

**BASF** Corporation

# Hydraulic Investigation Work Plan

### Point Hennepin Wayne County, Michigan

December 22, 2022

#### **Hydraulic Investigation Work Plan**

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### **Acronyms and Abbreviations**

Arcadis	Arcadis of Michigan, LLC
BASF	BASF Corporation
CSM	conceptual site model
DBO	distiller blowoff
EC	electrical conductivity
ECT	electrical conductivity tool
EGLE	Department of Environment, Great Lakes, and Energy
ERI	electrical resistivity imaging
GSI	groundwater to surface water interface
Work Plan	Hydraulic Investigation Work Plan
HPT	hydraulic profiling tool
NREPA	Natural Resources and Environmental Protection Act
PVC	polyvinyl chloride
report	Geophysical Report
SC	specific conductance
Site	Point Hennepin, located in Wayne County, Michigan

### **1** Introduction

On behalf of BASF Corporation (BASF), Arcadis of Michigan, LLC (Arcadis) prepared this Hydraulic Investigation Work Plan (Work Plan) for Point Hennepin, located in Wayne County, Michigan (Site; Figure 1). Point Hennepin is a 225-acre island located in the Detroit River located immediately north of Grand Ille and east of Wyandotte, Michigan. The objective of this Work Plan is to outline the hydraulic investigation to be conducted at the Site, which will be used to evaluate groundwater interaction with and potential flux to surface water in key areas identified during the geophysical field activities. Results of the hydraulic investigation will be integrated into the refined conceptual site model (CSM) that will help identify potential groundwater discharge areas and develop next steps for further assessment. The overarching goal for the Site is to obtain site closure through the Michigan Department of Environment, Great Lakes, and Energy (EGLE) voluntary Part 201 program that incorporates a sustainable perimeter groundwater management approach and allows for the establishment of the Site as a wildlife refuge. The general approach and rationale for this Work Plan were presented to the EGLE at a meeting held on November 9, 2022.

#### 1.1 Objective and Approach

Point Hennepin is an island in the Detroit River upon which distiller blowoff (DBO) was placed from the early to mid-1900s. Historical conditions associated with the island have the potential to exhibit elevated electrical conductivity, as such EC was selected as the preferred geophysical method. A geophysical investigation was completed between November 3, 2021 and July 15, 2022 (Arcadis 2022) to identify zones of anomalous electrical conductivity (EC), which were detected around Point Hennepin.

The objective of the hydraulic investigation is to collect high-resolution water level and specific conductance(SC) data, which will aid in identifying groundwater flux (if any) to surface water in key areas of anomalous EC identified by the geophysical survey. The groundwater flux results will assist in identifying areas for further assessment.

The following activities will be included in the hydraulic investigation:

- Installation of 10 sets of onshore nested piezometers (shallow and deep) along the site perimeter
- Installation of one onshore piezometer along the channel on the southern portion of the Site
- Installation of four stilling wells near shore in the Detroit River
- Installation of pressure transducers and/or sondes to collect high-resolution water level, temperature, and SC from each location (piezometers, Detroit River, and monitoring wells).
- Collection of groundwater elevation data from upland monitoring wells.

#### 1.2 Applicable Regulatory Framework

This Work Plan was developed to investigate potential groundwater discharge to prioritize areas for further assessment and achieve Site closure via Part 201 of Michigan's Natural Resources and Environmental Protection Act (NREPA). Pursuant to Section 324.20220e of NREPA, BASF is developing a response activity to assess and accordingly address potential venting groundwater from the Site. The primary exposure pathway at the Site is the groundwater to surface water interface (GSI) because the potential exists for groundwater above relevant criteria

from the Site to discharge to the Detroit River. The approach presented in this Work Plan follows EGLE (2018) guidance as a first step to understanding groundwater flux around the island.

#### 2 Investigation Activities

This section discusses piezometer and stilling well installation, piezometer development, and high-resolution data collection. Prior installation, utility clearance will be completed and documented in accordance with Arcadis' utility locate policy, which includes contacting Michigan's one call underground utility location service (MISSDIG). A private utility locator will also perform a geophysical survey (e.g., ground-penetrating radar, electromagnetic survey) over an area measuring approximately 25 by 25 feet to locate potential utilities at each proposed boring location. An Arcadis representative will oversee the contractor and inspect the proposed drilling locations to assess the presence of any previously unidentified subsurface utilities.

#### 2.1 Piezometer Location and Interval Selection

Multiple data sets were considered when identifying the key locations for piezometer installation and screened intervals from the 2021-2022 geophysics investigation data. The 11 proposed piezometer locations are shown on Figure 2. The proposed piezometer locations were chosen based on areas of anomalous EC onshore and offshore, and sand layers encountered onshore, as well as to provide coverage of the study area along the perimeter and/or alignment with existing wells. Proposed screen intervals were estimated based on previous boring logs and HPT/ECT and ERI data. The proposed screened intervals target sand lenses, permeable DBO, and relatively permeable clays/silts present at elevations where GSI interaction may occur. Adjustments to final piezometer and stilling well locations and screened intervals will be determined in the field, guided by field conditions, access, and subsurface data collected. Proposed screened intervals are included in Table 1 for each piezometer along with a justification summary based on the reviewed data discussed above.

#### 2.2 Piezometer Installation and Development

A direct-push/hollow stem auger rig will be used to install co-located piezometers (shallow and deep) along the site perimeter on the riverbank.

Each piezometer will be installed to the proposed depths (Table 1) with 2-inch Schedule 40 polyvinyl chloride (PVC) riser and 5 feet of 0.010-inch wire-wrapped stainless steel screen. The piezometer well screen intervals are shown on the associated HPT/EC boring log in Appendix A.

The soil from each piezometer boring will be continuously sampled and logged by trained Arcadis staff. Following installation, the piezometers will be developed using surge and purge development techniques. The piezometers will be surveyed by a licensed professional for horizontal coordinate location and vertical elevation of the top of casing and ground surface. Lithologic boring logs and piezometer construction logs will be developed for each new piezometer.

#### 2.3 Stilling Well Installation

Five stilling wells will be installed, two each on the east and west sides of the island and one in the channel to the south to measure elevations in the Detroit River for comparison to groundwater elevations within the island and

on the island perimeter. These installations will refine the understanding of groundwater to surface water interactions. Each stilling well will be constructed of a 5-foot length of 0.010-inch Schedule 40 PVC slotted pipe, secured to a steel pipe that will be driven several feet into the sediment bottom of the shore. The steel pipe will be installed using a slide hammer. The stilling wells will be stable or permanent enough in nature to withstand movement from the river current. A combination of concrete blocks, metal drive pipe, or green safety fence posts may be used to stabilize and reinforce the stilling well.

A staff gauge will be installed and secured at each stilling well. The staff gauge will be installed flush with the top of the stilling well to allow for quick manual measurements of water level stage and to easily correlate the surface water to a known elevation above mean sea level. The gauge will include a U.S. Geological Survey style graduated staff gauge label so that measurements can be taken by a photograph. The stilling wells will be surveyed by a licensed professional for horizontal coordinate location and vertical elevation of the top of casing.

