



April 13, 2026

Mr. Michael Smith, P.E.
Land Quality Bureau
Iowa Department of Natural Resources (IDNR)
6200 Park Avenue, Suite 200
Des Moines, IA 50321

**RE: Submission of Emergency Action Plan
Metro Waste Authority – Metro Park West Landfill
Permit No. 08-SDP-03-84P**

Dear Mr. Smith,

On behalf of Metro Waste Authority, HDR Engineering, Inc. (HDR) is submitting this emergency action plan (EAP) for the Metro Park West Landfill (MPW) located near Perry, Iowa. This plan provides guidance for the monitoring of the riverbank of the North Raccoon River adjacent to the closed municipal solid waste unit (Greene County Landfill) and includes recommendations on the installation and permitting requirements for potential protective measures.

The purpose of this emergency action plan is to address observed riverbank encroachment and its implications for critical infrastructure, including the toe drain and adjacent landfill slope. This submittal includes the following:

- Cover Letter
- Emergency Action Plan
- Appendixes for Emergency Action Plan

A brief summary of the EAP is illustrated as follows:

Purpose: The purpose of this EAP is to provide guidance on riverbank slope stability risk assessment and response for the Greene County municipal solid waste unit at Metro Waste Authority (MWA)'s Metro Park West (MPW), located northwest of Perry, Iowa. The channel of the Raccoon River to the south and west of MPW has migrated closer to the toe drain of the landfill. This EAP contains guidance on risk assessment from a channel migration and slope stability perspective to prevent collapse of the toe drain which could allow waste and leachate to enter the river.

Risk Assessment and Monitoring: Monitoring of the riverbank location and conditions is recommended at regular intervals with increased frequency during periods that indicate a slope stability emergency could occur. This monitoring consists of on-site observations of bank conditions and tracking of both predicted and observed rainfall and river flows from established gages.

Mitigation and Preparedness Measures: Bank stabilization measures can be used to improve slope stability and slow erosion of the riverbank. Riprap can be used to slow channel migration while sheet pile installation will provide protection for the toe drain of the landfill. The sheet pile protection will be designed



and constructed within the timeline identified by the Iowa Department of Natural Resources (IDNR) in the letter dated March 16, 2026.

EAP maintenance: The EAP will need to be updated to ensure that gages and measurement approaches are still applicable.

Please review the enclosed memorandum and supporting documentation. If you have any questions regarding this permit submittal, please do not hesitate to contact us at (402) 392-6980.

Sincerely,

HDR Engineering, Inc.

Katie Kinley, P.E.
Civil/Environmental Project Manager

Dan Bacehowski, CGP
Senior Client Manager

cc: Michael McCoy, Metro Waste Authority
Leslie Irlbeck, Metro Waste Authority
Andrew Phillips, Metro Waste Authority
Matt Morris, Metro Waste Authority

Attachments: Emergency Action Plan
Appendix A: Gage and Monitoring information
Appendix B: Permitting Matrix for stabilization methods
Appendix C: "Channel Meander Migration Analysis" HDR Report prepared for Metro Waste Authority (October 2025)
Appendix D: "Riverbank Slope Stability Analysis and Sheet Pile Design Evaluation" HDR Report prepared for Metro Waste Authority (November 2025)
Appendix E: Iowa Department of Natural Resources (IDNR) letter to Metro Waste Authority (MWA) dated March 16, 2026

Emergency Action Plan

Metro Waste Authority
Metro Park West Landfill

Perry, Iowa

April 2026

Table of Contents

Draft Emergency Action Plan (EAP).....	2
Introduction	2
Risk Assessment	2
Monitoring and Early Warning Systems	5
River Monitoring	5
Rainfall Monitoring.....	6
GAGE MONITORING ACTION:.....	7
Local, Site Specific Monitoring.....	7
RIVERBANK MONITORING ACTION:	8
Communication Protocols.....	8
Emergency Response Procedures.....	9
Activation Criteria	9
Sheet.....	9
Roles and Responsibilities.....	9
Resource Mobilization	10
Mitigation and Preparedness Measures	10
Bank Stabilization	10
Permit Considerations	11
Post Event Recovery and Rehabilitation	11
Damage Assessment	11
Restoration	12
Financial Aid and Funding	12
EAP Maintenance and Review	12
Annual Review	12
Updates & Lessons Learned	12
Training	12
Appendices	13

Draft Emergency Action Plan (EAP)

Metro Waste Authority – Metro Park West Landfill

Introduction

The purpose of this EAP is to provide guidance on riverbank slope stability risk assessment and response for the Greene County municipal solid waste unit at Metro Waste Authority (MWA)'s Metro Park West (MPW), located northwest of Perry, Iowa. The channel of the Raccoon River to the south and west of MPW has migrated closer to the toe drain of the landfill. This EAP contains guidance on risk assessment from a channel migration and slope stability perspective to prevent collapse of the toe drain which could allow waste and leachate to enter the river. Guidance is provided for monitoring precipitation and flow in the Raccoon River watershed using publicly available gages. Recommendations for measurement of riverbank migration and stabilization measures are also included. To prevent encroachment on the MPW location, mitigation measures and their corresponding permitting requirements are described.

Risk Assessment

An analysis of historical imagery and elevation data shows that the Raccoon River channel has migrated to the northeast and toward the MPW landfill, eroding the bank of the river approximately 8.7 feet per year (1930 – 2025) with increased rates of erosion associated with flooding events (Appendix C).

Migration of the Raccoon River is significant enough to risk slope stability within the landfill and threatens the aforementioned toe drain. A collapse of the toe drain could lead to failure of the adjacent closed landfill waste slope located to the northeast of the riverbank, potentially allowing waste and leachate to enter the river.

Figure 1 shows the drainage area above the North Raccoon River gage and the weather and stream gages that are applicable for the MPW site. Figure 2 shows the location of MWA monitoring wells at the MPW site. Figure 3 shows historic Raccoon River channel alignments from 1930 to 2024, illustrating the migration of or the river channel toward MPW.

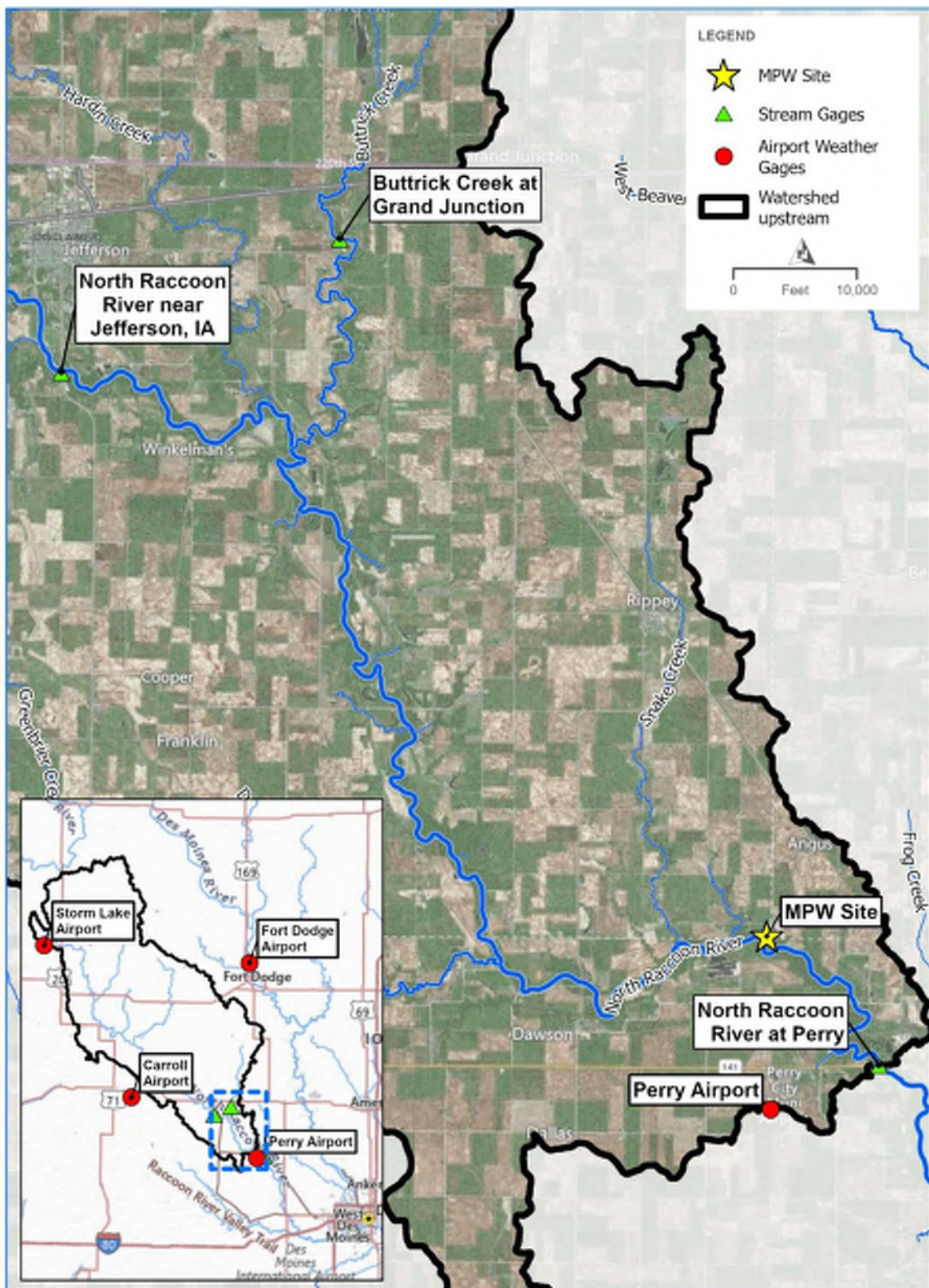


Figure 1. Site and gage locations

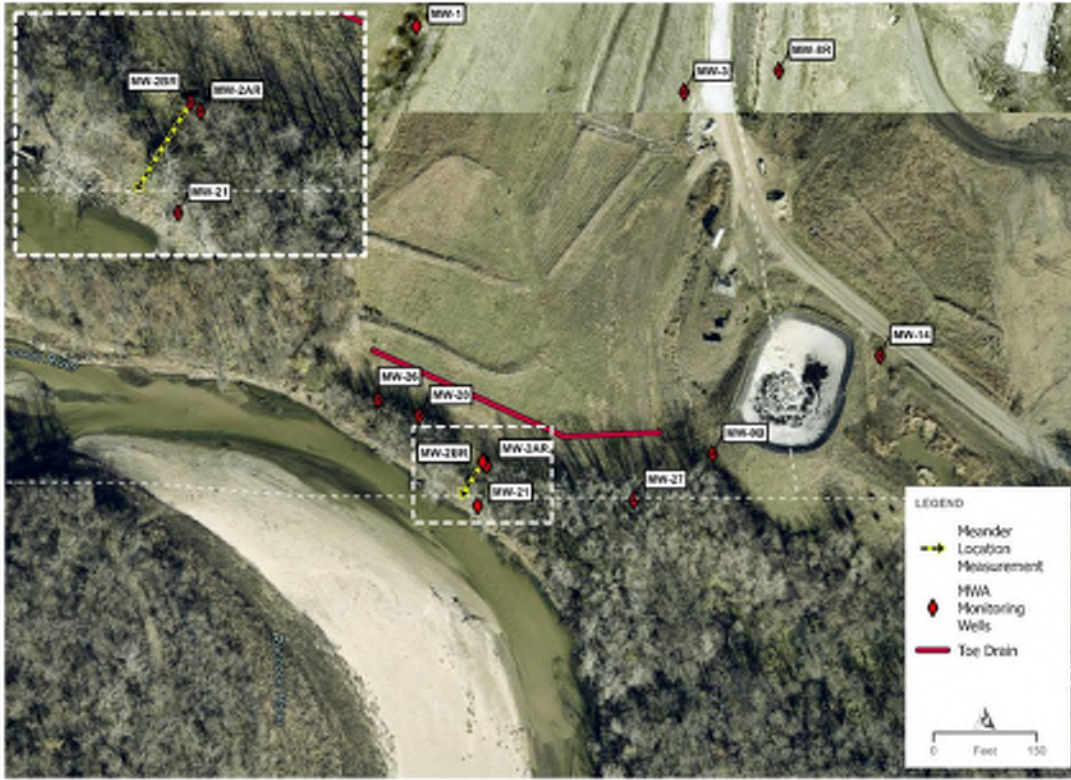


Figure 2. Location of MWA monitoring wells, MPW toe drain and suggested measurement alignment



Figure 3. Racoon River migration from 1930-2024

Monitoring and Early Warning Systems

Erosion risk is most severe in periods where soil is saturated, and the river levels are low, leaving wet soil exposed to the air. Additional caution and monitoring should be taken in these periods.

If runoff or soil moisture conditions indicate that a flood or slope stability emergency could occur, MWA may assign staff to perform additional monitoring. Generally, personnel will be needed for monitoring based upon the forecasted degree of high water and the distance of the riverbank to the toe drain. Additional personnel may be needed if emergency repairs operations are warranted.

River Monitoring

High water levels in the Raccoon River are typically caused by severe thunderstorms that occur in the spring through fall, though they are possible throughout the year. Utilization of nearby stream gages, advanced weather radar, storm/flood warnings from the National Weather Service, can assist MPW staff in the preparation and monitoring of flood events with potential to impact the site.

U.S. Geological Survey (USGS) gages within the Raccoon River watershed should be used to monitor both predicted floods and flood peak recession near the MPW site. The Iowa Flood Information System (IFIS) provides basin wide monitoring and forecasting and is a useful tool to visualize flows and flood alert levels. Specific gages of interest include:

USACE GAGE "NORTH RACCOON RIVER NEAR PERRY IOWA"

- Immediately downstream of MPW site, corresponds closely with flows experienced at MPW.
- Water surface elevation data is collected at 15-minute intervals
- Drainage Area 2,169 square miles
- National Water Prediction Service provides forecasts at this gage during times of high water (<https://water.noaa.gov/gauges/PROI4>) which can be used in flood response planning.
- This gage is owned and operated by the U.S. Army Corps of Engineers

USGS "NORTH RACCOON RIVER NEAR JEFFERSON IOWA"

- Drainage area 1,619 square miles
- Gage number 05482500
- National Water Prediction Service provides forecasts at this gage during times of high water (<https://water.noaa.gov/gauges/05482500>)

USACE GAGE "BUTTRICK CREEK NEAR GRAND JUNCTION, IA"

- Drainage Area 214 square miles
- National Water Prediction Service provides forecasts at this gage during times of high water (<https://water.noaa.gov/gauges/GJTI4>)

IOWA FLOOD INFORMATION SYSTEM (IFIS)

The Iowa Flood Information System (IFIS) provides real time flood forecasting using rainfall data, soil moisture and river gage data. Personnel responsible for monitoring flood risk at MPW should utilize IFIS as a resource for basin-wide forecasting.

- (<https://ifis.iowafloodcenter.org/ifis/automate.php>)

Rainfall Monitoring

After rainfall or extended snow melt periods, soils can become saturated. Under saturated conditions the likelihood of bank failure increases. Monitoring rainfall accumulation and soil moisture should be used to trigger maintenance and measurement actions.

The Racoon River near the MPW site drains 2,169 square miles, making complete understanding of the spatiotemporal nature of rainfall within the watershed difficult using only a few rain gages. The Perry Iowa Airport gage (Station ID: PRO) is located near the MPW site, while the Storm Lake (Station ID: SLB), Fort Dodge (Station ID: FOD) and Carroll (Station ID: CIN) airport gages are outside the watershed but near the boundary to monitor precipitation upstream.

Perry Iowa Airport Rainfall Gage

NOAA Atlas 14 data for the Perry, Iowa airport in **Error! Reference source not found.** below. A 5-year recurrence interval rainfall is recommended to trigger daily monitoring actions. The 5-year 6-hour duration storm precipitation depth is 3.1 inches while the 5-year 24-hour storm duration precipitation depth is 3.8 inches.

It is recommended the MWA personnel with responsibility for emergency actions (i.e. the Compliance Coordinator) create an account with the interactive National Weather Service website (iNWS) and set river level alerts based on the Racoon River near Perry Iowa gage and rainfall alerts based on the Perry Municipal Airport gage. Documentation on iNWS can be found in Appendix A.

Daily monitoring is recommended for as long as a gage remains at action level or and for 30-days after it falls below action level river stage.

(<https://forecast.weather.gov/data/obhistory/KPRO.html>)

Table 1. NOAA Atlas 14 data for Perry, Iowa Airport

Annual Exceedance Probability	Recurrence Interval (year)	Precipitation Depth (inches)	
		6-hour	24-hour
0.5	2	2.4	3.1
0.2	5	3.1	3.8
0.1	10	3.7	4.5
0.02	50	5.6	6.4

Annual Exceedance Probability	Recurrence Interval (year)	Precipitation Depth (inches)	
		6-hour	24-hour
0.01	100	6.5	7.3
0.002	500	9.0	9.8

GAGE MONITORING ACTION

Monitor river and rainfall gages with alerts set to correspond to predicted high river stages. If any of the following conditions are met, monitoring should be increased to a daily frequency, and continue for 30-days after such event:

- **River level meets or is predicted to reach action stage at Perry, Iowa gage (14 ft)**
- **5-year or higher rainfall occurs in the area OR soil moisture is very high due to persistent rainfall or melting snow**

Local, Site Specific Monitoring

MWA currently conducts semi-annual groundwater monitoring at monitoring wells in Figure 3. Measurements of the riverbank shall be conducted in conjunction with those monitoring semi-annual monitoring events.

