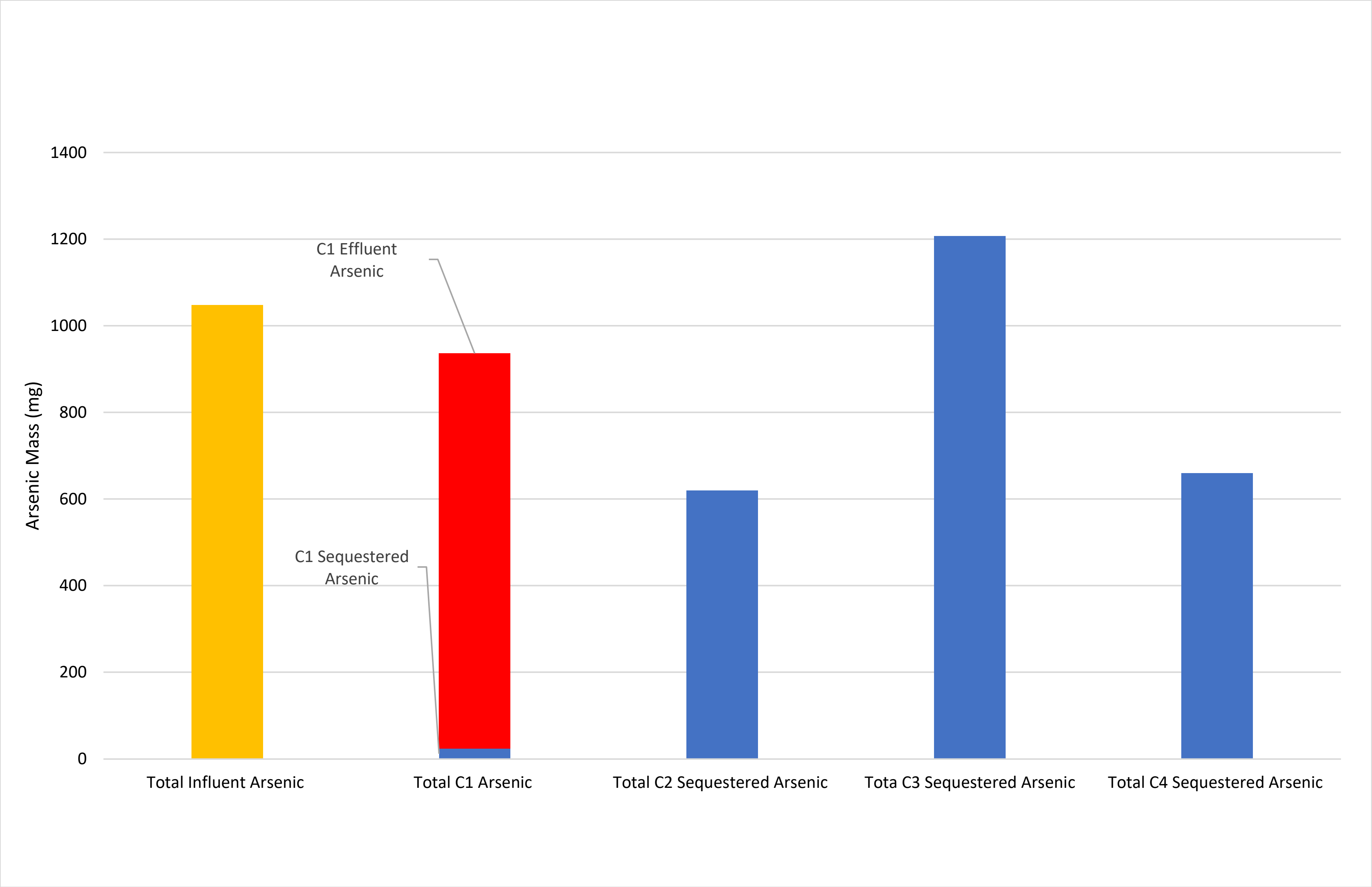


Exhibit A

Photolog

Exhibit 1: Photolog

D.E. Karn Generating Facility
Essexville, Michigan
December 2020 - March 2021

Photo #	Comments
1	Peerless Metal 8/50 Zero Valent Iron
2	Experimental columns prior to media loading
3	Off-site sand and ZVI mixture
4	Influent manifold including flow meters and sampling ports
5	Experimental columns after media loading
6	Effluent manifold and sample ports
7	33% and 66% sampling ports
8	Off-site sand and ZVI mixture after conclusion of experiment
9	Dark colored, dense cohesive media observed after conclusion of experiment
10	Rust colored build-up on influent screen of an experimental column