#### 2.4 High-Resolution Water Level and SC Collection

High-resolution water level and/or SC data will be collected at each piezometer, stilling well, and several existing monitoring wells (Table 1) using non-vented pressure transducers. The pressure transducers will continuously collect water level data, temperature, and/or SC data for a total of 3 months to encompass one wet and one dry season. A barometric pressure transducer will be deployed at the Site to measure atmospheric pressure during the monitoring periods. The barometric pressure measurements will be used to compensate and evaluate the influence of and correct for barometric pressure induced changes to groundwater levels. Manual water levels to a survey reference point will be collected during pressure transducer deployment and download events (monthly). During the monthly download, manual water levels will also be collected at all existing monitoring wells (labeled as DMW on Figure 2) across the Site in addition to locations where pressure transducers will be deployed to gain a better understanding of water levels across the Site through time.

#### 3 Data Analysis and Interpretation

Following the 3 months of monitoring, data collected from the pressure transducers will be processed by removing shifts in water levels resulting from the movement of the instruments that may occur when accessed and by calibrating the instrument water level measurements to water elevation with manual water levels measured at the respective well from a known survey reference point. SC and/or temperature data will also be evaluated at each location, as applicable, as additional lines of evidence to support the hydraulic analysis. Potential dike locations near the piezometers will be considered when assessing water level and SC data. These data, in combination with co-located HPT/EC data, will be used to evaluate hydraulic gradients from the Site to the river and assess groundwater flux to the river. Some potential endmember outcomes may include:

- High Groundwater Flux:
  - Observed steep horizontal hydraulic gradient from inland to the river, dominant downward vertical hydraulic gradient, correlating area high hydraulic conductivity, and high in-river EC from geophysics
- Potential Perimeter Dike Barrier:
  - Observed shallow horizontal hydraulic gradient from inland to the river, little to no correlation with groundwater levels and river levels, and low in-river EC from geophysics
- Little to No Groundwater Flux:

- Observed shallow horizontal hydraulic gradient from inland to the river, low downward to upward vertical hydraulic gradient from groundwater to the river, correlating area low hydraulic conductivity, and low in-river EC from geophysics
- Little to No Groundwater Flux and Presence of DBO:
  - Observed shallow horizontal hydraulic gradient from inland to the river, low downward to upward vertical hydraulic gradient from groundwater to the river, correlating area low hydraulic conductivity, and high in-river EC from geophysics

#### 4 Reporting

The results from the execution of this Work Plan and data evaluation will be summarized in a technical memorandum and submitted to EGLE. The memorandum will include the summary of activities and supporting documentation. The data evaluation will include charted data and supporting tables and figures to support the groundwater flux evaluation. Results will be used to develop a flux-based GSI strategy and to identify areas for potential further assessment.

### 5 Implementation Schedule

Implementation of the activities discussed in this Work Plan will begin upon approval from the EGLE. Piezometer and stilling well installation will be completed in early spring 2023. High-resolution water level monitoring will take place in spring 2023 (wet season) and summer 2023 (dry season). Results of the hydraulic and flux evaluation will be discussed with the EGLE following data evaluation.

#### 6 References

Arcadis. 2022. Geophysical Report. Point Hennepin, Wayne County, Michigan. December.

EGLE. 2018. Groundwater-Surface Water Pathway Compliance Options. Remediation and Redevelopment Division Resource Materials. April 23.

# **Table**

Table 1 Hydraulic Monitoring Network Hydraulic Investigation Work Plan Point Hennepin Wayne County, Michigan

Piezometer/ Stilling Well Location	Associated HPT/ECT Boring from 2022 Geophysics	Proposed/Existing Location	Proposed Shallow Screen Interval (feet bgs)	Proposed Shallow Interval Justification <sup>1</sup>	Proposed Deep Screen Interval (feet bgs)	Proposed Deep Interval Justification <sup>1</sup>	Water Level, Temperature, and Specific Conductivity	Water Level and Temperature
P01	E1	Proposed Piezometers	9-14	DBO; K > 20 ft/day; Elevated EC (ERI and HPT/ECT) up to > 1000 mS/m	25-30	Clay; Potential K analomies; low EC (both ERI and HPT/ECT); confirm low K / low flux	х	
P02	W2	Proposed Piezometers	5-10	Shallow sands; K > 20 ft/day; variable EC >/< 500 mS/m	13-18	Low HPT pressure; Increasing ERI and EC; permeable clay zone located above tighter clay; confirm lower K / low flux	х	
P03	W4	Proposed Piezometers	5-10	Shallow sands, silts, and DBO; K > 20 ft/day; ERI at 1000 mS/m and EC > 2000 mS/m	13-18	Intermediate sands, EC > 1000 mS/m and maxed out ERI (2500 mS/m); and K > 20 ft/day	х	
P04	W8	Proposed Piezometers	15-20	Very soft, silt/DBO and K up to 20 ft/day; K maxed at 100 ft/day; EC > 500 mS/m	26-31	Permeable clay, silt, and sand; HPT data shows K 10-20 ft/day; EC/ERI ~ 300 mS/m	х	
P05	W10	Proposed Piezometers	8-13	Very soft silt/DBO; HPT data shows K at 100 ft/day ; EC variable up to 1000 mS/m	23-28	Intermediate sands; HPT data shows K up to 75 ft/day; ERI increasing and EC > 1500 mS/m	х	
P06	W11	Proposed Piezometers	10-15	Adjacent boring log in DBO; HPT data shows K 20-40 ft/day; ERI increasing and EC > 1000 mS/m	20-25	HPT data shows K > 60 ft/day a; HPT pressure low to variable; ERI and EC > 1000 mS/m	х	
P07	E11	Proposed Piezometers	9-14	Silty DBO; HPT data shows K > 60 ft/day a; ERI increasing and EC > 1000 mS/m	20-25	Permeable clay; HPT data shows K ~ 20 ft/day; low HPT pressure; ERI spike > 2000 mS/m and EC > 1000 mS/m	х	
P08	E8	Proposed Piezometers	10-15	DBO, sands, and silts; HPT data shows K at 20 ft/day; ERI increasing and EC at 1500 mS/m	25-30	Sands and silts; K up to 30 ft/day; ERI and EC =/> 1500 mS/m	х	
P09	E7	Proposed Piezometers	9-14	DBO and top of clay; K > 20 ft/day; Elevated EC (HPT/ECT only) up to 2000 mS/m	22-27	Clay; Potential K analomies; lower EC (both ERI and HPT/ECT) at 500 mS/m; confirm low K / low flux	х	
P10	E5	Proposed Piezometers	8-13	Sandy DBO; K varies up to > 80 ft/day; Elevated EC (ERI and HPT/ECT) up to 1000 mS/m	17-22	Clay; K > 20 ft/day; Elevated EC (ERI and HPT/ECT) up to 2000 mS/m; Confirm K	х	
P11	E2	Proposed Piezometer		Surface elevation is high at this location and a shallow piezometer would not aid in GSI assessment	23-28	Base of DBO and top of clay; K up to 20 ft/day; Elevated EC (ERI and HPT/ECT) up to > 1500 mS/m	х	
SW01		Proposed Stilling Well						Х
SW02		Proposed Stilling Well						Х
		. Topoood Junning Well					-	~

Table 1 Hydraulic Monitoring Network Hydraulic Investigation Work Plan Point Hennepin Wayne County, Michigan