Regular monitoring shall be performed semiannually, with additional monitoring in high flow or high rainfall periods as described above. Results of monitoring will be recorded and reported to Iowa DNR annually with the groundwater monitoring results.

The individuals assigned to site monitoring will be responsible for traversing the site adjacent to the streambank, completing the site observation and monitoring forms (see Data Log Sheets), and identifying signs of bank erosion/ instability.

Reporting to DNR

Monthly reports documenting the observations shall be submitted to the Iowa DNR by the 15th of each month. These reports should include observations and documentation for the action items in the monitoring plan as well as any steps taken or expected for banks stabilization measures. If monitoring or other situations trigger any actions, the DNR's Field Office and Central Office shall be notified immediately

Riverbank Measurement

The Riverbank Channel Migration Memo (HDR 2025) tracks channel migration using measurements from monitoring well MW-2BR to the closest edge of the left bank near monitoring well MW-21.

In the event of a predicted flood (action level of 14 feet or higher) it is critical to monitor any additional channel migration. This should include measurement of the bank as soon as the NWS predicts the river will reach action level and for 30 days afterward. Additional erosion or

sloughing may have occurred due to high water, so additional caution is critical when taking these measurements.

Erosion and Instability

Indicators of bank erosion and instability include:

- Cracks in soil, seepage, or unusual wet areas
- Collapse of vegetation into the river or down the bank
- Slumping or sliding of bank areas
 - o Early signs may be observed as cracks along the edge of the bank

Debris in River Channel

Local events such as the collapse of a tree can cause riverbank retreat. Changes in flow patterns due to debris in the channel can increase stream velocities against the bank causing increased erosion. Monitoring should include observation of changes to the channel so that debris can be removed as quickly as possible.

RIVERBANK MONITORING ACTION

If new bank collapse is observed or large debris is noticed in the Raccoon River channel that has the potential to change flow patterns perform daily monitoring checklist below and notify MWA Compliance Coordinator.

Monitoring Responsibilities:

- **Patrol via foot or vehicle the stream bank**
- **Take photographs of all significant issues**
- **Record Stream gage readings on appropriate forms (see Data Log Sheets)**
- **Monitor and record distance from monitoring well to bank edge**
- **Look for signs of erosion and instability and document with photographs**
- **Monitor eroded/eroding areas along the streambank**
- **Notify supervisor of the status, any concerns, or maintenance needs**
- **Notify DNR's field and central office if any observations require corrective action**

Communication Protocols

In the event of an imminent bank collapse or rapid bank movement, do the following:

- Perform a head count of employees, contractors and guests
- Stay away from other nearby areas that may also be at risk
- Contact the MWA Compliance Coordinator
- Call 911 if there are any injuries or if someone may be buried under the failed slope

Emergency Response Procedures

Activation Criteria

Activation Criteria for bank stabilization measures is dependent on the distance from the bank to the MPW toe drain. Permitting timelines will affect the installation of bank stabilization measures and should be considered part of the overall timeline. See Permit Considerations for more information.

Riprap

Riprap installation can be used to stabilize the riverbank to slow channel migration toward MPW. Permitting for the riprap installation is necessary because the required design will extend from the top of the riverbank to the toe of the riverbank (See Appendix D, section 6.2).

Sheet Pile

Sheet Pile installation requirements will depend on construction approach. The minimum distance necessary between the toe drain to the edge of the riverbank to install sheet pile will depend on the machinery and design requirements. Appendix D, section 6.2 and 7 include information on design requirements for sheet pile.

Roles and Responsibilities

In accordance with IDNR letter dated March 16, 2026 (Appendix E), the initiation of designing, permitting, and installation of permanent bank stabilization must begin by May 30, 2026, with installation completed by December 31, 2027. While these activities are underway monitoring actions will continue as described in this EAP.

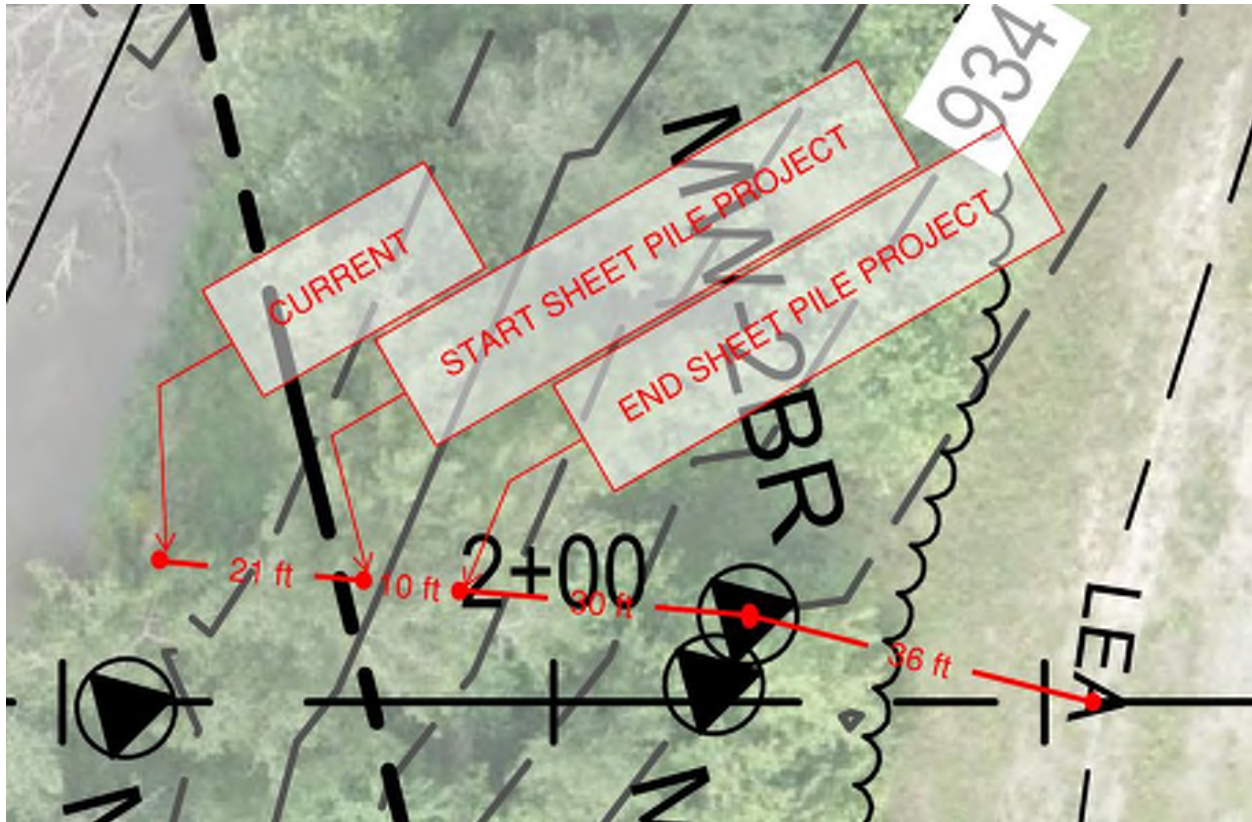


Figure 4. Sheet pile installation guidance

Sheet pile installation shall be installed between the tree line and toe drain for a minimum distance of 100-ft east of MW-2BR, and to 15-ft from the western property line. Resource Mobilization

If channel migration reaches a point at which stabilization measures are needed, the MWA compliance coordinator will initiate sheet pile installation. This will entail an abbreviated design and bid process to install the sheet pile wall within 1-yr of triggering this action.

Mitigation and Preparedness Measures

Bank Stabilization

Sheet pile as a riverbank protection measure will meet the factor of safety criteria for slope failure while riprap can provide scour protection and additional slope stability. EPA guidance provides a recommended minimum value of Factor of Safety of 1.5 for slope stability measures in this location. Documentation of slope stability models using sheet pile and riprap can be found in Appendix D. Other stability approaches such as bendway weirs may also be considered to change behavior of flow in the river.

Sheet Pile Stabilization

Piles are a common stabilization method as they can withstand considerable shear forces. Slope stabilization using pile reinforcement can be used to reinforce the riverbank to increase the factor of safety under applied pore water pressure.

A slope stability engineering study (Appendix D) shows that a single layer sheet pile installed approximately 50 feet from the toe drain will provide adequate protection. The sheet pile specifications needed to satisfy the factor of safety criteria for both circular wedge and sliding block failure mechanisms are 30,000 lbf per unit length with installation at grade.

Rock Installation for bank protection and channel preservation

RIPRAP

Riprap installation can improve slope stability but does not reach an adequate factor of safety to prevent slope failure. Riprap should be considered in combination with other mitigation methods. Riprap sizing guidelines and requirements are listed below:

- Iowa Department of Transportation (IDOT) guidance specifies Class E riprap for this site (Appendix D)
- Placement of riprap will require regulatory approvals, including coordination with the U.S. Army Corps of Engineers (USACE).

Permit Considerations

The permitting matrix in Appendix B can be used to select the appropriate mitigation measure given the extent of channel migration, encroachment on the MPW and the predicted time to implement the measures.

Post Event Recovery and Rehabilitation

Damage Assessment

Damage Survey

Following a high flow event, or after an observation or measurement of channel migration toward the MW-2BR monitoring well, it is critical to document the distance from the well to the edge of the bank.

- MPW personnel should use monitoring stakes previously installed from the monitoring well to measure the distance from the well to the bank
- Drone imagery should be flown to assess the loss of bank or collapse of any structurally significant vegetation
- Inspection of the river channel should include documentation of any new debris in the river as well as changes to the path of the river

Damage Reporting

Damages will be reported to the chief executive officer.

Restoration

Repairs

Repairs will be determined by the degree of encroachment and the distance from the MPW toe drain and the riverbank. Refer to Mitigation and Preparedness Measures for repair criteria.

Financial Aid and Funding

Applications for funding of bank stabilization or other measures may affect project timelines. Funding of stabilization measures are outside the scope of this EAP but will need to be considered when anticipating timing of any design or construction measures.

EAP Maintenance and Review

Annual Review

River and Rain Gages:

Ensure that gages are still active and that website links are accurate.

On-Site Monitoring Plan:

Check that monitoring well (MW-2BR) is still the most appropriate starting point for migration measurement. If this is no longer appropriate, update the EAP with alternate wells or landmarks from which to measure. If the closest path to the riverbank has changed from the current alignment new measurement stakes or flags should be installed for future repeatable measurement.

Monitoring of Stabilization Measures

If bank stabilization measures are installed, MWA should perform semi-annual inspection of the bank near the installation. Report any changes to the bank or that indicate further erosion or movement to the MWA compliance officer.

Updates & Lessons Learned

After a slope failure event, notable movement in meander location, or any other slope related events at the MPW this EAP should be reviewed. If there are questions or issues that arise that this EAP does not address those sections should be noted and added. The MPW ERRAP should also be consulted as guidelines for emergency response.

Training

This EAP is structured as a reference and guide for monitoring and response of the Raccoon River riverbank. Employees of the MWA or MWP who have responsibilities related to monitoring and emergency response at the MWP should all be familiar with the contents of this EAP. The existence and contents of this document should be part of both onboarding and ongoing training for MPW staff.

Appendices

Appendix A: Gage and Monitoring information

Appendix B: Permitting Matrix for stabilization methods

Appendix C: "Channel Meander Migration Analysis" HDR Report prepared for Metro Waste Authority (October 2025)

Appendix D: "Riverbank Slope Stability Analysis and Sheet Pile Design Evaluation" HDR Report prepared for Metro Waste Authority (November 2025)

Appendix E: Iowa Department of Natural Resources (IDNR) response letter to Metro Waste Authority; dated March 16, 2026

Appendix A

Gage and Monitoring Information



(https://www.noaa.gov/) (https://www.weather.gov/)



NCRFC (/rfc/ncrfc) / DMX (/wfo/dmx) / PRO14

North Raccoon River near Perry

Last updated: Jan 2, 2026, 12:19 PM CST

No watches, warnings or advisories are in effect for this area.

Official Forecast

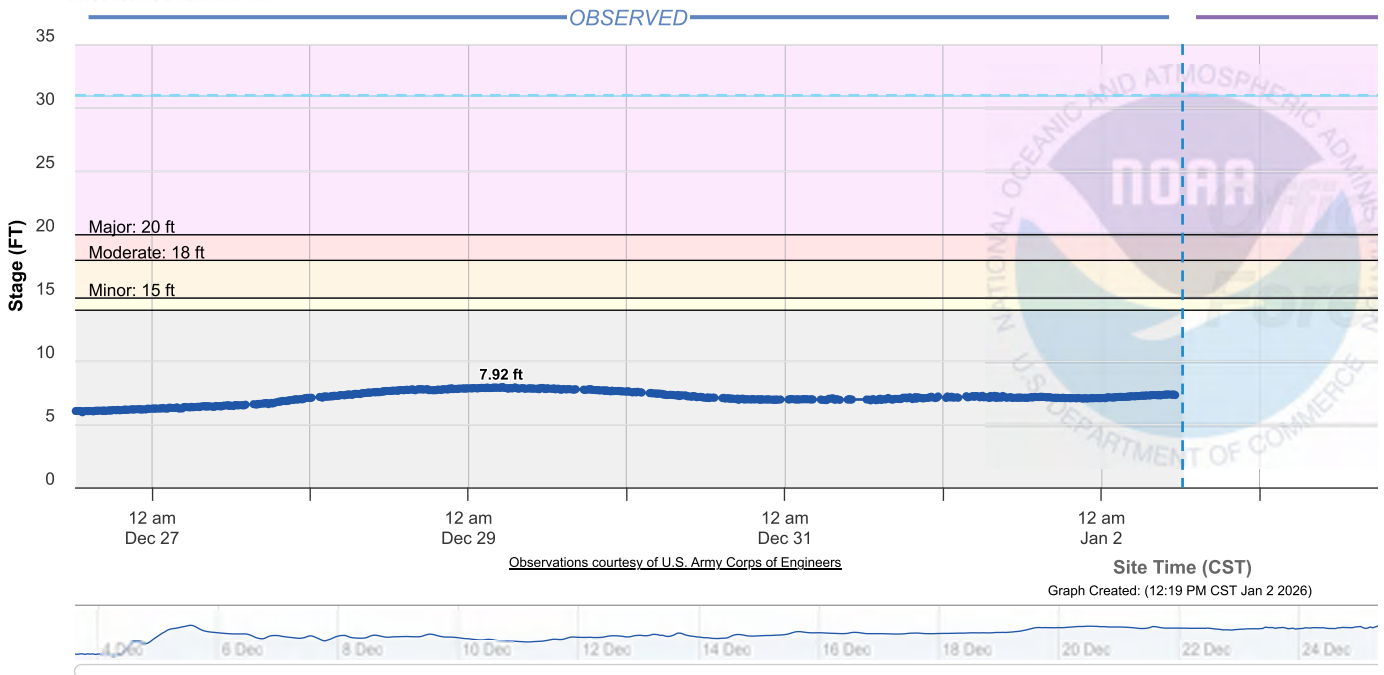
National Water Model Guidance

← UPSTREAM GAUGE (DAWI4)

DOWNSTREAM GAUGE (MBNI4) →

Latest observed value: 7.29 ft
11:15 AM CST 2-Jan-2026
Flood Stage is 15 ft

North Raccoon River near Perry
NWSLI: PRO14, Reach ID: 6610898



Zoom 1d 2d 7d **14d** All

Scale to Flood Categories

Auto Refresh

Traces and Thresholds Click to turn on/off display

Observed (OBS) 01/02/2026 11:15 AM CST

Record: 31 ft

CATEGORY	STAGE
✓ Major Flooding	20 ft
<i>Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.</i>	
✓ Moderate Flooding	18 ft
<i>Some inundation of structures and roads near stream.</i>	
✓ Minor Flooding	15 ft
<i>Minimal or no property damage, but possibly some public threat.</i>	
✓ Action	14 ft
<i>The level which, when reached by a rising stream, represents the level where the NWS or a customer/partner needs to take some type of mitigation action in preparation for possible significant hydrologic activity.</i>	

Reliability of the Forecast:

NOTE: Forecasts are issued as needed during times of high water, but are not routinely available.

Flood Impacts ●

21.6 - Water affects a two-block area of Grove St in Adel east of US 169. Water is 2 to 3 feet deep over the south entrance to the Dallas county fairgrounds off of US 169. Water affects businesses north of Adel on west side of US 169 as well as the entrance to Island Park campground and soccer complex in Adel.

20 - Limited evacuations may begin in residential areas of Adel...along with extensive sandbagging.

19 - Approaches to the US 169 bridge over the river north of Adel are impassable.

18 - Water affects many rural roads.

17.1 - Water begins impacting US 169 just north of Adel near the fairgrounds.

17 - Water approaches the bottom of the US 169 bridge on the north side of Adel and affects agricultural land northeast of Adel.