Photo 1: Peerless Metal 8/50 Zero Valent Iron

Photo 2: Experimental columns prior to media loading

Photo 3: Off-site sand and ZVI mixture

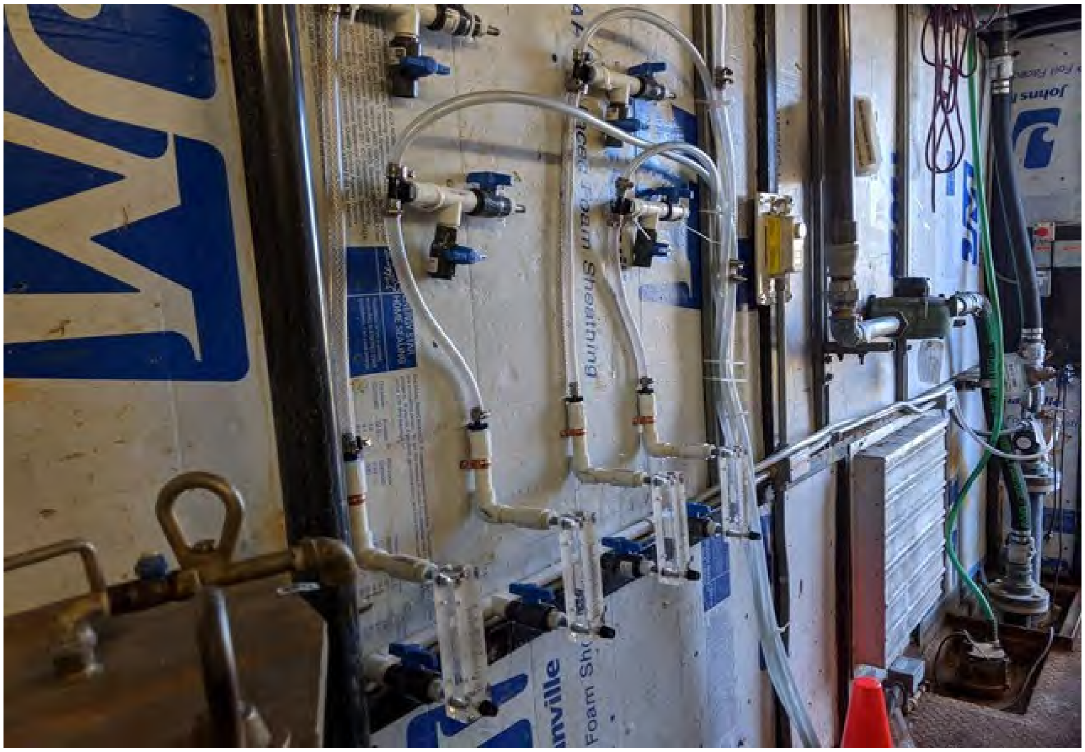


Photo 4: Influent manifold including flow meters and sampling ports

Photo 5: Experimental columns after media loading

Photo 6: Effluent manifold and sample ports

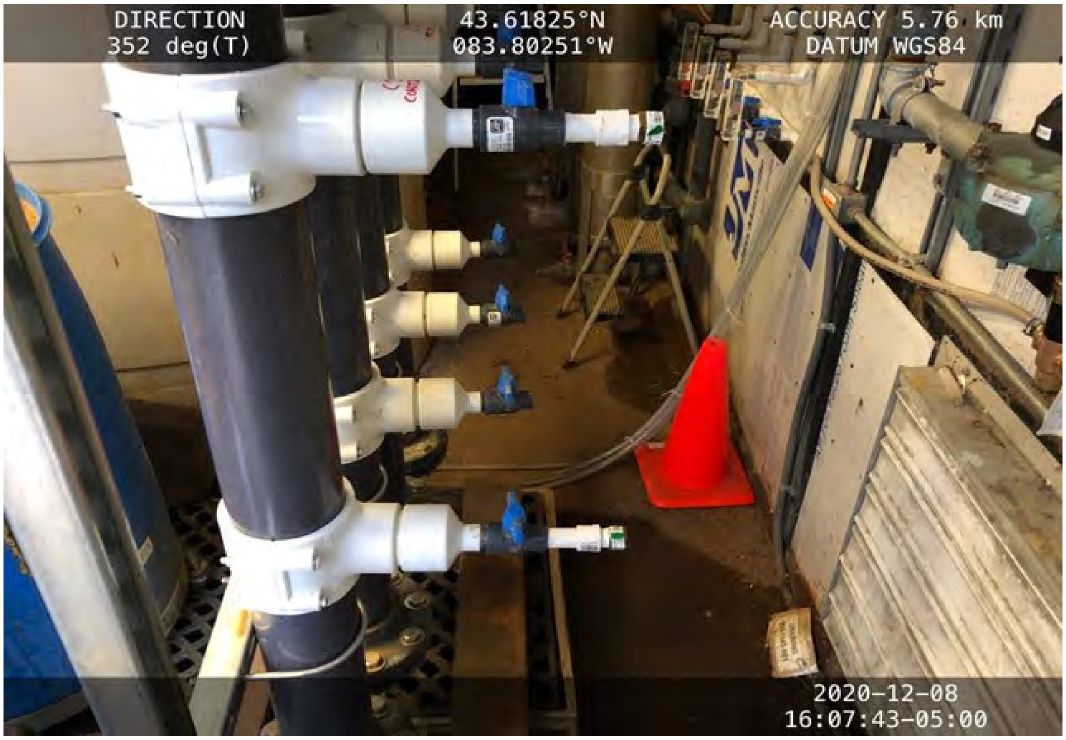


Photo 7: 33% and 66% sampling ports

Photo 8: Off-site sand and ZVI mixture after conclusion of experiment

Photo 9: Dark colored, dense cohesive media observed after conclusion of experiment

Photo 10: Rust colored build-up on influent screen of an experimental column