Piezometer/ Stilling Well Location	Associated HPT/ECT Boring from 2022 Geophysics	Proposed/Existing Location	Proposed Shallow Screen Interval (feet bgs)	Proposed Shallow Interval Justification <sup>1</sup>	Proposed Deep Screen Interval (feet bgs)	Proposed Deep Interval Justification <sup>1</sup>	Water Level, Temperature, and Specific Conductivity	Water Level and Temperature
SW03		Proposed Stilling Well						Х
SW04		Proposed Stilling Well						Х
SW05		Proposed Stilling Well						Х
DMW-1		Existing Monitoring Well <sup>2</sup>						Х
DMW-6		Existing Monitoring Well <sup>2</sup>						Х
DMW-7		Existing Monitoring Well <sup>2</sup>						Х
DMW-8		Existing Monitoring Well <sup>2</sup>						Х
DMW-10		Existing Monitoring Well <sup>2</sup>						Х
SMW-3		Existing Monitoring Well <sup>2</sup>						Х
SMW-4		Existing Monitoring Well <sup>2</sup>						Х

#### Acronyms and Abbreviations:

-- = not applicable

bgs = below ground surface

DBO = distiller blowoff

EC = electrical conductivity

ECT = electrical conductivity tool

ERI = electrical resistivity imaging

ft/day = feet per day

GSI = groundwater to surface water interface

HPT = hydraulic profiling tool

K = hydraulic conductivity

mL/min = milliliter per minute mS/m = milliSiemen per meter

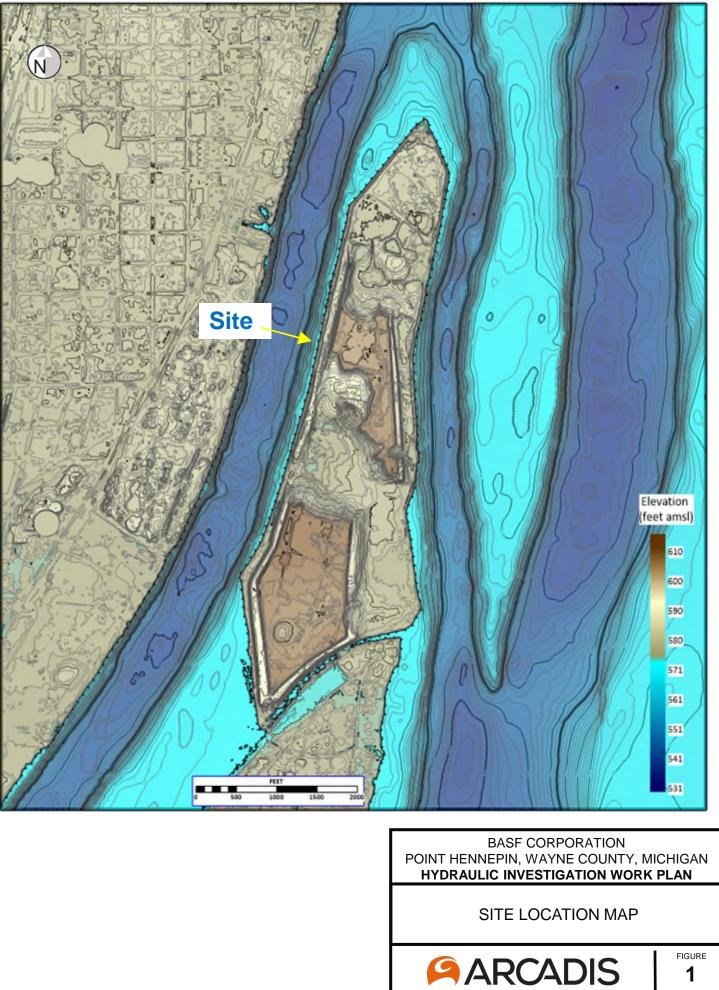
X = applicable monitoring parameters

#### Notes:

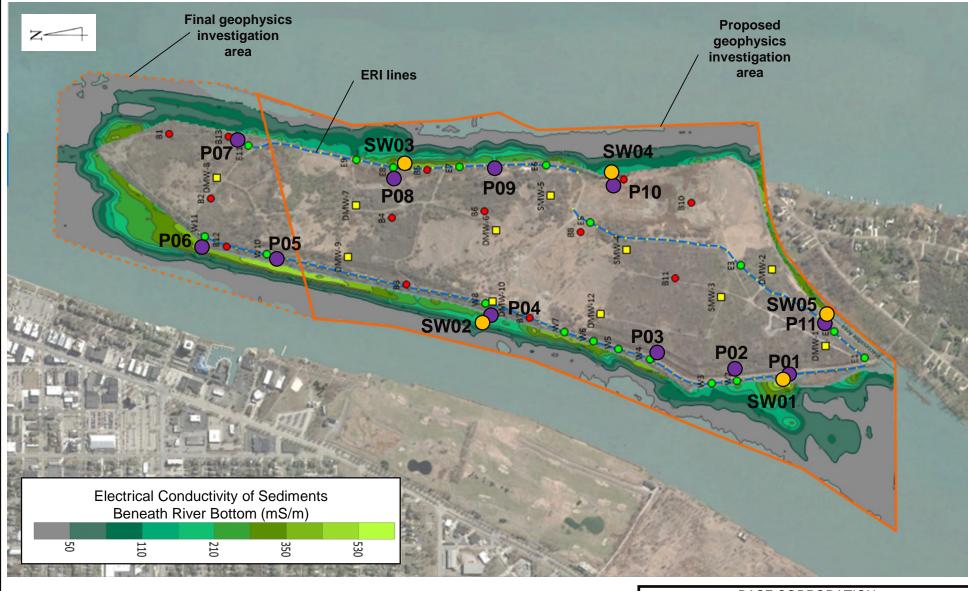
<sup>1</sup> Piezometer interval justification based on boring logs and HPT/ECT and ERI data near proposed location.

<sup>2</sup> The number of existing monitoring wells fitted with transducers may be adjusted on field conditions





1



- Proposed piezometer location
- Proposed stilling well location
- Golder 2021 boring locations
- HPT/ECT boring locations
- Existing monitoring wells

#### Notes:

HPT = hydraulic profiling tool EC = electrical conductivity tool ERI = electrical resistivity imaging mS/m = milliSiemen per meter BASF CORPORATION POINT HENNEPIN, WAYNE COUNTY, MICHIGAN HYDRAULIC INVESTIGATION WORK PLAN