16.5 - Water affects 125th Trl north of Dawson and west of Hwy P46. Water may also affect portions of US 169 north of Adel near the fairgrounds.

16 - Water affects 180th Lane west of Minburn.

15 - Water affects the wastewater treatment facility as well as agricultural land in the Perry area. Near Adel...water affects the fairgrounds and golf course. Northwest of Adel...water affects Sportsman Club Rd and Midland Trl.

13 - Water affects agricultural land.

Gauge Info

Coordinates	41.8354, -94.1320
RFC	NCRFC (/rfc/NCRFC)
State	IA (/state/IA)
WFO	DMX (/wfo/dmx)
County	Dallas
Data Provider(s)	
USACE	U.S. Army Corps of Engineers

Gauge Location



1000 ft

Display PRO14 marker

Display FEMA's National Flood Hazard Layers

Recent Crests

1. 12.58 ft on 12-28-2022 **(P)**
2. 31.04 ft on 01-29-2022
3. 29.52 ft on 02-11-2021 **(P)**
4. 12.99 ft on 03-22-2020 **(P)**
5. 18.09 ft on 03-20-2019 **(P)**
6. 30.05 ft on 01-18-2018 **(P)**
7. 15.48 ft on 05-24-2017 **(P)**
8. 20.78 ft on 12-17-2015
9. 19.40 ft on 06-26-2015
10. 15.28 ft on 07-03-2014 **(P)**

SHOW ALL

Historic Crests

1. 31.04 ft on 01-29-2022
2. 30.05 ft on 01-18-2018 **(P)**
3. 29.52 ft on 02-11-2021 **(P)**
4. 23.00 ft on 07-10-1993
5. 22.70 ft on 03-20-1979
6. 21.67 ft on 06-10-2008
7. 20.82 ft on 08-13-2010 **(P)**
8. 20.78 ft on 12-17-2015
9. 20.29 ft on 04-27-2007
10. 20.00 ft on 06-19-1990

SHOW ALL

Low Water Records

1. 2.37 ft on 03-14-1998
2. 2.38 ft on 09-09-2023
3. 2.45 ft on 09-03-2017
4. 2.45 ft on 10-01-2017
5. 2.54 ft on 02-19-2022
6. 2.56 ft on 12-14-2020
7. 2.69 ft on 09-29-2020
8. 2.71 ft on 02-11-2012
9. 2.95 ft on 04-10-2014
10. 2.96 ft on 02-05-2000

SHOW ALL

Vertical Datum Table

TYPE

NGVD29

Major Flooding

929.41 ft

Moderate Flooding

927.41 ft

Minor Flooding

924.41 ft

Action

923.41 ft

Latest Value

916.70 ft

Gauge Zero

909.41 ft

Gauge Photos

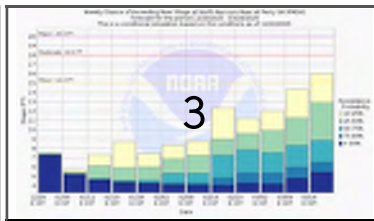
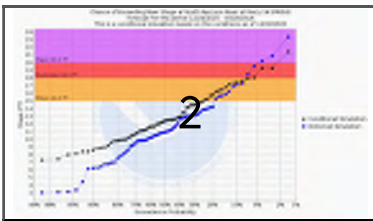
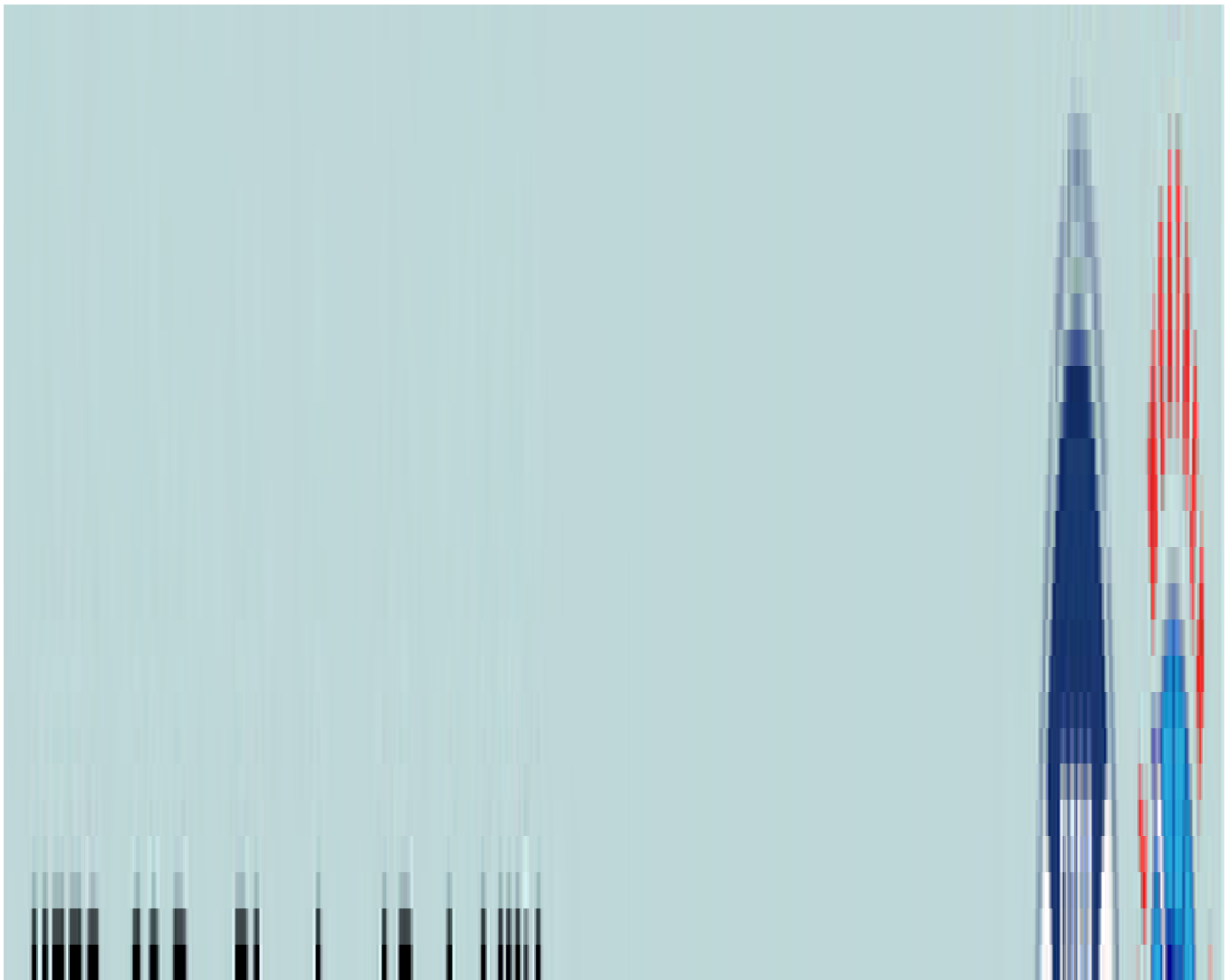
No Images Found

Probability Information

Photo 1 of 3

Short Range Forecast Uncertainty

[About this graph \(/about/chance-of-exceeding-river-stage\)](#) | [Product Description Document \(/about/short-term-probabilistic-guidance-product\)](#)



Unique Local Info

- [How low could the river get?](http://water.weather.gov/resources/rsync/exceedance/PROI4.nonexc.90day.gif) (<http://water.weather.gov/resources/rsync/exceedance/PROI4.nonexc.90day.gif>)

Collaborative Agencies

The National Weather Service prepares its forecasts and other services in collaboration with agencies like the US Geological Survey, US Bureau of Reclamation, US Army Corps of Engineers, Natural Resource Conservation Service, National Park Service, ALERT Users Group, Bureau of Indian Affairs, and many state and local emergency managers across the country. For details, [please click here \(/about/meet-our-partners\)](#).

Resources

Hydrologic Resource Links

- [River Forecast Centers \(/about/rfc\)](#)
- [NWS Des Moines Hydro Decision Support Page \(https://www.weather.gov/dmx/dsshhydro\)](https://www.weather.gov/dmx/dsshhydro)
- [NWS Inundation Mapping Locations \(/about/fim-locations\)](#)

Additional Resource Links

- [NWS Precipitation and River Forecasting \(https://www.noaa.gov/jetstream/rfcs\)](https://www.noaa.gov/jetstream/rfcs)
- [U.S. Geological Survey \(map of sites\) \(https://waterwatch.usgs.gov/new/index.php?r=ia&id=ww_current\)](https://waterwatch.usgs.gov/new/index.php?r=ia&id=ww_current)

- [NWS Flood Inundation Mapping Information](https://www.weather.gov/news/232609-experimental-flood-inundation-maps)
(<https://www.weather.gov/news/232609-experimental-flood-inundation-maps>)
- [Area Hydrographs \(/area/DMX\)](#)
- [Hourly River Stages](https://forecast.weather.gov/product.php?site=DMX&issuedby=DMX&product=RVA&version=1&glossary=1) (<https://forecast.weather.gov/product.php?site=DMX&issuedby=DMX&product=RVA&version=1&glossary=1>)
- [NWPS Resources & Frequently Asked Questions \(FAQs\)](https://www.weather.gov/media/dmx/Hydro/DMX_NWPS_WebPageResourcesFAQs.pdf)
(https://www.weather.gov/media/dmx/Hydro/DMX_NWPS_WebPageResourcesFAQs.pdf)
- [U.S. Geological Survey \(table of sites\)](https://waterdata.usgs.gov/ia/nwis/current/?type=flow&group_key=basin_cd)
(https://waterdata.usgs.gov/ia/nwis/current/?type=flow&group_key=basin_cd)
- [U.S. Army Corps of Engineers](#)
- [Iowa Flood Center \(stream sensors\)](#)
- [Snow Information](https://www.nohrsc.noaa.gov/) (<https://www.nohrsc.noaa.gov/>)

WFO Information

Weather Forecast Office

Des Moines

9607 NW Beaver Dr.

Des Moines, IA 50131

(515) 270-2614 (tel:(515) 270-2614)

[Ask Questions/Webmaster](mailto:w-dmx.webmaster@noaa.gov) (<mailto:w-dmx.webmaster@noaa.gov>, cr.dmx-hydro@noaa.gov?)

[Official Homepage](https://www.weather.gov/DMX) (<https://www.weather.gov/DMX>)



(<https://www.usa.gov>)



(<https://www.weather.gov/owp/operations>)

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Population 3,190,369

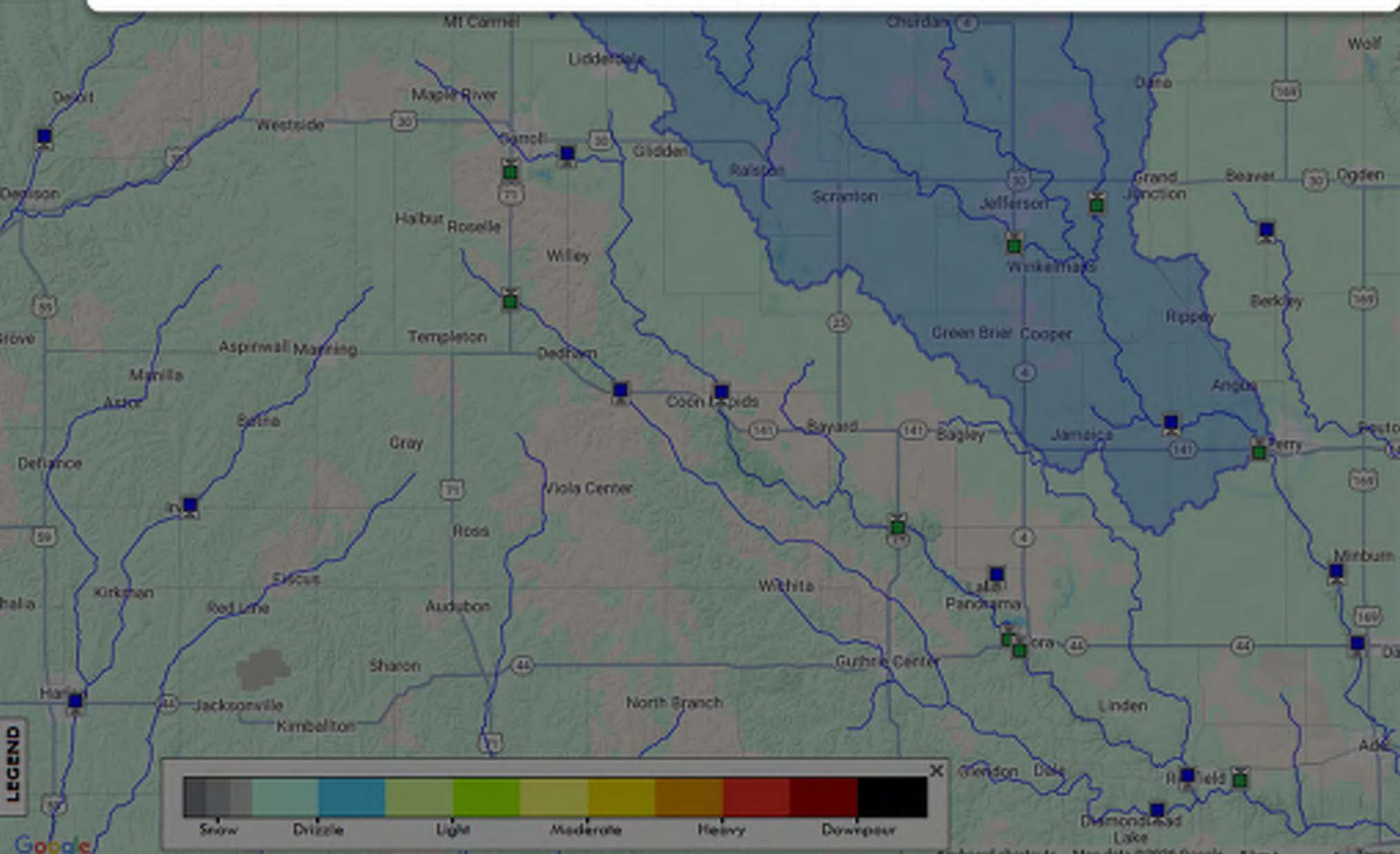
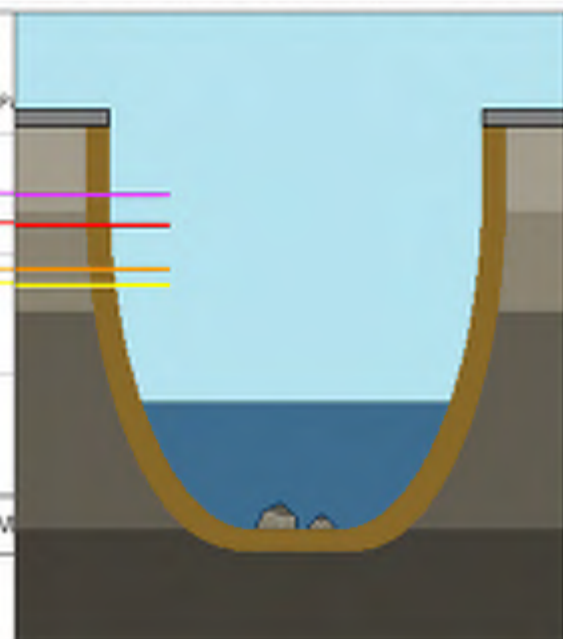
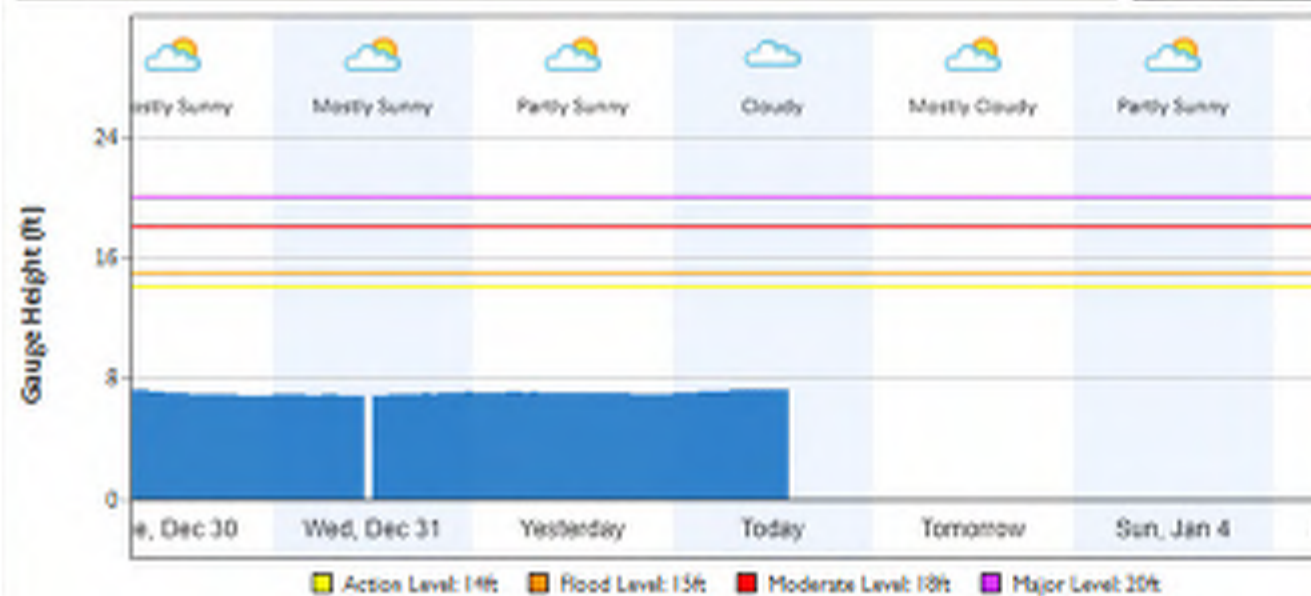
Land Area 55,872 sq mi