PROPOSED PIEZOMETER AND STILLING WELL LOCATIONS

FIGURE

2





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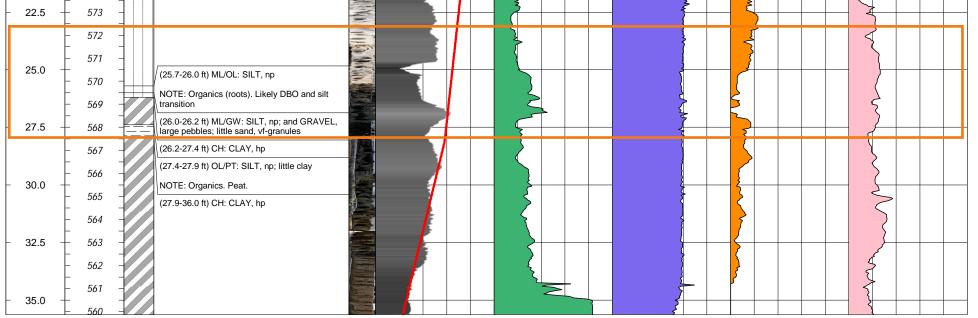
PROJE DATE BORIN PROJE SURFA	LOGGED	E: BASF Point Hennepin		LOGGED BY: HPT TOTAL DE SB TOTAL DEF	<b>ABER:</b> 30107324         Arcadis - SB and         Geophysics         Dakota - HPT         EPTH:       31.5 ft bgs         PTH:       32 ft bgs         e Appendix A for more	6 ✓ Soil E ✓ Samp ✓ HPT ✓ HPT ✓ HPT ✓ HPT ✓ HPT ✓ HPT ✓ Electri Electri	<ul> <li>Sample Photo</li> <li>HPT Pressure</li> <li>HPT Flow Max</li> <li>HPT Estimated Hydraulic Conductivity</li> <li>HPT Rate of Penetration</li> <li>HPT Electrical Conductivity (EC)</li> </ul>					
Depth 1ft:50ft	Elevation (ft amsI)	Abbreviated Soil Description	Sample Pl	HPT EC 0 mS/m 2500 ERI EC 0 mS/m 2500	Corr. HPT Press. psi 100	HPT Flow Max 0 mL/min 500	Est. K 0 ft/day 100	ROP 0 mm/sec 50				
- 2.5 -	578 – 577 – 577 – 576 – 575 – 574 – 574 – 572 – 572 – 571 –	(0.0-3.0 ft) CL/GW: CLAY, np; and GRAVEL; little sand, vf-vc (3.0-3.9 ft) CH: CLAY, hp (3.9-4.2 ft) ML: SILT, np; little clay (4.2-13.5 ft) ML: SILT, np NOTE: DBO										
- 10.0 -	- 569 - - 568 - - 567 - - 567 - - 566 - 	(13.5-13.9 ft) ML: SILT, np; little clay	and the second									
- 15.0 - - 17.5 - - 20.0 -	- 564 - - 563 - - 562 - - 561 - - 560 - - 559 - - 558 -  - 557 -	(13.9-32.0 ft) CH: CLAY, hp										



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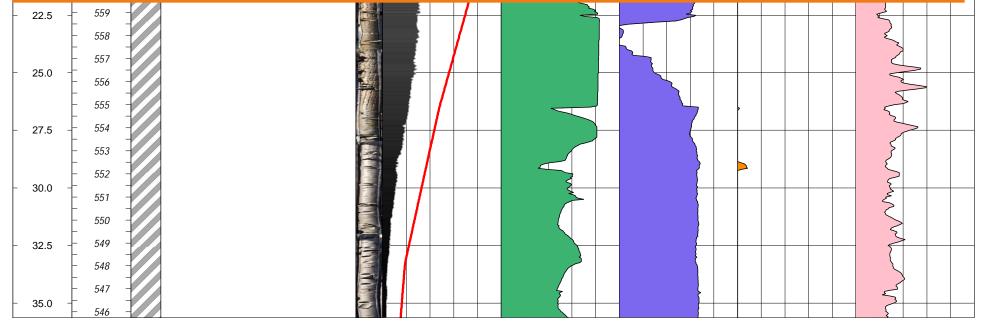
BORIN PROJE DATE BORIN PROJE		CLIENT: BASF PROJECT NUMBER: 30107326 LOGGED BY: Arcadis - SB and Geophysics Dakota - HPT HPT TOTAL DEPTH: 51.3 ft bgs SB TOTAL DEPTH: 36 ft bgs							<ul> <li>Logging Methods</li> <li>✓ Soil Description</li> <li>✓ Sample Photo</li> <li>✓ HPT Pressure</li> <li>✓ HPT Flow Max</li> <li>✓ HPT Estimated Hydraulic Conductivity</li> <li>✓ HPT Rate of Penetration</li> <li>✓ HPT Electrical Conductivity (EC)</li> <li>✓ Electrical Resistivity Imaging (ERI) Electrical Conductivity (EC)</li> <li>✓ Proposed Piezometer P-11 Screen Interval</li> </ul>										
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- 2.5 -	- 593 -  - 592 -	(2.5-25.7 ft) ML: SILT, np NOTE: DBO, soft-very soft, hard at 5.1-5.5 ft																P	
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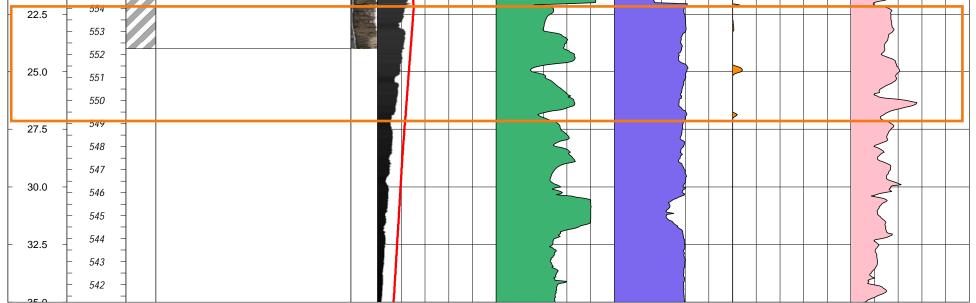
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PROJE SURF#	ECTION:	X 322934.52         Y 4672970.93         Universal Transverse Mercator (UTM)         VATION: 581.4 ft amsl         ATUM: World Geodetic System 1984	<ul> <li>HPT TOTAL DEPTH: 41.4 ft bgs</li> <li>SB TOTAL DEPTH: 40 ft bgs</li> <li>See Appendix A for more detailed soil description</li> <li>HPT Electrical Conductivity (EC)</li> <li>Electrical Conductivity (EC)</li> <li>Proposed Piezometer P-10 Screen Intervals for Hydraulic Investigation Work Plan</li> </ul>							
Depth 1ft:50ft	Elevation (ft amsl)	Abbreviated Soil Description	HPT EC       Corr. HPT Press.       HPT Flow Max       Est. K       ROP         mS/m       2500       0       psi       100       mL/min       500       0       ft/day       100       0       mm/sec       50         mS/m       2500       100 </td							
- 2.5 -	- 581 -  - 580 -  - 579 -	(0.0-4.3 ft) CL: CLAY, mp; some silt								
- 5.0 -	- 578 - 577 - - 577 - - 576 -  - 575 -	(4.3-6.0 ft) CH: CLAY, mp-hp; little silt (6.0-10.7 ft) ML: SILT, np; little sand, vf-med								
- 7.5 -	- 574 - - 574 -	NOTE: DBO								
- 10.0 -	- 5/3 -  - 572 -  - 571 -  - 570 -	(10.7-11.7 ft) ML: SILT, np NOTE: DBO								
- 12.5 -	- 569 - 	(11.7-13.0 ft) ML: SILT, np; some clay								
- 15.0 -	- 568 - 567 - - 567 -  - 566 - 	(13.0-40.0 ft) CH: CLAY, hp								
- 17.5 -	- 564 -  - 563 -  - 562 -									
- 20.0 -	- 561 -  - 560 -									



- 37.5 -			
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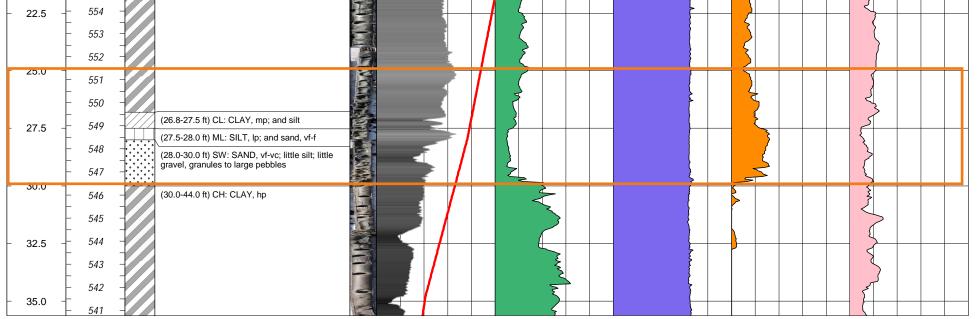
		CLIENT: BASF PROJECT NUMBER: 30107326 Arcadis - SB and Geophysics Dakota - HPT	Logging Methods         ✓       Soil Description         ✓       Sample Photo         ✓       HPT Pressure         ✓       HPT Flow Max         ✓       HPT Estimated Hydraulic Conductivity         ✓       HPT Rate of Penetration         ✓       HPT Electrical Conductivity (EC)						
PROJEC SURFAC	X 323098.38 Y 4673354.55 TION: Universal Transverse Mercator (UTM) E ELEVATION: 576.3 ft amsl ION DATUM: World Geodetic System 1984	HPT TOTAL DEPTH:       35.8 ft bgs         SB TOTAL DEPTH:       24.0 ft bgs         See Appendix A for more detailed soil description       Proposed Piezometer P-09 Screen Intervior for Hydraulic Investigation Work Plan							
Depth 1ft:50ft	Elevation (ft amsl) Abbreviated Soil Description Sample Photos 0	mS/m 2500	T Flow Max Est. K ROP mL/min 500 0 ft/day 100 0 mm/sec 50						
- 2.5	576       (0.0-2.5 ft) SW: SAND, vf-vc; and gravel; little clay; little silt; little gravel, granules to large pebbles         575       (2.5-4.1 ft) ML: SILT, np; some gravel, granules to large pebbles; little sand, vf-med         573       (2.5-4.1 ft) ML: SILT, np; some gravel, granules to large pebbles; little sand, vf-med         574       (2.5-4.1 ft) ML: SILT, np; some gravel, granules to large pebbles; little sand, vf-med         577       (4.1-4.3 ft) CH: CLAY, hp; some gravel, granules to med. pebbles         570       (4.3-12.7 ft) ML: SILT, np; some gravel, granules to large pebbles; little sand, vf-med         569       NOTE: DBO         568       NOTE: DBO								
- 10.0 - - - - - - - - - - - - - - - - - - -	566       -								
- 20.0 -	557 556 555								



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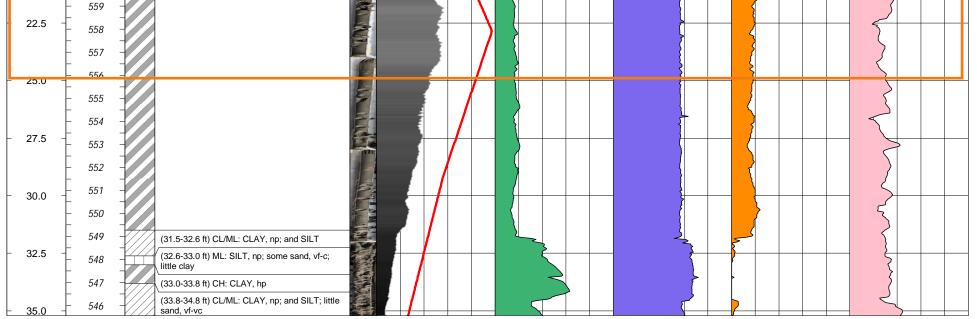
DATE LO BORING PROJEC SURFAC	CT NAM OGGEE G COOF CTION: CE ELE	IE: BASF Point Hennepin D: 03/28/2022 RDINATES: X 323096.38 Y 4673548.70 Universal Transverse Mercator ( VATION: 576.4 ft amsl	LOGGE HPT TO SB TOT	CT NUM ED BY: DTAL DE TAL DEF Se	Arcadis - S Geophysic Dakota - H	B and S PT 45.2 ft b 44.0 ft b	ogs	<ul> <li>✓ Soil Description</li> <li>✓ Sample Photo</li> <li>✓ HPT Pressure</li> <li>✓ HPT Flow Max</li> <li>✓ HPT Estimated Hydraulic Conductivity</li> <li>✓ HPT Rate of Penetration</li> <li>✓ HPT Electrical Conductivity (EC)</li> <li>✓ Electrical Resistivity Imaging (ERI) Electrical Conductivity (EC)</li> <li>✓ Proposed Piezometer P-08 Screen Intervals for Hydraulic Investigation Work Plan</li> </ul>						
ELEVATION DATUM: World Geodetic System 1984			HPT EC		Corr. HPT	Press.	НРТ	Flow Max	Est. K		F	ROP		
1ft:50ft	pth (ft amsl) 50ft Elevation (ft amsl)	Abbreviated Soil Description	Sample Photos	ERI EC	2500 0 2500	psi	100	0 r	nL/min 500	0 ft/day	100	0 mn	n/sec 50	
- 2.5	576 - 575 - 574 - 573 - 573 - 572 - 571 -	(0.0-1.8 ft) SW: SAND, vf-vc; some gravel, granules-large pebbles (1.8-11.5 ft) ML: SILT, np; little sand, vf-med NOTE: DBO						May				Man		
- 7.5 - - - - - - - - - - - - - - - - - - -	570 - 569 - 568 - 567 - 566 -							2						
- - - - - - - - - - - - - - - - - - -	565 - 564 - 563 - 562 - 561 -	(11.5-11.8 ft) SW: SAND, vf-f; and silt (11.8-11.9 ft) ML: SILT, np NOTE: DBO (11.9-12.2 ft) ML: SILT, np; some clay (12.2-26.8 ft) CH: CLAY, mp-hp; little silt						-						
- 17.5   	560 - 559 - 558 - 557 - 556 - 555 - 555 -							-						



07.5	- 540 - - 539 -				
- 37.5 -	- 539 - 538 -				
- 40.0 -	- 537 -  - 536 -		<u>}</u>	<b></b>	
- 42.5 -			Marine Marin		
- 42.5 -	- 533 -				
45.0	- 532 -				