[Flood Alerts \(observations\)](#)

USGS USGS STREAM GAUGE

City: Perry
 River: North Raccoon River
 Station ID: [PRO14](#) (NWS)
 Forecast: NWS Forecast ([PRO14](#))
 Last Reported: Fri, January 2, 2026 1:15 pm
 Last Reading: 7 ft 4 in [Switch Data View: \[stage - elevation\]](#)

Satellite -



NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: IA

Data description
 Data type: Units: Time series type:

Select location
 1) Manually:
 a) By location (decimal degrees, use "N" for S and W): Latitude Longitude
 b) By station (list of IA stations):
 c) By address:

2) Use map:

a) Select location
 Move crosshair or double click
 b) Click on station icon
 Show stations on map

Location information:
 Name: Perry, Iowa, USA*
 Station name: PERRY
 Site ID: 13-6566
 Latitude: 41.8384°
 Longitude: -94.1100°
 Elevation: 965 ft

* Source: ESRI Maps
 * Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION NOAA Atlas 14, Volume 8, Version 2

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)¹

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.388 (0.310-0.500)	0.455 (0.393-0.588)	0.570 (0.453-0.735)	0.672 (0.532-0.856)	0.821 (0.637-1.08)	0.944 (0.715-1.25)	1.07 (0.790-1.43)	1.21 (0.881-1.62)	1.40 (0.995-1.90)	1.55 (1.04-2.11)
10-min	0.568 (0.453-0.732)	0.668 (0.531-0.859)	0.835 (0.664-1.08)	0.988 (0.779-1.27)	1.20 (0.932-1.58)	1.38 (1.06-1.83)	1.57 (1.16-2.10)	1.77 (1.28-2.38)	2.05 (1.41-2.79)	2.27 (1.63-3.08)
15-min	0.693 (0.553-0.882)	0.812 (0.647-1.02)	1.02 (0.810-1.31)	1.20 (0.950-1.55)	1.47 (1.14-1.94)	1.68 (1.28-2.23)	1.91 (1.41-2.55)	2.16 (1.54-2.91)	2.50 (1.72-3.40)	2.77 (1.95-3.77)
30-min	0.988 (0.787-1.27)	1.16 (0.926-1.56)	1.46 (1.19-1.88)	1.72 (1.38-2.23)	2.11 (1.64-2.79)	2.42 (1.84-3.21)	2.75 (2.03-3.68)	3.10 (2.21-4.18)	3.59 (2.48-5.00)	3.98 (2.68-5.42)
60-min	1.27 (1.02-1.64)	1.51 (1.20-1.94)	1.92 (1.53-2.48)	2.29 (1.81-2.98)	2.85 (2.21-3.73)	3.31 (2.51-4.30)	3.80 (2.80-5.00)	4.33 (3.09-5.84)	5.07 (3.55-7.02)	5.67 (3.91-7.72)
2-hr	1.56 (1.26-1.98)	1.85 (1.50-2.38)	2.38 (1.92-3.00)	2.98 (2.29-3.84)	3.58 (2.82-4.73)	4.19 (3.25-5.50)	4.84 (3.62-6.40)	5.55 (4.00-7.40)	6.55 (4.61-8.95)	7.38 (5.00-9.93)
3-hr	1.72 (1.40-2.17)	2.05 (1.67-2.58)	2.65 (2.15-3.34)	3.25 (2.58-4.04)	4.05 (3.22-5.20)	4.75 (3.70-6.22)	5.54 (4.17-7.30)	6.39 (4.64-8.50)	7.60 (5.24-10.2)	8.58 (5.87-11.5)
6-hr	2.02 (1.67-2.50)	2.39 (1.97-2.98)	3.07 (2.52-3.81)	3.71 (3.03-4.61)	4.79 (3.79-6.00)	5.55 (4.30-7.15)	6.47 (4.94-8.44)	7.49 (5.51-9.87)	8.96 (6.38-11.9)	10.2 (7.01-13.8)
12-hr	2.31 (1.93-2.81)	2.72 (2.27-3.32)	3.46 (2.88-4.23)	4.14 (3.42-5.07)	5.15 (4.19-6.52)	6.01 (4.77-7.82)	6.93 (5.33-8.90)	7.92 (5.88-10.3)	9.33 (6.68-12.3)	10.5 (7.30-13.8)
24-hr	2.69 (2.27-3.23)	3.08 (2.60-3.75)	3.79 (3.19-4.58)	4.48 (3.74-5.37)	5.48 (4.52-6.84)	6.35 (5.10-7.94)	7.29 (5.69-9.24)	8.33 (6.28-10.7)	9.81 (7.10-12.8)	11.0 (7.78-14.4)
2-day	3.07 (2.63-3.62)	3.50 (3.00-4.13)	4.27 (3.65-5.08)	4.98 (4.23-5.90)	6.05 (5.00-7.41)	6.94 (5.64-8.54)	7.90 (6.23-9.86)	8.94 (6.79-11.3)	10.4 (7.63-13.4)	11.6 (8.27-15.0)
3-day	3.33 (2.81-3.88)	3.81 (3.29-4.48)	4.66 (4.00-5.48)	5.42 (4.64-6.38)	6.55 (5.45-7.89)	7.49 (6.12-9.12)	8.48 (6.72-10.6)	9.56 (7.28-12.6)	11.1 (8.15-14.7)	12.3 (8.80-16.7)
4-day	3.56 (3.00-4.14)	4.08 (3.54-4.74)	4.98 (4.21-5.80)	5.75 (4.90-6.75)	6.98 (5.80-8.30)	7.96 (6.50-9.52)	8.99 (7.10-11.0)	10.1 (7.74-12.6)	11.6 (8.61-14.8)	12.9 (9.27-16.4)
7-day	4.22 (3.70-4.83)	4.80 (4.21-5.50)	5.81 (5.08-6.67)	6.76 (5.83-7.72)	8.01 (6.80-9.30)	9.08 (7.63-10.8)	10.2 (8.20-12.4)	11.4 (8.81-14.1)	13.1 (9.74-16.4)	14.4 (10.4-18.2)
10-day	4.63 (4.27-5.48)	5.46 (4.82-6.21)	6.56 (5.78-7.47)	7.52 (6.59-8.58)	8.92 (7.61-10.5)	10.1 (8.50-11.6)	11.2 (9.00-13.5)	12.5 (9.72-15.3)	14.2 (10.7-17.8)	15.6 (11.4-19.7)
20-day	6.00 (5.61-7.38)	7.41 (6.64-8.28)	8.77 (7.83-9.82)	9.90 (8.82-11.1)	11.8 (9.87-13.3)	12.9 (10.8-14.9)	14.2 (11.6-16.8)	15.6 (12.3-18.8)	17.4 (13.2-21.8)	18.9 (13.9-23.8)
30-day	8.00 (7.30-9.92)	9.96 (8.16-10.8)	10.7 (9.60-11.8)	12.8 (10.7-13.3)	13.9 (12.0-15.7)	15.3 (13.0-17.5)	16.7 (13.7-19.5)	18.1 (14.3-21.7)	20.0 (15.2-24.5)	21.5 (16.9-26.8)
45-day	9.95 (8.91-10.8)	11.2 (10.2-12.2)	13.1 (11.9-14.4)	14.7 (13.3-16.2)	16.8 (14.6-18.9)	18.4 (15.7-20.9)	19.9 (16.8-23.1)	21.5 (17.6-25.4)	23.4 (17.9-28.4)	24.9 (18.9-30.8)
60-day	11.5 (10.5-12.5)	13.0 (11.9-14.1)	15.2 (13.9-16.8)	17.0 (15.5-18.8)	19.4 (17.0-21.5)	21.1 (18.1-23.8)	22.8 (19.9-25.2)	24.6 (20.4-28.6)	26.4 (20.2-31.7)	27.8 (20.9-34.1)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parentheses are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format:

Note: Temporary disruptions may occur Wednesdays from 4-7 pm ET during routine maintenance.

iNWS - FAQ

General

Supported Web Browsers

Chrome
Firefox 3.6+
Internet Explorer 8+
Opera 15+
Safari 6+

Using iNWS on a mobile device

iNWS was designed to be used in a desktop web browser.
One of our top priorities is to create a mobile-friendly version of iNWS in the future.

Alerts

How do I receive text message (SMS) alerts on my phone?

You can enable text message alerts on the Account Settings page.

Which cell phone carriers does iNWS support?

We currently support the following carriers: AT&T/Cingular, Sprint/Nextel/Boost, T-Mobile, Verizon, Alltel, U.S. Cellular, Cellular One/Dobson, Virgin Mobile US, Cincinnati Bell, Midrivers, and Nemont/Sagebrush.

How long should it take to receive an iNWS alert once the NWS issues a product?

We send our alerts only a few moments after the NWS product is issued by the Weather Forecast Office. However, the time it takes for you to receive the alert depends on your cell phone carrier or email provider.

When creating an iNWS alert area, what types of NWS products fall into each product category?

Severe

- Severe Thunderstorm Watches, Warnings, and Statements
- Tornado Watches and Warnings

Winter Weather

- Avalanche Watches, Warnings, and Special Bulletins
- Snow Squall Warnings
- Blizzard Watches and Warnings
- Lake Effect Snow Watches, Warnings, and Advisories
- Wind Chill Watches, Warnings, and Advisories
- Winter Storm Watches and Warnings
- Winter Weather Advisories
- Freezing Rain Advisories
- Ice Storm Warnings

Hydrology

- Flood Statements and Warnings
- Flash Flood Watches, Statements, and Warnings

Marine Weather

- Open Lake Forecasts (GLF)
- Special Marine Warnings and Marine Weather Statements
- Small Craft Advisories
- Gale Watches and Warnings
- Storm Watches and Warnings
- Hurricane Force Wind Watches and Warnings
- Heavy Freezing Spray Watches and Warnings
- Hazardous Seas Watches and Warnings
- Ashfall Warnings
- Nearshore Marine Forecasts (NSH)
- Offshore Water Forecasts (OFF)

Coastal Hazards

- Coastal Flood Watches, Warnings, Advisories, and Statements
- Lakeshore Flood Watches, Warnings, and Advisories
- High Surf Advisories and Warnings
- Rip Current Statements
- Beach Hazard Statements
- Public Tsunami Messages (TSU)
- LSH Products
- TIB Products

Tropical

- Hurricane/Typhoon Local Statements (HLS)
- Tropical Cyclone Forecasts and Advisories (TCM)
- Tropical Cyclone Public Advisories (TCP)
- Hurricane Watches and Warnings
- Tropical Storm Watches and Warnings
- Typhoon Watches and Warnings

Aviation

- Airport Weather Warnings

Non-Precipitation

- Excessive Heat Watches and Warnings
- Freeze Watches and Warnings
- High Wind Watches and Warnings
- Extreme Cold Watches and Warnings
- Dust Storm Warnings
- Hard Freeze Warnings
- Air Stagnation Advisories
- Ashfall Advisories
- Blowing Dust Advisories
- Dense Fog Advisories
- Dense Smoke Advisories
- Freezing Fog Advisories
- Frost Advisories
- Heat Advisories
- Lake Wind Advisories

Civil Emergencies

- Child Abduction Emergencies
- Civil Danger Warnings
- Civil Emergency Messages
- Earthquake Warnings
- Evacuation Immediate
- Fire Warnings



Appendix B

Permitting Matrix for
stabilization methods

Permit / Approval	Agency	Applicability	Agency Review	Notes
Clean Water Act Section 404: Nationwide Permit No. 13 "Bank Stabilization" OR Regional Permit No. 40 "Bank Stabilization in Iowa"	USACE Rock Island Regulatory	TBD Dependent Upon Selected Alternative	30-90 days	404 authorization would be required of the riprap alternative, but is likely not required of the sheet pile alternative. Both the Nationwide and Regional permits authorize riprap bank stabilization, but the Regional Permit includes higher impact allowances than the Nationwide Permit: 2,000 linear feet vs 500 linear feet of impacted channel bank, and 2.0 CY vs 1.0 CY of riprap volume per running foot of bank below the OHWM. The Iowa DNR has provided Section 401 Water Quality Certification for both the Nationwide and Regional permits. Individual WQC is not required. If required, CWA Section 404 authorization is a federal nexus that necessitates USACE-demonstrated compliance with the National Historic Preservation Act and the Endangered Species Act, as noted in the following.
Endangered Species Act Section 7	USFWS	TBD Dependent Upon Selected Alternative and Federal Nexus	30-120 days	A USFWS Information for Planning and Consultation (IPaC) resource list was generated for the project area. The following ESA-listed species may occur in the project area: Indiana bat (endangered), Tricolored bat (proposed endangered), Topeka shiner (endangered), and Monarch butterfly (proposed threatened). Notably, the project reach of the Racoon River is designated critical habitat for Topeka shiner. As associated, the riprap alternative (only) would likely require some level of consultation with USFWS. Less notably, tree removal activities could impact listed bat species and may be subject to seasonal timing restrictions.
National Historic Preservation Act Section 106	Iowa SHPO	TBD Dependent Upon Selected Alternative and Federal Nexus	1-30 days	ISites public viewer shows no historic standing structures in proximity to the project and no archaeological resources in the section in which the project is located. No effects to historic properties are anticipated.
National Environmental Policy Act (NEPA)	TBD Dependent Upon Federal Funding			This entry is specific to possible federal funding sources, which would prompt NEPA compliance by the funding agency, and possible information provisions from MWA. This entry goes beyond the NEPA approval that is inherent to CWA Section 404 permit authorization, as listed above.
Floodplain Development	Iowa DNR	Yes	30-120 days	Zone A. Panel 19073C0500C Iowa DNR PERMT system indicates coordination is required.
NPDES General Permit No. 2: Construction Stormwater	Iowa DNR	Likely	1-10 days	Assumes greater than 1 acre of ground disturbance. Requires a public notice and Stormwater Pollution Prevention Plan development.

Sovereign Lands	Iowa DNR	No	N/A	Iowa DNR PERMT system indicates Sovereign Lands permitting is not required.
Floodplain Development	Greene County	TBD	TBD	Zone A. Panel 19073C0500C Greene County website does not specify whether or not the county requires floodplain permitting beyond that of Iowa DNR. Specific coordination is required.
Other Local Permits	Greene County	TBD	TBD	Greene County website does not specify whether or not the county requires any permitting for the proposed activities. Specific coordination is required.

Appendix C

Channel Meander Migration Analysis

Metro Waste Authority
Metro Park West Landfill

Perry, Iowa

October 2025

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Table of Contents

1	Purpose	1
2	Data Collection and Review	2
2.1	Topographic and Bathymetric Data	2
2.2	Aerial and Historic Imagery	2
2.3	Infrastructure Inventory	2
3	Site Visit	2
4	Channel Meander Migration Analysis	6
4.1	Meander Belt Width	6
4.2	Comparison of Aerial Imagery	7
4.3	Migration Rate	8
4.4	Bank Migration in Relation to Well MW-2BR	9
5	Conclusions	11

Figures

Figure 1:	Vicinity map showing study area	1
Figure 2:	Planview of site visit image locations	3
Figure 3:	Image of tape measurement from MW-2BR well to top of bank (looking towards river)	4
Figure 4:	View of tape measure from top of bank to edge of water	4
Figure 5:	View of MW-21 looking east	5
Figure 6:	Large woody debris in channel looking upstream	5
Figure 7:	Large woody debris directly upstream of well MW-21	5
Figure 8:	Looking upstream to the west at the concrete slabs on the left bank	6
Figure 9:	Meander belt (shown in yellow dots) overlayed on the relative elevation surface	7
Figure 10:	Digitized channel outlines 1930-2024	8
Figure 11:	Showing outline of river for 1990 and 2010 with best fit circles to match the outer bends. The arrows demonstrate the migration of the bends	9
Figure 12:	Planview of cross section	10
Figure 13:	Plot of cross section (looking downstream)	10

Attachments

Attachment A Historic Channel Outlines

References

1. United States Department of Transportation, Federal Highway Administration. (2023). *Highways in the river environment: Roads, rivers, and floodplains (Hydraulic Engineering*

- Circular [HEC] No. 16, 2nd ed.*) (Report No. FHWA-HIF-23-004).
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<https://www.fhwa.dot.gov/engineering/hydraulics/pubs/hif23004.pdf>
 3. Transportation Research Board. (2004). *Handbook for predicting stream meander migration (NCHRP Report 533)*. https://www.trb.org/publications/nchrp/nchrp_rpt_533.pdf
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 7. Iowa Geographic Map Server. (n.d.). <https://ortho.gis.iastate.edu/#MapLayersReview>

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1 Purpose

The purpose of this report is to present the results of the channel meander analysis for the riverbank that is actively retreating toward the closed Greene County municipal solid waste unit (MSW) at Metro Waste Authority's Metro Park West, located northwest of Perry, Iowa. The objective of this task is to estimate the rate of approximate meander migration to characterize the risk to the existing landfill infrastructure. This memo details the process used to evaluate the rate of meander migration using available aerial imagery, LiDAR, and data collected during the site visit.