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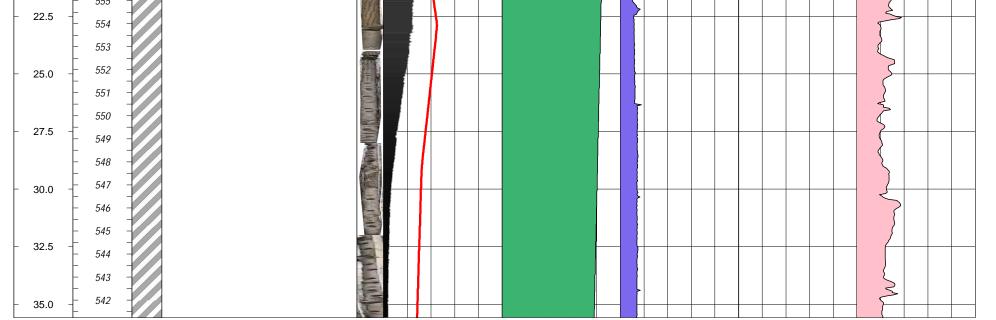
PROJE DATE BORIN		E: E11 IE: BASF Point Hennepin D: 03/28/2022 RDINATES: X 323161.09 Y 4673973.88 Universal Transverse Mercator (UTM)	CLIENT: BASF PROJECT NUMBER: 30107326 Arcadis - SB and Geophysics Dakota - HPT HPT TOTAL DEPTH: 39.4 ft bgs SB TOTAL DEPTH: 40.0 ft bgs	Logging Methods         ✓       Soil Description         ✓       Sample Photo         ✓       HPT Pressure         ✓       HPT Flow Max         ✓       HPT Estimated Hydraulic Conductivity         ✓       HPT Rate of Penetration         ✓       HPT Electrical Conductivity (EC)         ✓       Electrical Resistivity Imaging (ERI)         Electrical Conductivity (EC)         ✓         Proposed Piezometer P-07 Screen Intervals
SURFA	ACE ELE	VATION: 580.8 ft amsl	See Appendix A for more REMARKS: detailed soil description	for Hydraulic Investigation Work Plan
<b>Depth</b> 1ft:50ft	Elevation (ft amsI)	Sample P	HPT EC     Corr. HPT Press.     H       0     mS/m     2500     0       ERI EC     0     psi     100       0     mS/m     2500     0	PT Flow Max Est. K ROP mL/min 500 0 ft/day 100 0 mm/sec 50
- 0.0 -	- 581 - - 580 - - 579 - - 579 - - 578 - 577 -	(0.0-0.4 ft) SW: SAND, vf-f; some silt; little granules (0.4-4.5 ft) SW/ML: SAND, vf-f; and SILT NOTE: DBO		
- 5.0 -	576 - - 575 - - 575 - - 574 - - 573 - - 573 - - 572			
- 10.0 -	- 571 - - 571 - - 570 - - 569 - - 568 -			
- 15.0 -	567 - - 566 - - 565 - - 565 - 	(14.5-16.2 ft) ML: SILT, np; some clay; little organics (16.2-31.5 ft) CH: CLAY, mp-hp		
- 17.5 -	- 563 - - 562 - - 562 - - 561 - - 560 -			



-	545					}			
	544	(36.2-40.0 ft) CH: CLAY, hp						$\left  \right\rangle$	
- 37.5 -	543 -				5			5	
	542 -								
	541 -		The second secon						

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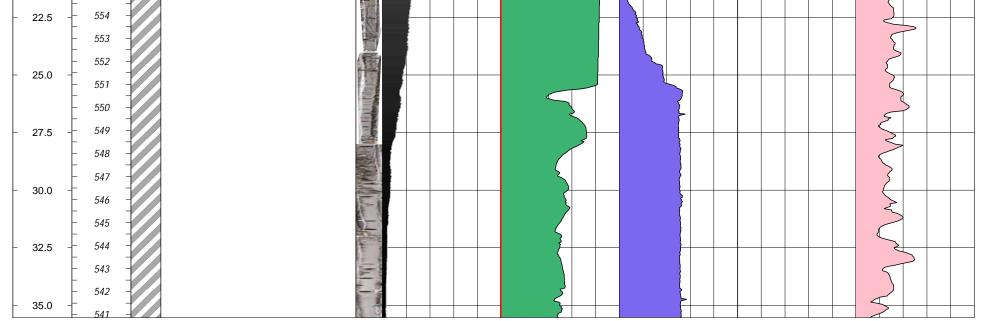
PROJ		IE: BASF Point Hennepin D: 03/24/2022		PROJECT N	CLIENT: BASF       ✓       Soil Description         PROJECT NUMBER: 30107326       ✓       Soil Description         LOGGED BY:       Arcadis - SB and Geophysics Dakota - HPT       ✓       HPT Flow Max         ✓       HPT Estimated Hydration         ✓       HPT Rate of Penetration         ✓       HPT Electrical Conduct         ✓       HPT Electrical Resistivity Integration									
BORIN	IG COOI	X 322468.48 Y 4672540.45		HPT TOTAL	<b>DEPTH:</b> 62.4 ft b	gs	<ul> <li>Electrical Resistivity Imaging (ERI)</li> <li>Electrical Conductivity (EC)</li> </ul>							
PROJE	ECTION:	Universal Transverse Mercator (L	JTM)	SB TOTAL D	<b>EPTH:</b> 61.8 ft b See Appendix A for more	-		osed Piezometer P-0 aulic Investigation W	2 Screen Intervals for					
SURF	ACE ELE	VATION: 576.8 ft amsl		REMARKS:	detailed soil description		Tiyun							
ELEVA		ATUM: World Geodetic System 198	34											
				HPT EC										
Depth	t amsl)	Abbreviated Soil Description	Sample Photos	mS/m 2500	Corr. HPT Press.	HPT	Flow Max	Est. K	ROP					
1ft:50ft	Elevation (ft amsl)			ERI EC	0 psi 100	0 n	nL/min 500	0 ft/day 100	0 mm/sec 50					
	Eleva		0	mS/m 2500										
- 0.0 -	- 576	(0.0-1.1 ft) SW/GW: SAND, vf-vc; and GRAVEL; little silt	MAN A											
	- 575	(1.1-8.0 ft) SP/ML: SAND, vf-f; and SILT				_								
- 2.5 -	- 574	NOTE: DBO		•	$\overline{\xi}$				$\left\{ \right\}$					
- 50 -	- 573 						2 A							
	- 571				5		$\sum$							
- 7.5 -	- 570								$\sum$					
	- 569 	(8.0-8.5 ft) SP: SAND, vf-f; some silt				-	5							
10.0	- 567	(8.5-9.0 ft) ML: SILT, np; some sand, vf-f				~								
	- 566	(9.0-10.0 ft) SP: SAND, vf-f; little silt												
- 12.5 -	- 565	(10.0-12.0 ft) CH: CLAY, mp-hp; little silt (12.0-48.0 ft) CH: CLAY, mp-hp					{							
	- <u>564</u> - 563						$\left\{ \begin{array}{c c} & & \\ & & \\ \end{array} \right\}$	5						
- 15.0 -	- 562						2		$\sum$					
	- 561						$\left\{ \left  \right  \right\}$							
17.5 -	- 560						~							
	- 558													
- 20.0 -	- 557								}					
	- 556 - 555													

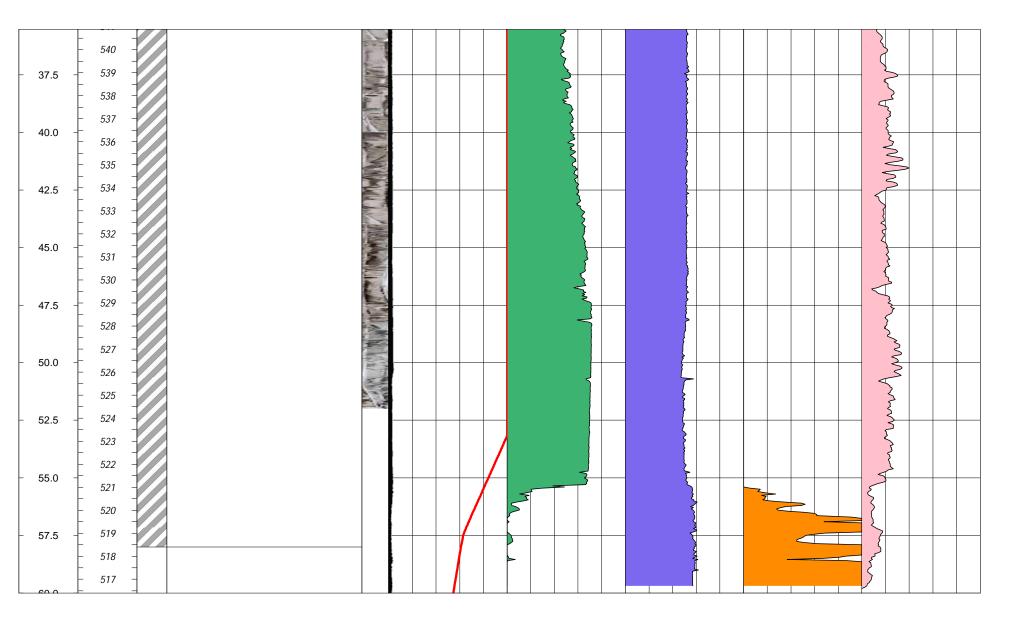


	- 541 -			
	- 540 -			
- 37.5 -	- 539 -			
	- 538 -			
- 40.0 -	- 537 -			
	536			
	- 535 -			
- 42.5 -	- 534 -			
	533			
- 45.0 -	- 532 -	[]		
	- 531 -			
	- 530 -			
- 47.5 -	- 529 -			
	– – – (48.0-56.0 ft) No Recovery – 528 –			
- 50.0 -	- 527 -			
- 52.5 -	- 524 -			
	- 523 -			
- 55.0 -	522	F 1		
	- 521 -		₹	
	– – – – (56.0-59.7 ft) CH: CLAY, hp			
- 57.5 -	- 519 -			
	518 -			
- 60.0 -				
		E F		
	- 516 - (60.0-61.8 ft) ML: SILT, np; some granules to large pebbles			
- 62.5 -	NOTE: Sulfur Odor			
	 - 513 -			
65.0				
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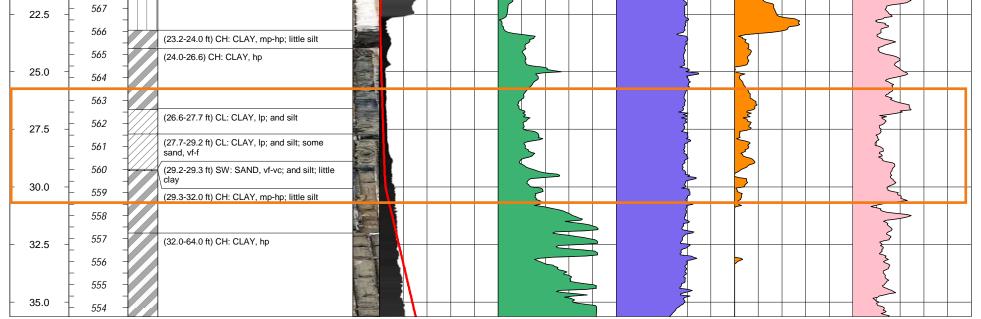
BORING NAME: W4 PROJECT NAME: BASF Point Hennepin DATE LOGGED: 03/24/2022 BORING COORDINATES: X 322532.36 Y 4672795.34 PROJECTION: Universal Transverse Mercator (UTM) SURFACE ELEVATION: 576.4 ft amsl	<text><text><text><text><text></text></text></text></text></text>	Logging Methods         ✓       Soil Description         ✓       Sample Photo         ✓       HPT Pressure         ✓       HPT Flow Max         ✓       HPT Estimated Hydraulic Conductivity         ✓       HPT Rate of Penetration         ✓       HPT Electrical Conductivity (EC)         ✓       Electrical Resistivity Imaging (ERI)         Electrical Conductivity (EC)         ✓       Proposed Piezometer P-03 Screen Intervals for         Hydraulic Investigation Work Plan								
ELEVATION DATUM: World Geodetic System 1984										
Depth (() 1ft:50ft () 1ft:50ft () 1ft:50f	mS/m 2500	T Flow Max Est. K ROP mL/min 500 0 ft/day 100 0 mm/sec 50								
0.0       576       (0.0-1.0 ft) SW/GW: SAND, vf-vc; and GRAVEL; little silt         -       575       (1.0-2.2 ft) CH/SC: CLAY, mp-hp; and SAND         -       574       (2.2-7.2 ft) SP: SAND, vf-f         -       573       NOTE: DBO										
7.5 - 569 - (7.2-8.0 ft) CL/ML: CLAY; and SILT (8.0-13.8 ft) CH: CLAY, mp-hp										
- 10.0 - 566 - 565 - 12.5 - 564 - 564										
15.0 562 561 560 (13.8-16.8 ft) CH: CLAY, mp-hp; little silt 560 (14.8 4 18 0 ft) CH: CLAY, mp-hp; little silt										
17.5       -       559       (16.8-18.0 ft) CL/SC: CLAY, lp; some sand, vf-med: little silt         -       558       -       (18.0-58.0 ft) CH: CLAY, mp-hp         -       557       -       NOTE: Poor Recovery and Sulfur Odor at 56-58 ft         -       555       -       -										





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PROJE DATE I BORIN PROJE SURFA	LOGGEE IG COOF ECTION: ACE ELE	IE: BASF Point Hennepin         D: 03/25/2022         RDINATES:       X 322696.49 Y 4673278.09		LOGGED HPT TOTA SB TOTAL	NUMBER: Arcadis BY: Geophy Dakota	- SB and /sics - HPT 62.8 ft bg 64.0 ft bg dix A for more	S SC	<ul> <li>Sample Photo</li> <li>HPT Pressure</li> <li>HPT Flow Max</li> <li>HPT Estimated Hydraulic Conductivity</li> <li>HPT Rate of Penetration</li> <li>HPT Electrical Conductivity (EC)</li> </ul>							
Depth 1ft:50ft	Elevation (ft amsl)	Abbreviated Soil Description	Sample Photos	ERI EC	0	PT Press. psi 100	HPT Flow Max	00 0 ft/da		ROP 0 mm/sec 50					
- 2.5 - - 5.0 - - 7.5 - - 10.0 - - 12.5 -	- 589 - - 588 - - 588 - - 587 - - 586 -  - 584 -  - 584 -  - 583 -  - 583 -  - 583 -  - 583 -  - 580 -  - 578 -  - 577 -  - 576 -  - 576 -  - 576 -  - 576 -   - 574 -                	(0.0-2.0 ft) SW: SAND, vf-f; some gravel, granules to med. pebbles (2.0-3.3 ft) ML: SILT, np; some gravel, granules to med. pebbles; little sand, vf-f (3.3-3.6 ft) ML: SILT, np; some sand, vf-f NOTE: Likely start of the DBO (3.6-23.2 ft) ML: SILT, np NOTE: DBO								MMMM					
- 17.5 -	- 573 - - 572 - - 571 - - 570 - - 570 - - 569 -  - 568 - 														