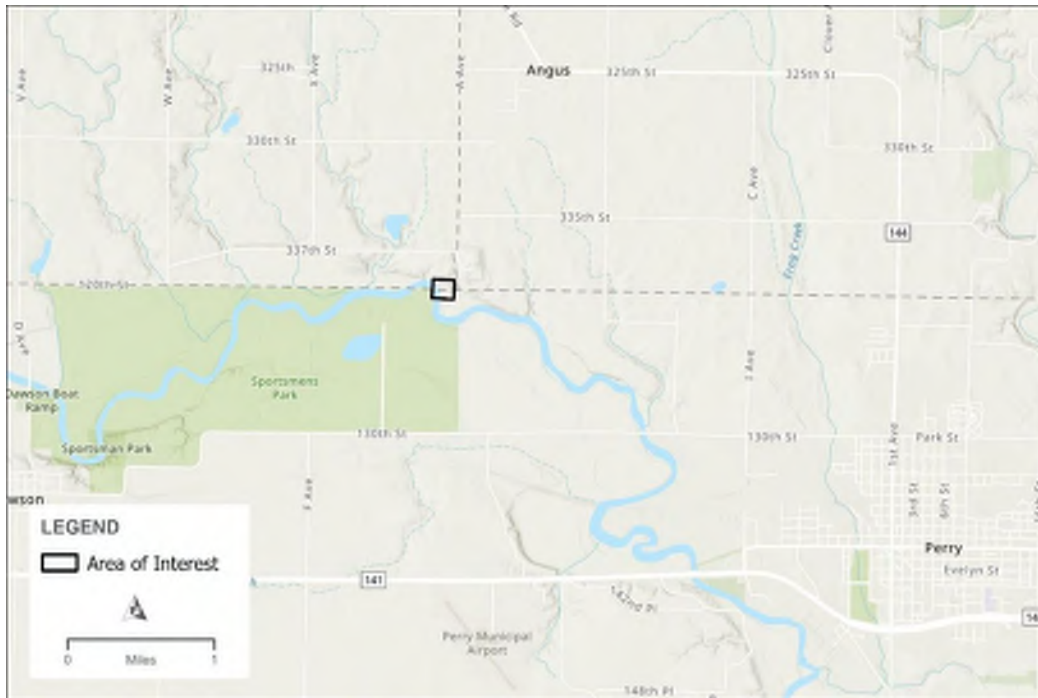


Figure 1: Vicinity map showing study area

The site lays on the intersection of three counties, Greene, Dallas, and Boone. United States Geological Survey (USGS) gages are located along this stretch of river, one on the upstream side near Jefferson and one on the downstream near Van Meter below the confluence of the South Raccoon and North Raccoon Rivers. The dominant land use for the region draining to the area of interest is row crops of soybean and corn. Channel migration was assessed using methods found in Federal Highway Administration's (FHWA) manuals, HEC-16 (**Reference 1**) and HEC-20 (**Reference 2**), and in the National Cooperative Highway Research Program (NCHRP) report 533 (**Reference 3**).

2 Data Collection and Review

2.1 Topographic and Bathymetric Data

Light detection and ranging (LiDAR) derived topographic data were downloaded from USGS (**Reference 4**) to gain an understanding of current and historic elevations. For the current observation, LiDAR flown in 2020 was used (**Reference 5**). The LiDAR has 1-meter raster cell sizes. For the historic observation LiDAR, flown between 1999 and 2013 was used (**Reference 6**). This dataset does not have an exact year for when it was flown above the study area but based on aerial imagery it was prior to 2010. This LiDAR has approximately 30-meter by 30-meter (98.4252-foot by 98.4252-foot) raster cell sizes. Both datasets have a horizontal datum of North American of Datum of 1983 (NAD 83) and a vertical datum of North American Vertical Datum of 1988 (NAVD 88). A bathymetric surface was not used in this analysis because it is not publicly available for this area.

2.2 Aerial and Historic Imagery

Historic aerial imagery was pulled down from the Iowa Geographic Map Server (**Reference 7**) for the years 1930, 1960, 1990, 2010, 2019, 2023, and 2024. The data pre-2000 does not contain the years the imagery was collected. It was assumed that the starting year of those decades be used for the calculations in the analysis.

2.3 Infrastructure Inventory

Existing topographic survey provided infrastructure inventory and locations for monitoring wells, landfill toe drain, pump for toe drain, and seepage pond.

3 Site Visit

On October 16, 2025, the HDR team visited Metro Waste Authority's west campus to conduct a site visit for the study bank. The team took collected measurements and pictures to characterize existing conditions of the site and bank location. Locations of photos are shown below in Figure 2.

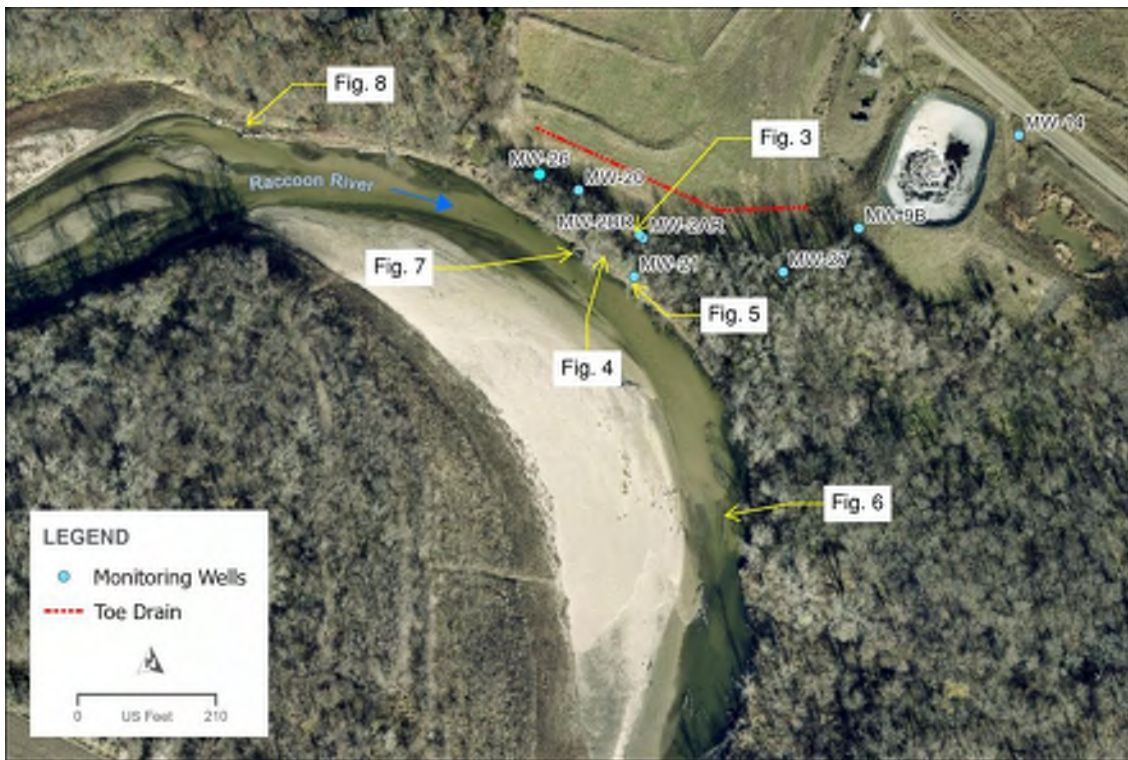


Figure 2: Planview of site visit image locations

To understand the current state of the site, the team measured the distance from well MW-2BR (center of well) to the edge of the left bank near well MW-21. This measurement alignment was chosen because it is where the bank is closest to the toe drain and is a known location where repeated measurements can be easily performed in the future. The measurement was 61.8 feet which is shown in Figure 3 and is used in one of the analyses for the migration of the bank for the 2025 data point.



Figure 3: Image of tape measurement from MW-2BR well to top of bank (looking towards river)

From where the edge of bank was measured above, the top of bank to the edge of water was measured to be approximately 14 feet. Depth of water on the day of site visit was visually estimated to be approximately 5 to 10 feet.



Figure 4: View of tape measure from top of bank to edge of water

Well MW-21 was 2 feet from the top of bank when measuring parallel to the river and was 4 feet from the top of bank when measuring perpendicular to the water. The bank is eroding from the west of the well at a greater extent than from the from the south. The bank on the south side of the well seems to be staying in place due to the roots from a large bush. Well MW-21 is at an immediate risk of being undermined by the channel.



Figure 5: View of MW-21 looking east

Large woody debris was observed in many places along the banks and in the channel which can be seen in Figure 6. Figure 7 shows an accumulation of large woody debris pile just upstream of MW-21. This illustrates that the channel is actively eroding the left bank causing large woody material to fall into the channel and against the banks. .



Figure 6: Large woody debris in channel looking upstream



Figure 7: Large woody debris directly upstream of well MW-21

In Figure 8, upstream of the site on private land, large slabs of concrete were seen along the left bank.



Figure 8: Looking upstream to the west at the concrete slabs on the left bank

4 Channel Meander Migration Analysis

4.1 Meander Belt Width

The NCHRP (**Reference 3**) manual defines “meander belt” as “the distance between lines drawn tangent to the extreme limits of successive, fully developed meanders”. The meander-belt width outlines the area where the river has previously been and can be used to extrapolate where the river may migrate to in the future (**Reference 1**). The elevations shown in LiDAR can be used to estimate the area the river meanders within by noting abrupt changes in ground surface elevation. These features are created by the river as the meanders propagate through the area. For this analysis a relative elevation model (REM) was created from LiDAR flown in 2020. The REM symbolizes the surrounding land based on its elevation relative to the channel centerline. Since a bathymetric surface was not available, the stream centerline elevation is based on water surface elevation from when the LiDAR was flown in 2020. In Figure 9, areas that are bright white show where the channel currently is and areas of more grey-white show where it has been in the past. The dotted yellow line in this figure was drawn where abrupt changes in elevation occur. This is the estimated meander belt.

The FHWA (**Reference 2**) manual states: “The meander belt formed is often fifteen to twenty times the channel width.” The meander belt in Figure 9 is approximately 4 times the channel width. Meander belt width extents on the right bank (south) have been potentially obscured by agricultural practices and the ratio of meander belt to channel width could be larger than estimated.

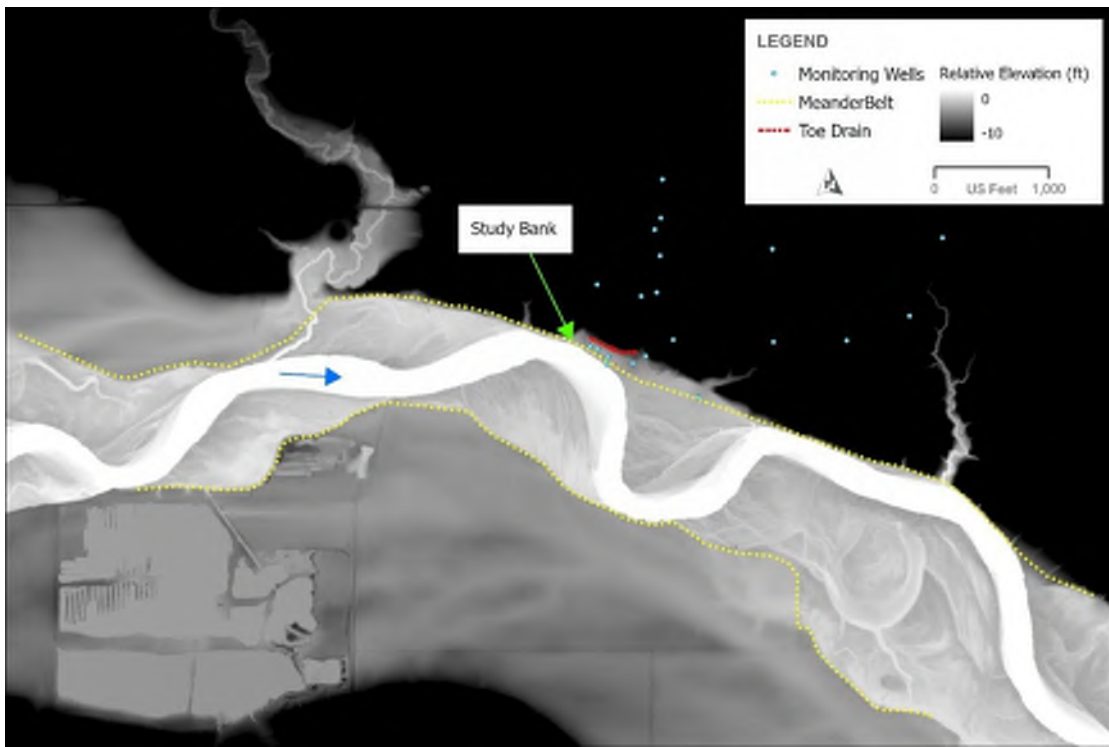


Figure 9 Meander belt (shown in yellow dots) overlaid on the relative elevation surface

4.2 Comparison of Aerial Imagery

For each year of aerial imagery, the channel outline was digitized starting from 5,000 feet upstream and ending 3,000 feet downstream of the study bank. Figure 10 shows the bank outlines overlaid on top of each other. Maps for each year can be found in Appendix A.



Figure 10: Digitized channel outlines 1930-2024

4.3 Migration Rate

The magnitude of meander migration was estimated by drawing circles to best fit the outer bank of the study meander. This method is outlined in the NCHRP manual and FHWA manuals. Two circles were drawn each year because the meander is not one simple arc but instead is comprised of two. The rate of migration was determined by measuring from the centroid of a circle from one year to the next. An example of this can be seen in Figure 11. Using all the analyzed years, the average migration change was 7.3 feet per year for the western bend and 8.2 feet per year for the eastern bend. The greatest per year change for the western bend was between 2010 and 2019 when the channel shifted approximately 9.4 feet per year. For the eastern bend, the greatest change was from 1960 to 1990 when the channel moved at a magnitude of 11.7 feet per year. Additionally, the time period of 1990 to 2010 was on the larger scale with 10.3 feet of change per year. These results can help to predict future bank retreat however they cannot account for localized scour and erosion.

	Western Bend		Eastern Bend	
Years ^a	Total Migration (feet)	Average Annual migration (feet per year)	Total Migration (feet)	Average Annual migration (feet per year)
1930 to 1960	236.2	7.9	224.8	7.5
1960 to 1990	245.7	8.2	350.8	11.7
1990 to 2010	99.8	5.0	94.6	4.7
2010 to 2019	84.3	9.4	93.0	10.3
2019 to 2023	20.9	5.2	6.9	1.7
2023 to 2024	3.5	3.5	2.9	2.9
Interval Average^b	N/A	6.5	N/A	6.5
Period of Record Average^c	N/A	7.3	N/A	8.2

^a Prior to 2010, the aerial imagery did not contain the exact year the photos were collected, for this analysis it was assumed that the data were collected at the beginning of the decade

^b Calculated using the interval specific rates of migration

^c Calculated using the total distance migrated over the total period of record

Table 1: Migration distances and rates from 1930-2024

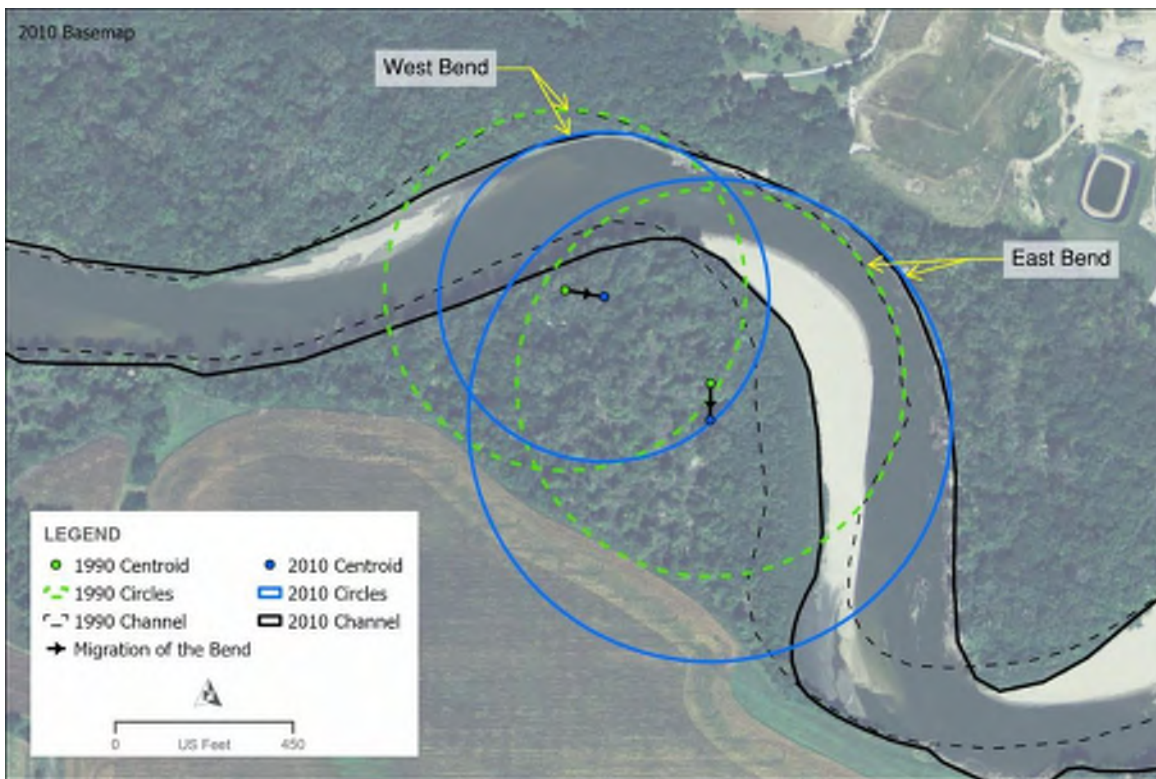


Figure 11: Showing outline of river for 1990 and 2010 with best fit circles to match the outer bends. The arrows demonstrate the migration of the bends

4.4 Bank Migration in Relation to Well MW-2BR

As the meander bend propagates downstream, the perpendicular distance between the left bank of the river to well MW-2BR decreases. During the site visit, the distance from MW-2BR to the top of the left bank was measured approximately perpendicular to the channel because it represents the shortest distance between the bank and the toe drain of the closed landfill and because the measurement can be repeatable for future analyses. Based on this measurement a cross section was developed (Figure 12) to understand the change in distance from the well to the top of bank over the years of record. This cross section was plotted, and each bank line was drawn based on relative station to the well. The 1930 aerial shows the creek was nearly 900 feet away, while the 2024 aerial shows the creek approximately 62-feet away. In the last forty years the bank has migrated approximately 140 feet closer to MW-2BR. These distances can be seen in Table 2. The greatest yearly bank retreat was seen from 1960 to 1990 when the rate of change was 21 feet per year. In the last six years the rate of bank retreat has been approximately a foot per year; however still in relatively recent years from 2010 to 2019 the bank moved roughly 7 feet per year. On average, over the period studied, the yearly bank retreat was 8.7 ft.

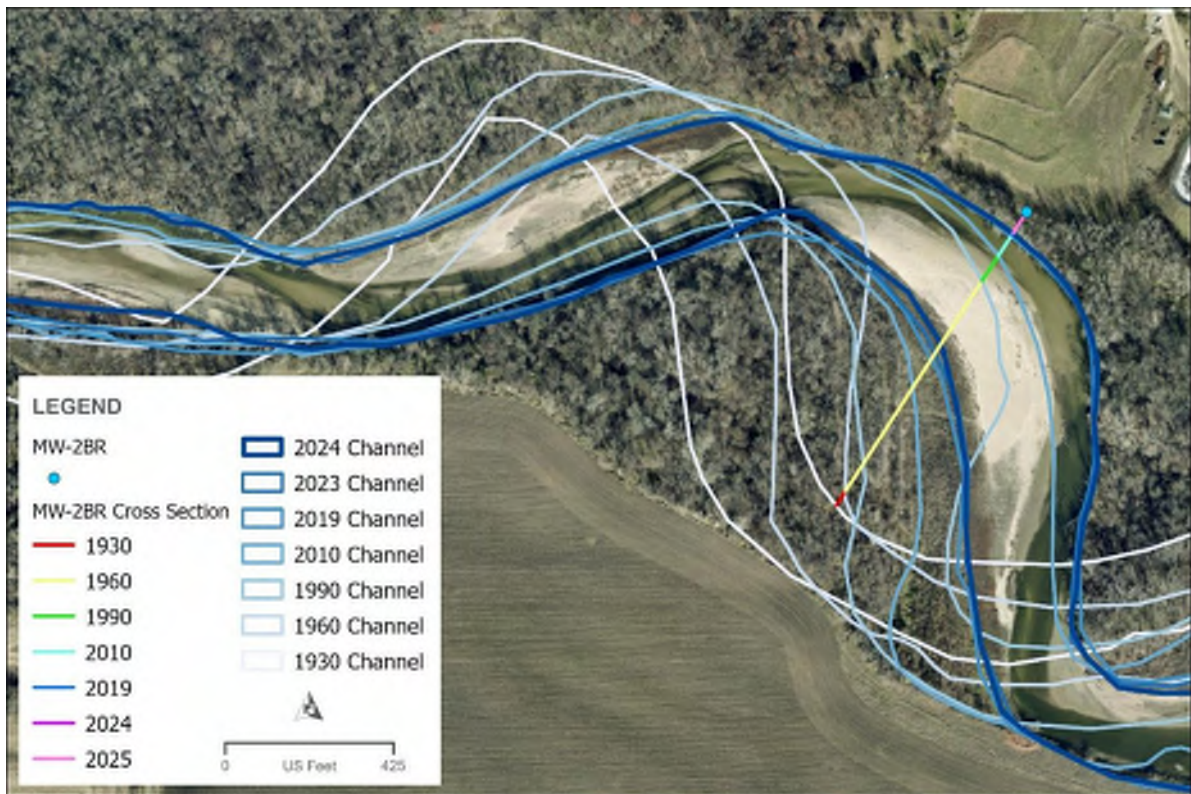


Figure 12: Planview of cross section

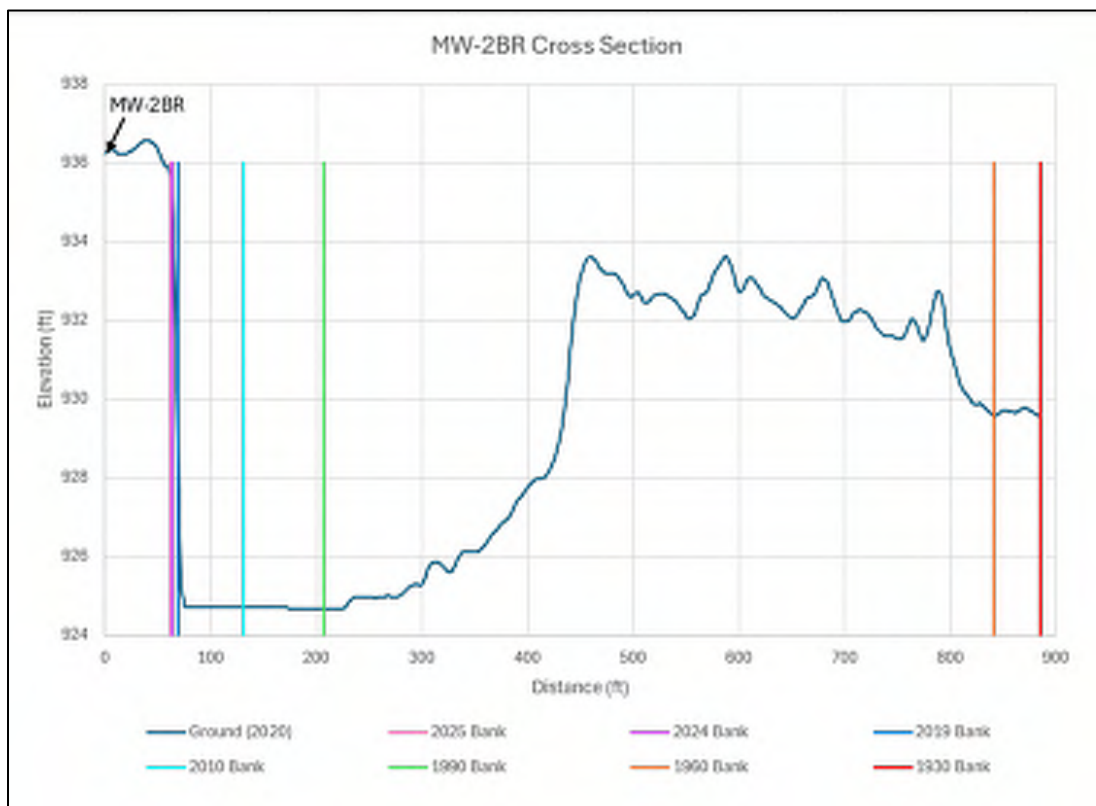


Figure 13: Plot of cross section (looking downstream)

Year	Distance to MW-2BR (ft)	Average Annual migration (feet per year)
1930	884.7	
1960	840.8	1.5
1990	207.0	21.1
2010	131.5	3.8
2019	68.9	7.0
2024	62.9	1.2
2025	61.8 ^a	1.1
Period of Record Average		8.7

^a Measurement taken in the field

Table 2: Measurements of distance from MW-2BR to the top of left bank

5 Conclusions

The channel migration analysis shows that over 90 years, the meander bend that is threatening to erode into well MW-21 has moved east and slightly north approximately 790 feet. The relative distance from MW-2BR to the top of the bank of has decreased from 884.4 feet (1930) to 61.8 feet (2025). The period of record average for the bank retreat heading toward MW-2BR was estimated 8.7 feet per year. From 1930 to 2024, the average meander migration rate of was 7.3 feet per year for the western bend and 8.2 feet per year for the eastern bend, with a maximum yearly rate of 9.4 feet per year for the western bend and 11.7 feet per year for the eastern bend. The landfill infrastructure is at risk as the Raccoon River continues to migrate and as the left bank continues to retreat. A monitoring plan is recommended to observe the bank location over time and to develop mitigation strategies.