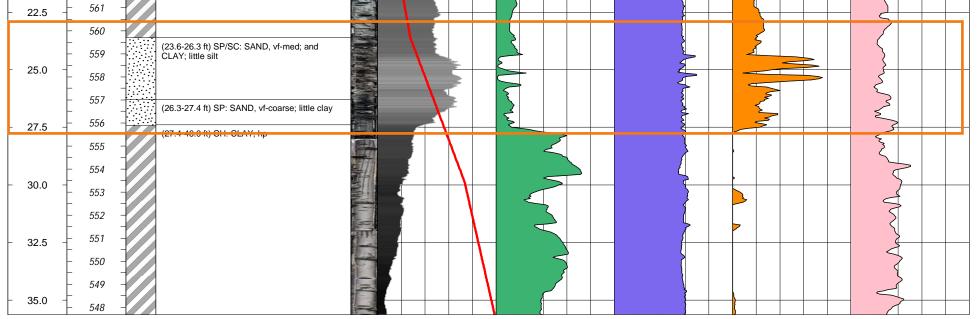


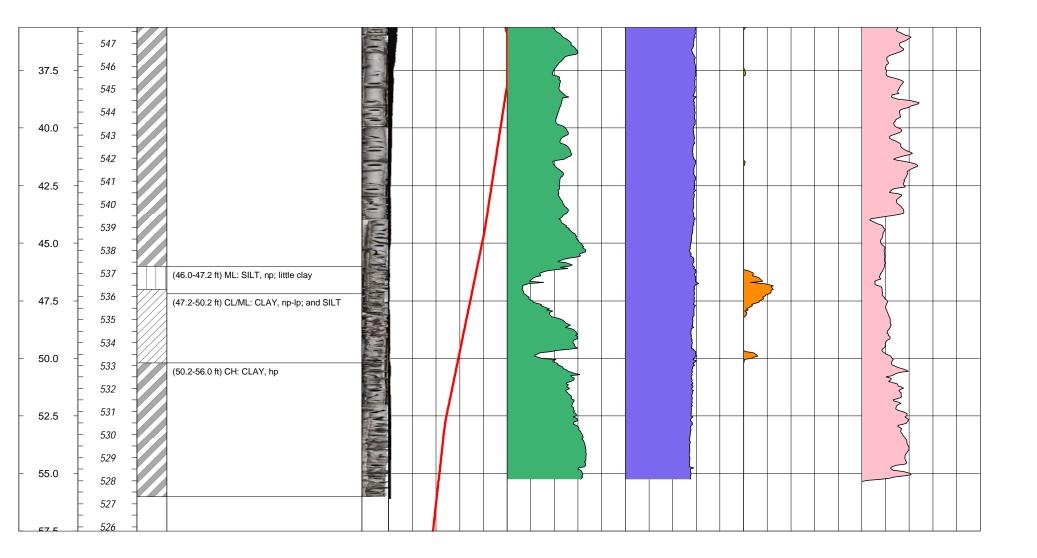
	- 553 -	
	- 552 -	
- 37.5 -	- 551 -	
- 40.0 -		
	548 -	
- 42.5 -		
42.5	546 -	
	- 545 -	
- 45.0 -	- 544 -	
	- 543 -	
- 47.5 -	- 542 -	
	541 -	
	540 -	
- 50.0 -	- 539 -	
	- 538 -	
- 52.5 -	537 -	
	- 536 -	
- 55.0 -	- 535 -	
55.0	- 534 -	
	- 533 -	
- 57.5 -		
	- 531 - - 530 -	
- 60.0 -	- 530	
	- 529 - 528 -	
- 62.5 -		
65.0		

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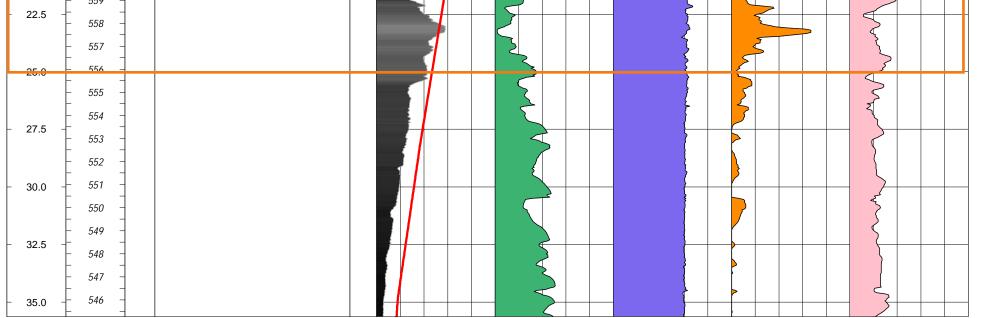
PROJE DATE BORIN PROJE SURFA	LOGGEE IG COOF ECTION: ACE ELE	IE: BASF Point Hennepin	CLIENT: BASF   PROJECT NUMBER: 30107326   Arcadis - SB and   LOGGED BY:   Arcadis - SB and   Geophysics   Dakota - HPT   HPT Flow Max HPT Estimated Hydraulid HPT Rate of Penetration HPT Electrical Conductivity (Electrical Conductivity	lic Conductivity on tivity (EC) aging (ERI) (EC) 5 Screen Intervals			
Depth 1ft:50ft	Elevation (ft amsl)	Abbreviated Soil Description	HPT EC     Corr. HPT Press.     HPT Flow Max     Est. K       0     mS/m     2500     0     psi     100     mL/min     500       0     mS/m     2500     0     mL/min     500     0     ft/day     100	ROP 0 mm/sec 50			
- 2.5 -	- 583 - - 582 - - 581 - - 581 - - 580 - - 579 -  - 578 -  - 578 - 	(0.0-2.4 ft) SW: SAND, vf-f; some silt; little gravel (2.4-4.5 ft) ML: SILT, np; some sand, vf-med; little granules to large pebbles NOTE: DBO (4.5-15.7 ft) ML: SILT, np NOTE: DBO					
- 7.5 -	- 576 - - 575 - - 574 - - 573 - - 573 - - 572 - - 571 -						
- 15.0 - - 17.5 - - 20.0 -	- 570 - - 569 - - 568 - - 567 - - 566 - - 566 - - 565 - - 564 -  - 564 -  - 563 -	(15.7-18.0 ft) ML: SILT, np; some clay NOTE: Peat and Organics (18.0-19.7 ft) CL: CLAY, mp; some silt NOTE: Peat and Organics (19.7-23.6 ft) CH: CLAY, hp					
- 20.0 -		(19.7-23.6 ft) CH: CLAY, hp					





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PROJE		E: W11 IE: BASF Point Hennepin D: 03/30/2022		PR	IENT: B	NUMBER: 30107326 Arcadis - SB and	Soil D Samp HPT HPT HPT	<ul> <li>HPT Flow Max</li> <li>HPT Estimated Hydraulic Conductivity</li> <li>HPT Rate of Penetration</li> </ul>							
PROJE SURF#	ECTION: ACE ELE <sup>V</sup>	X 322893.15 Y 4674101.92 Universal Transverse Mercator (U VATION: 580.9 ft amsl XTUM: World Geodetic System 198	-	SB	<ul> <li>HPT TOTAL DEPTH: 39.8 ft bgs</li> <li>SB TOTAL DEPTH: NA</li> <li>REMARKS:</li> <li>HPT Electrical Conductivity (EC)</li> <li>Proposed Piezometer P-06 Scree for Hydraulic Investigation Work F</li> </ul>										
Depth 1ft:50ft	Elevation (ft amsl)	Abbreviated Soil Description	Sample Photos	0 mi	PT EC S/m 2500 RI EC S/m 2500	0 psi 100 C	HPT Flow Max	Est. K 0 ft/day 100	ROP 0 mm/sec 50						
- 2.5 - - 5.0 - - 7.5 - - 12.5 - - 17.5 -	580	No boring log installed at this location for soil description.         Image: solution of the solutio													
20.0	- 561 -  - 560 -  - 559 -		+		R F										



07.5	- 545 -  - 544 -				Ę		}	• •		$\left\{ \right\}$	
- 37.5	- 543 -				~	\$	}			5	
	- 542 -										
- 40.0	541										_
42.5	- 540 -  - 539 -	No boring log installed at this location for soil description.									

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