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Attachment A

Historic Channels



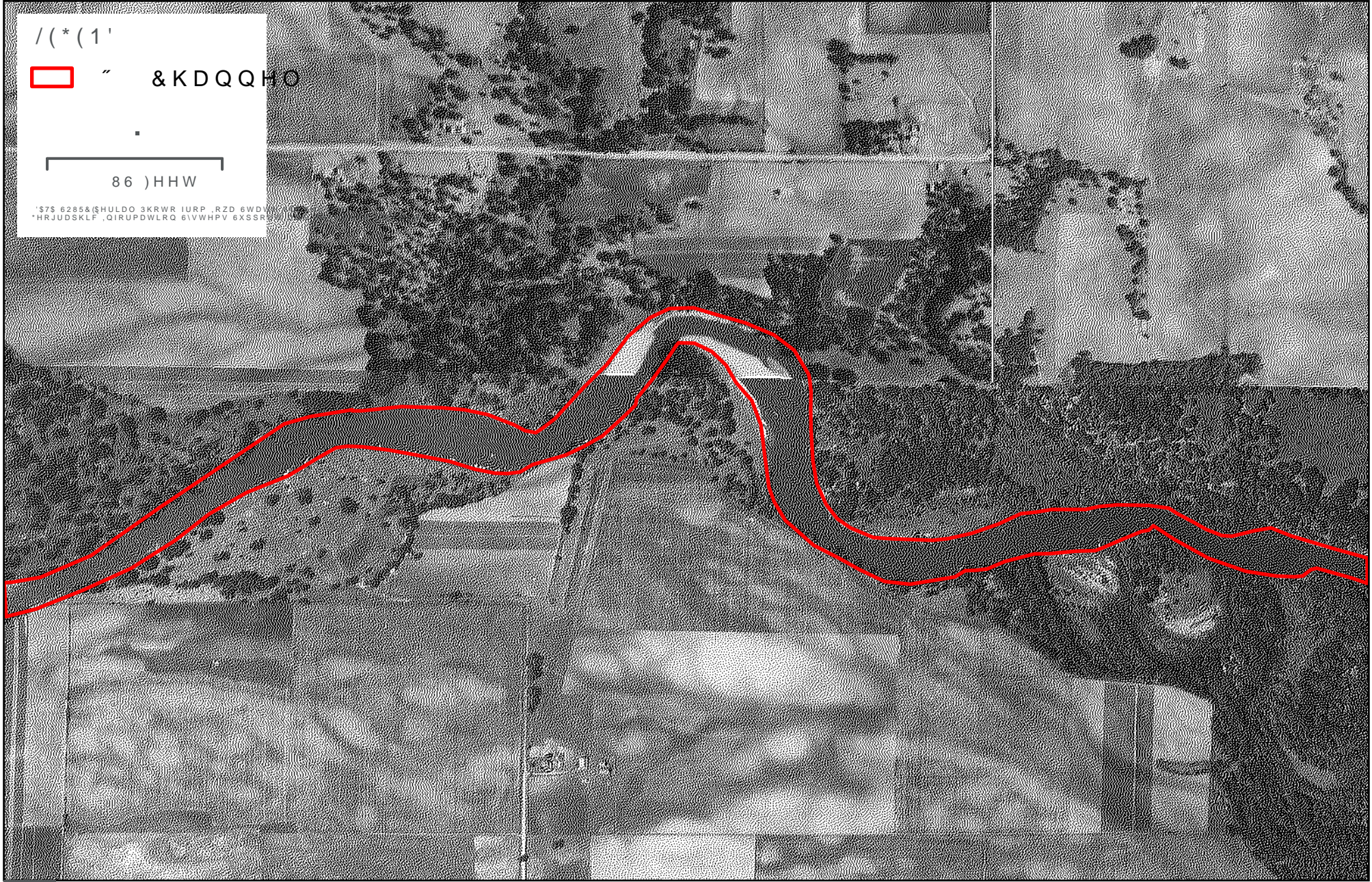
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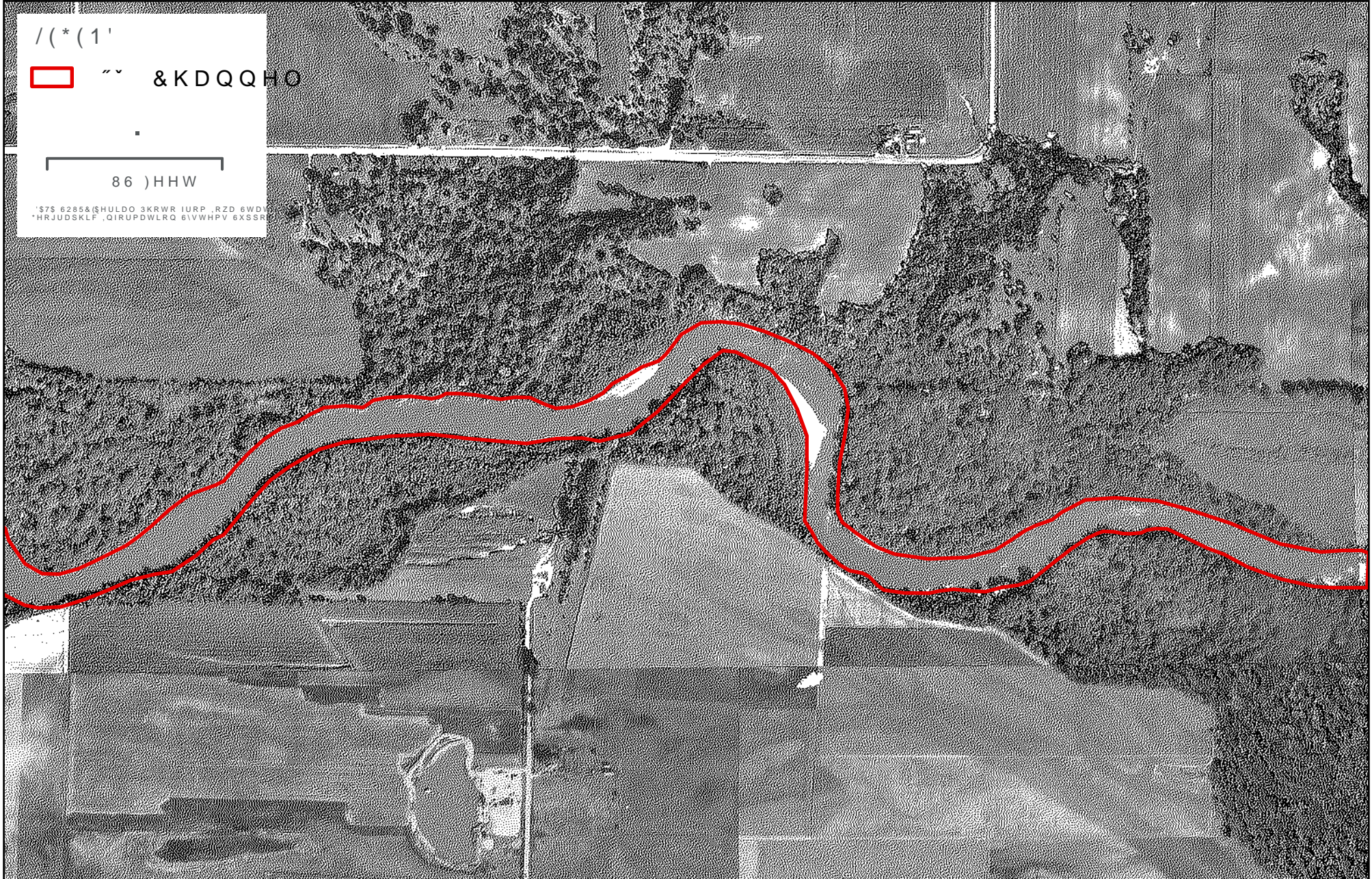
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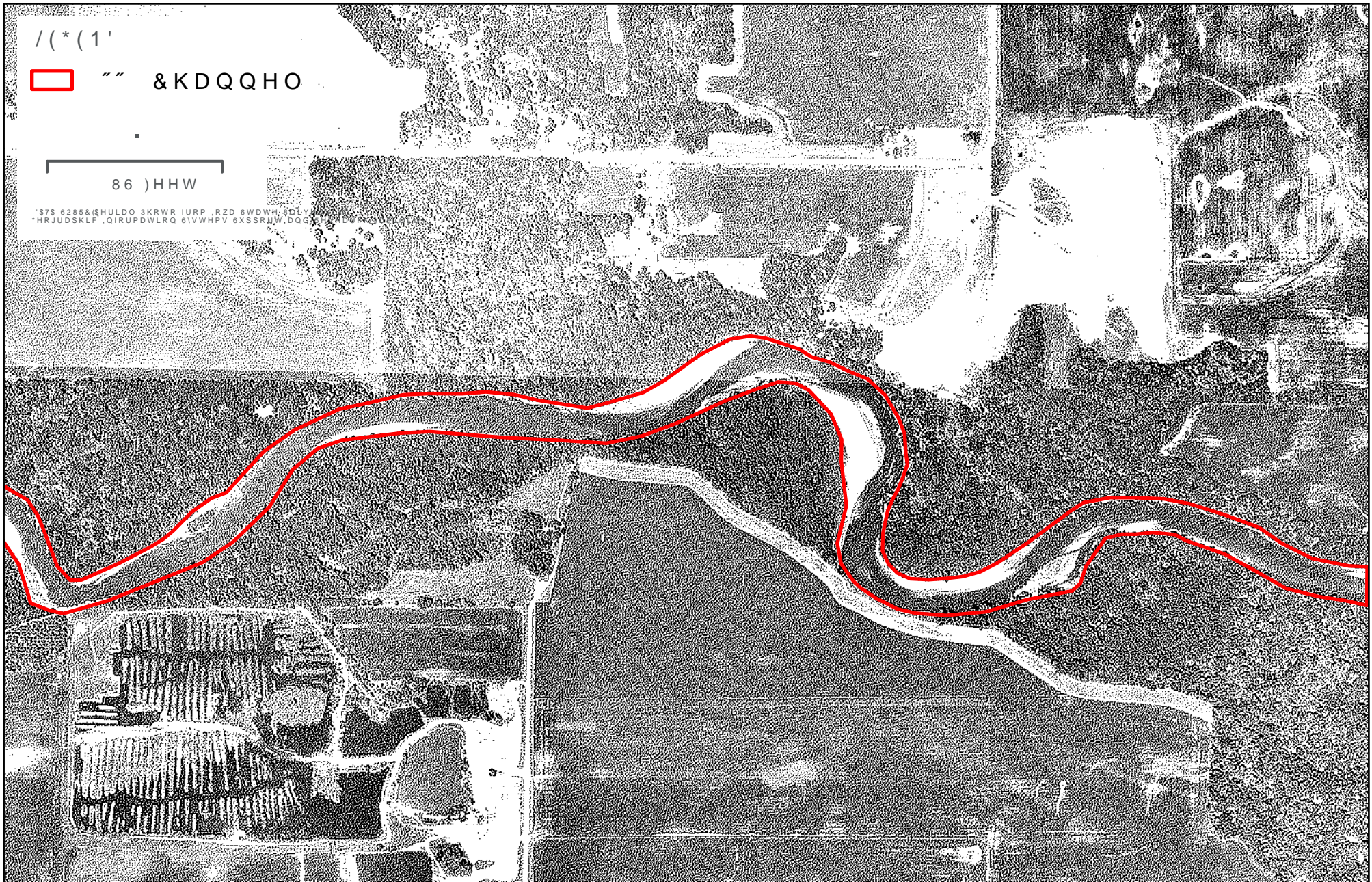
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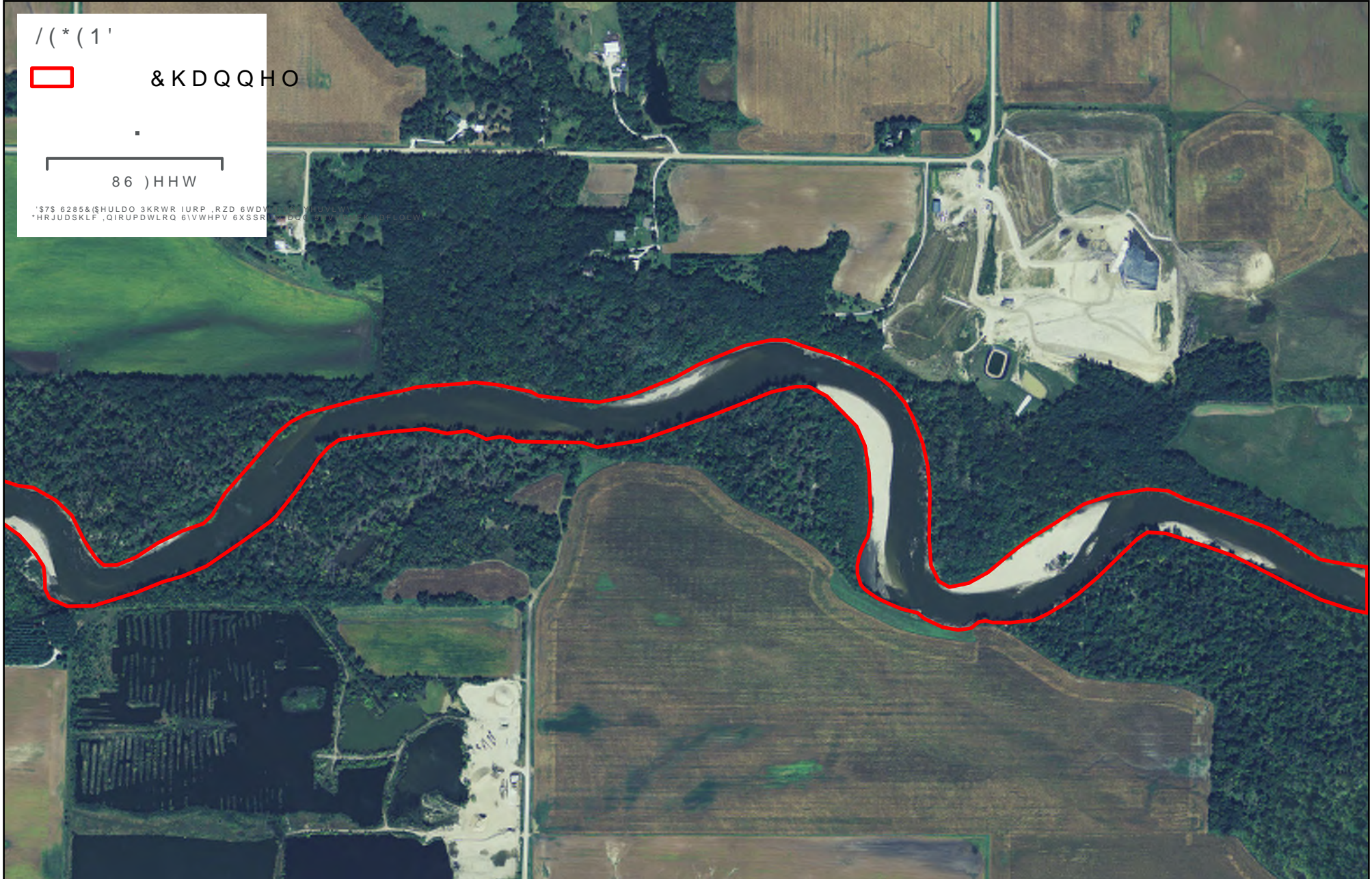
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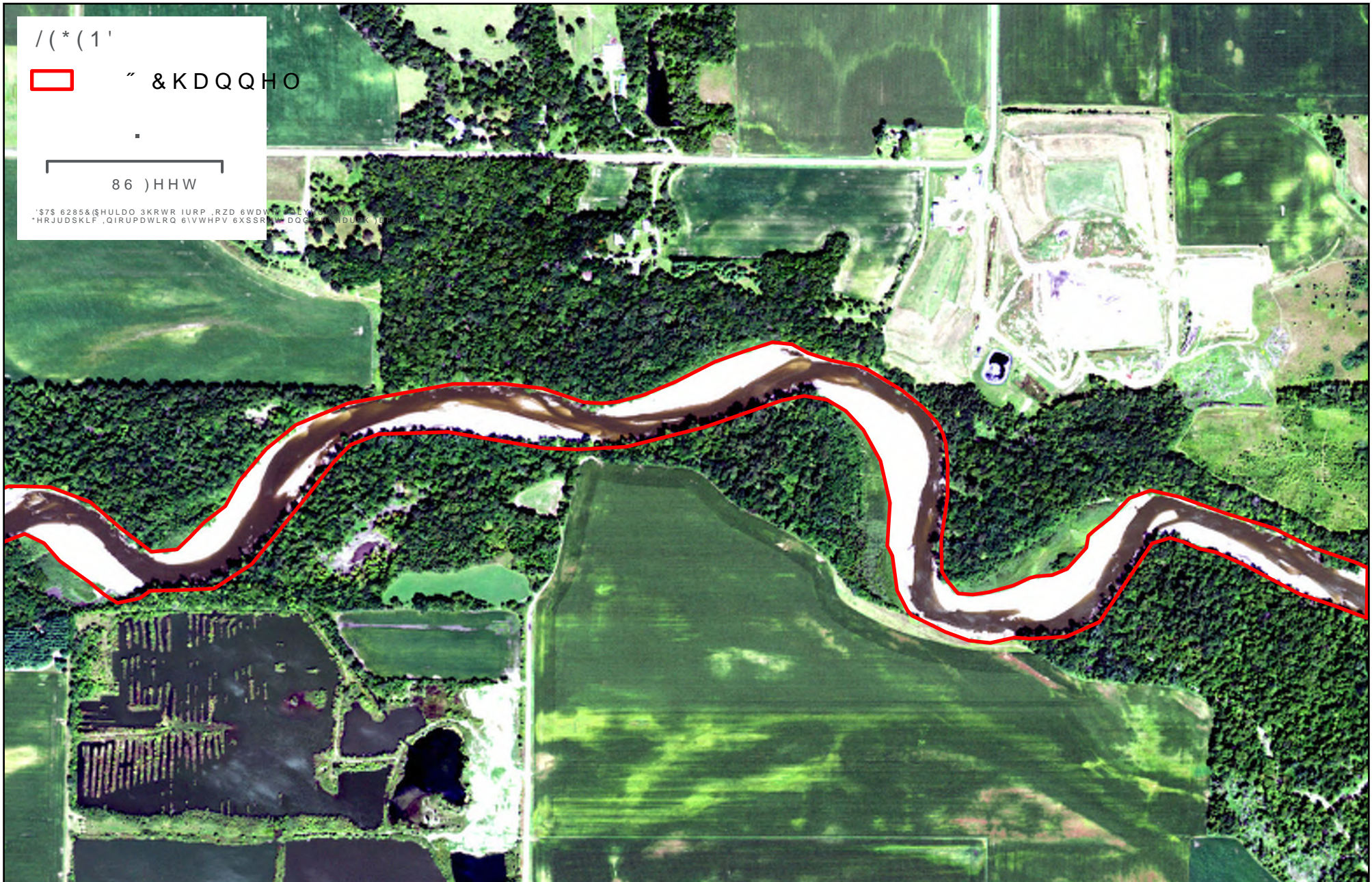
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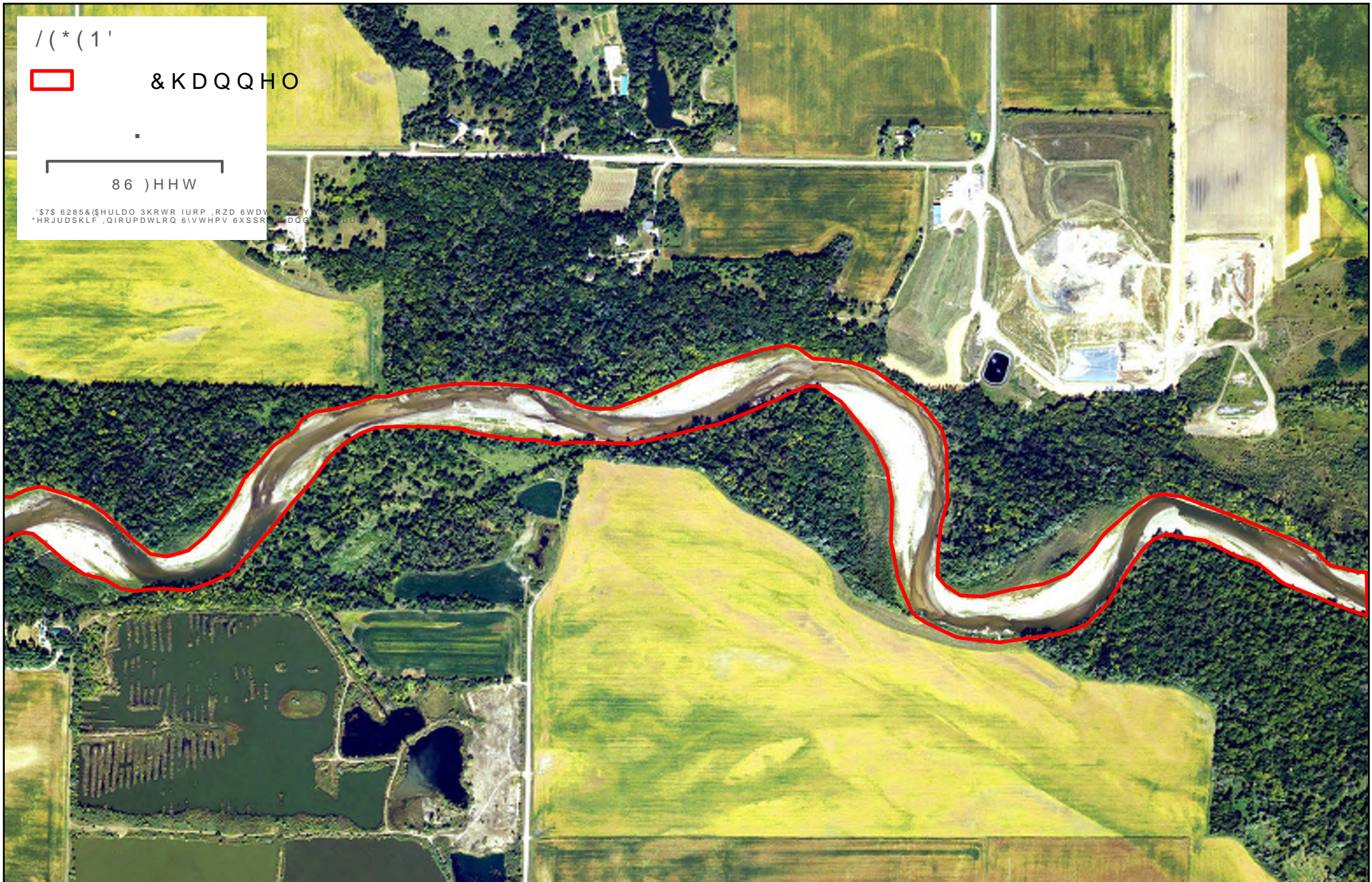
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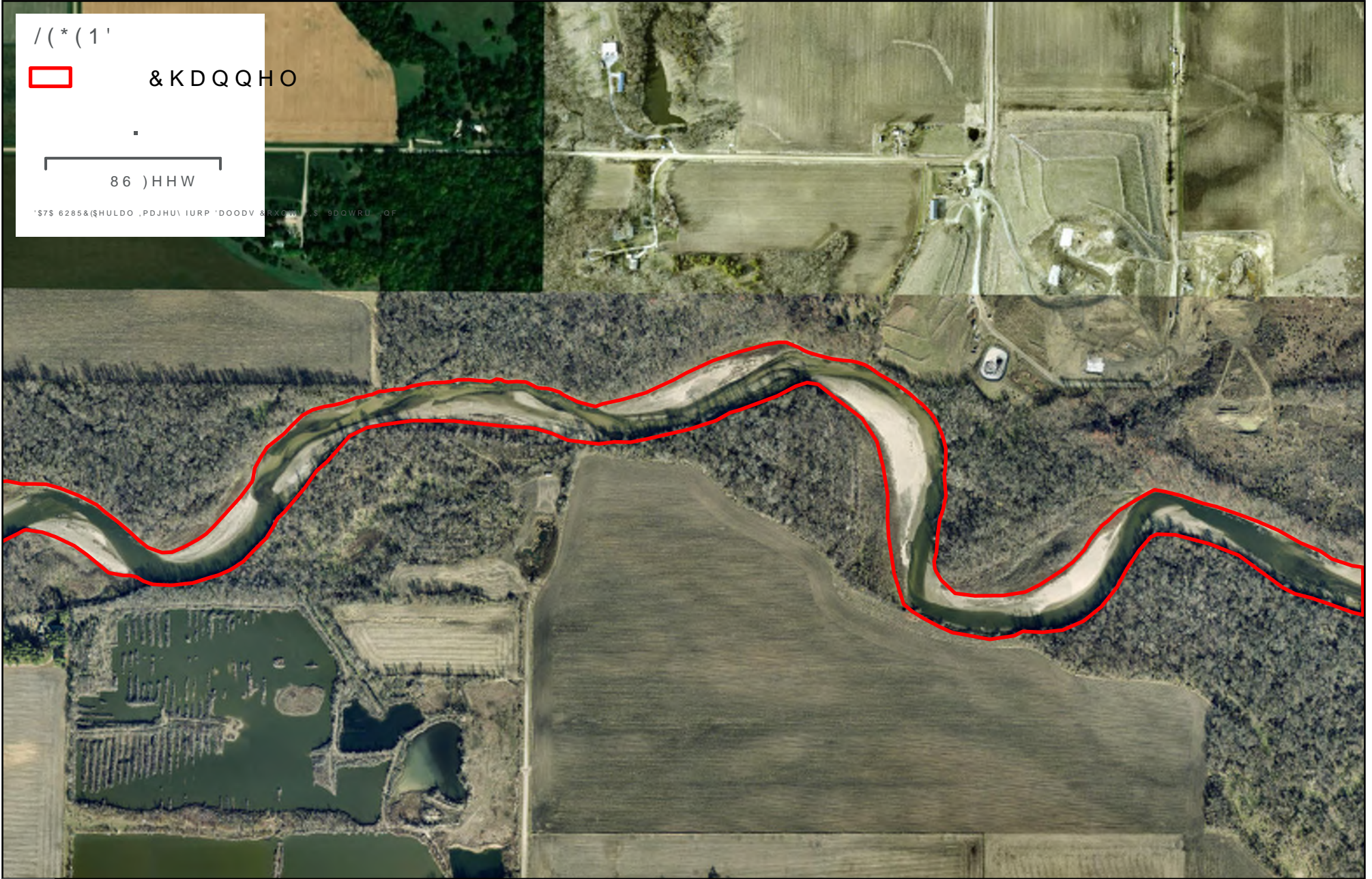


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Appendix D

Riverbank Slope Stability Analysis and Sheet Pile Design Evaluation

Metro Waste Authority
Metro Park West Landfill

Perry, Iowa

November 2025



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Table of Contents

1	Purpose	1
2	Approach	1
2.1	Model Development Showing Riverbank Failure Progression.....	2
2.2	Model Development for Riverbank Stabilization.....	3
3	Material Properties and Sections.....	4
4	Seismicity.....	4
5	Stability Analysis Results and Conclusions	5
5.1	Model Results: Riverbank Failure Progression	5
5.2	Model Results: Riverbank Protective Measures.....	5
6	Results.....	6
6.1	Riverbank Failure.....	6
6.2	Riverbank Protective Measures	7
7	Conclusions and Recommendations	8
7.1	Recommendations.....	8

Figures

Figure 1 – Riverbank Analysis

Figure 2 – Riverbank Cross Sections

Attachments

Attachment A Slope Stability Run Results

Attachment B Reference Information

Attachment C USGS Seismic-Hazard Analysis

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1 Purpose

The purpose of this report is to present the results of a slope stability evaluation completed for the closed Greene County municipal solid waste unit (MSW) at Metro Waste Authority's Metro Park West, located northwest of Perry, Iowa. The analyses were done for the southwest-facing landfill slope; the riverbank of the North Raccoon River (River) adjacent to the MSW; and the larger area combining both the riverbank and the landfill slopes.

The slope stability evaluations presented in this report are intended to assess the current conditions of the North Raccoon Riverbank, specifically its behavior in the event of riverbank landward shift and encroachment upon the previously installed toe drain. The objective is to identify suitable locations for implementing protective measures to prevent potential collapse of the toe drain and failure of the adjacent closed landfill waste slope located to the northeast (landward – toward the right on the model cross sections in **Attachment A**) of the toe drain.

2 Approach

To address potential slope instability along the southwest side of the existing closed MSW landfill, a sheet pile wall is considered near the toe drain to intercept lateral movement of the North Raccoon River. This measure would protect critical infrastructure, including the toe drain and adjacent landfill slope, from failure due to riverbank encroachment. As part of this evaluation, slope stability analyses using GeoStudio models will simulate scenarios where the riverbank advances toward the toe drain and waste slope. These simulations will help assess reductions in the factor of safety and evaluate a potential mitigation method consisting of a sheet pile wall to reduce the potential for slope instability. Two-dimensional limit equilibrium methods were used to evaluate slope stability for static conditions. Per the United States Geological Survey (**Reference 2**), the site was determined not to be in a seismic impact zone. See Section 4 of this report for additional discussion regarding seismic analysis. The base computer program, GeoStudio Slope/W (**Reference 1**), was used to run Morgenstern-Price analysis type circular arc and sliding block slip surfaces. Search techniques within Slope/W were used to find the critical slip surface producing the minimum factor of safety for each method. The location of the critical slip surface is a function of the site geometry (slope angle and height); material stratigraphy; physical properties of the soil and waste; external loads; weight of soil and/or waste; and groundwater conditions.

The factor of safety for the circular arc failure assumed slip surfaces passing through the riverbank, waste fill, and the underlying foundation soils. A sliding block stability was checked by projecting a failure surface through the anticipated failure plane.

Soil properties used to evaluate stability of existing conditions, as well as the impact of installing a sheet pile near the toe drain, were modeled utilizing long-term soil characteristics. These characteristics were chosen because the riverbank, waste, and underlying soils have been in place for extended periods of time and have become consolidated over time. The long-term parameters are more representative of the existing conditions than short term parameters.

2.1 Model Development Showing Riverbank Failure Progression

Each scenario of potential failure surface, riverbank, and waste slope through riverbank was analyzed under the following cases. For all the model runs, a high groundwater level at about 10 feet above historic observations recorded in nearby groundwater monitoring wells and low Raccoon River level, at an elevation of 920 ft above mean sea level [AMSL] are conservatively estimated.

- **Case 1 - Base Model**

Riverbank is assumed to remain in the same location as it was during the installation of the toe drain, approximately 140 ft southeast (SE) of the toe drain. This base model serves as a reference condition for evaluating slope stability and understanding how encroachment scenarios may impact the factor of safety.

- **Case 2 – Riverbank shifted 20 ft. NE**

Riverbank is assumed to have shifted 20 ft. northeast (NE), moving closer to the toe drain, located approximately 120 ft to the SE of the toe drain.

- **Case 3 - Riverbank shifted 40 ft. NE**

Riverbank is assumed to have shifted 40 ft. NE, moving closer to the toe drain, located approximately 100 ft to the SE of the riverbank toe.

- **Case 4 - Toe Drain Collapse – Riverbank Shifted 120 ft. NE**

Riverbank is assumed to have shifted 120 feet NE, resulting in a slip surface that initiates at the top of the toe drain and terminates at the riverbank toe. Because the toe drain was installed in close proximity to the riverbank, the groundwater did not have sufficient time to lower through dewatering. This configuration represents a critical encroachment condition used to evaluate slope stability.

- **Case 5 - Toe Drain Collapse – Clay Softened - Riverbank Shifted 120 ft. NE**

Similar to the condition described in Case 4, with an additional assumption that the underlying silty clay soil layer of the riverbank is saturated due to the advancing riverbank resulting in a fully softened condition. Saturation leads to a loss of cohesive strength in the clay, reducing its cohesion. The loss of cohesion will result in the clay behaving more like a granular material with a friction angle of approximately 28°. This softened soil condition significantly impacts the slope's stability by diminishing the soil's ability to resist shear forces. The fully softened case is thought to be the critical case and highlights the vulnerability of the slope to failure during extreme hydraulic changes.

- **Case 6 - Toe Drain Collapse – Clay Softened - Riverbank Shifted 120 ft. NE – New Riverbank Surface**

This scenario builds directly upon the conditions modeled in Case 5. The slip plane of the riverbank which corresponds to a factor of safety of close to 1 in Case 5, is now assumed to represent the new geometry of the riverbank following slope failure. This updated surface reflects the progressive nature of riverbank failure, where the weakened soil mass collapses and the bank advances inland toward the adjacent waste slope.

By incorporating the failed geometry into the model, Case 6 simulates the post-failure condition and evaluates the implications of continued encroachment. It highlights how slope instability can evolve over time, especially when cohesive strength is lost in saturated clay layers and underscores the importance of proactive stabilization measures to prevent further advancement toward waste mass.

The trial slip surfaces are defined using both a. Entry and Exit (Circular Wedge) and b. Block Specified method (Sliding Block) in all cases. All slip surfaces originate from the top of the bank and exit at the bottom, under the river. The Morgenstern-Price limit equilibrium method is used to determine the factor of safety of the trial slip surfaces. A piezometric line establishes the pore water pressure conditions throughout the domain.

2.2 Model Development for Riverbank Stabilization

As a riverbank protection measure, a single layer of sheet pile was modeled approximately 50 ft northwest of the installed toe drain. Based on the model run for progressive riverbank failure, it is assumed that the riverbank has advanced 70 ft towards the toe drain from its existing location (Base Model – Case 1). In the GeoStudio 2D model, the sheet piles are represented as a single layer of pile reinforcement with a shear reduction factor of 1.5 and an out-of-plane spacing of 1 ft. The model assumes that the resisting shear force acts parallel to the slip surface, as specified in the pile reinforcement settings.

The resisting shear force provided by the sheet pile is determined through a trial-and-error approach, evaluating two types of trial slip surfaces:

- a. Entry and Exit (Circular Wedge)
- b. Block Specified (Sliding Block)

For each case, the factor of safety is checked to ensure it is greater than 1.5, confirming the effectiveness of the sheet pile in stabilizing the failure surface.

3 Material Properties and Sections

Soil material characteristics of each soil were determined based on a combination of historic boring logs from the 2019 phytoremediation project, 2022 Assessment of Corrective Management (ACM) boring logs and lab soil tests, historic groundwater well boring logs, and review of known correlations between index properties and estimated strength properties. The material characteristics are listed in the following table.

Material Characteristics – Long Term

Material/Description	Moist Unit Weight (PCF)	Cohesion (PSF)	Friction Angle (DEG)
Silty Clay	110	250	21
Silty Clay (Softened)	110	0	28
Silty Sand	115	0	31
Toe Drain Aggregate	125	0	33
Waste	70	300	33

Notes (Basis):

1. Drained cohesion (long term) for the clay materials was estimated to be 250 PSF. Typical values range from 0 to 500 PSF assumed for over-consolidated clays.
2. Effective cohesion (long term) for the sands was assumed to be zero.
3. Friction angle for the sands and silt was estimated using the average dry unit weight and using Figure 7, Correlations of Strength Characteristics for Granular Soils from NAVFAC Soil Mechanics Design Manual 7.1.
4. Effective friction angle (long term) for the clays was estimated based on the plasticity index values.
5. In both Case 5 and Case 6, regions adjacent to the riverbank surface are assumed to lose cohesive strength due to saturation caused by progressive riverbank advancement toward the toe drain. This saturation effect is modeled by modifying the soil properties of the silty clay layer in affected zones, designating them as silty clay (softened).

4 Seismicity

The site location was not within a seismic impact zone, which is defined in EPA guidance documents. According to seismic-hazard maps, such zones are characterized by a peak bedrock horizontal acceleration exceeding 0.1g, with a 2% probability of exceedance in 50 years (or 10% in 250 years). As shown in Attachment C, the specific location of Metro Park West exhibits a peak bedrock acceleration of only 0.0281g, which is well below the threshold. Therefore, seismic loading was not considered in any of the slope stability model runs.

5 Stability Analysis Results and Conclusions

5.1 Model Results: Riverbank Failure Progression

The table below summarizes results from the stability analyses for the different scenarios of riverbank slope failure:

Run	GW Height	River Height	Slip Surface	Factor of Safety	Slip Surface Location
<i>Base Model – Case 1</i>					
1	High	Low	Circular (Critical)	0.996	Riverbank
7	High	Low	Sliding Block (Critical)	0.634	Riverbank
<i>Riverbank shifted 20 ft – Case 2</i>					
2	High	Low	Circular (Critical)	1.022	Riverbank
8	High	Low	Sliding Block (Critical)	0.650	Riverbank
<i>Riverbank shifted 40 ft – Case 3</i>					
3	High	Low	Circular (Critical)	1.059	Riverbank
9	High	Low	Sliding Block (Critical)	0.663	Riverbank
<i>Toe Drain Collapse - Riverbank shifted 120 ft – Case 4</i>					
4	High	Low	Circular (Critical)	0.903	Toe Drain and Riverbank
10	High	Low	Sliding Block (Critical)	0.609	Toe Drain and Riverbank
<i>Toe Drain Collapse – Clay Softened - Riverbank Shifted 120 ft. NE – Case 5</i>					
5A	High	Low	Circular (Critical)	0.587	Toe Drain, and Riverbank
5B ¹	High	Low	Circular (Not critical)	0.997	Toe Drain, and Riverbank
5C	High	Low	Circular (Not Critical)	1.500	Waste toe, Toe Drain, and Riverbank
5C	High	Low	Circular (Not Critical)	1.532	Waste toe, Toe Drain, and Riverbank
11A	High	Low	Sliding Block (Critical)	0.229	Riverbank
11B ¹	High	Low	Sliding Block (Not critical)	0.999	Waste toe, Toe Drain, and Riverbank
11C	High	Low	Sliding Block (Not Critical)	1.498	Overall slope
<i>Toe Drain Collapse – Clay Softened - Riverbank Shifted 120 ft. NE – New Riverbank Surface – Case 6</i>					
6A	High	Low	Circular (Not Critical)	0.992	Waste toe, Toe Drain, and Riverbank
6B	High	Low	Circular (Not Critical)	1.492	Overall slope
12A	High	Low	Sliding Block (Not Critical)	0.991	Waste toe, Toe Drain, and Riverbank
12B	High	Low	Sliding Block (Not Critical)	1.496	Overall slope

¹ The slip plane of the riverbank which corresponds to a factor of safety of close to 1 in model run 5B and 11B, is assumed to represent the new geometry of the riverbank following slope failure for Case 6 models.

5.2 Model Results: Riverbank Protective Measures

The table below summarizes the results of the stability analyses used to determine the required resisting shear force for sheet pile design. This was achieved through a trial-and-error approach, ensuring the factor of safety is higher than 1.5 for each evaluated slip surface, and includes evaluation with rip rap installation.

Run	GW Height	River Height	Slip Surface	Factor of Safety	Decision
<i>Resisting shear force per unit length along the riverbank = 15,000 lbf</i>					
13A	High	Low	Circular (Critical)	1.629	Qualifies
13B	High	Low	Sliding Block (Critical)	0.803	Fails
<i>Resisting shear force per unit length along the riverbank = 30,000 lbf</i>					
14A	High	Low	Circular (Critical)	1.629	Qualifies
14B	High	Low	Sliding Block (Critical)	4.665	Qualifies
<i>Resisting shear force with rip rap installation</i>					
15A	High	Low	Circular (Critical)	0.973	Fails
15B	High	Low	Sliding Block (Critical)	0.668	Fails

6 Results

EPA Guidance (Solid Waste Disposal Facility Criteria, EPA530-R-93-017) provides recommended minimum values of Factor of Safety (FS) for slope stability based on consequences and uncertainty of strength measurements. For these analyses, FS of 1.5 was used because seismic loading was not considered in any of the slope stability model runs.

6.1 Riverbank Failure

The localized slope stability for the riverbank should be addressed immediately with corrective actions that will reinforce the slope and further prevent additional sloughing and slope failure, which could lead to uncertainty of the slope that is acting as a buttress to the south side of the closed MSWLF Unit.

Initial model runs for both circular wedge and sliding block failure modes revealed a factor of safety (FS) close to or less than 1, indicating that the driving forces acting on the riverbank slope exceed the resisting forces. This imbalance suggests an imminent failure condition, with the slip surface likely to migrate toward the toe drain.

In Case 5, the assumption that the silty clay layer becomes saturated and loses cohesive strength results in a significant reduction in FS. This condition demonstrates how saturation and softening of soil can critically compromise slope integrity, leading to toe drain failure. A comparison between Case 4 and Case 5 highlights the impact of soil softening on slope stability under encroachment conditions.

Case 6 builds upon this progression by adopting the failure surface from Case 5 (FS \approx 1) as the new riverbank geometry, simulating post-failure conditions. Analysis of failure surfaces with FS < 1 and FS < 1.5 in both Case 5 and Case 6 for circular wedge and sliding block modes indicates a clear trend: that riverbank failure may continue to advance toward the closed landfill waste slope unless effective stabilization measures are implemented.

The calculated factors of safety for the analyses indicate the riverbank slope is unstable. This is also evident and consistent with current conditions. Several of the monitoring wells show subsidence (settlement) between the concrete pad and the existing surrounding grades.

6.2 Riverbank Protective Measures

Using sheet piles as a riverbank protection measure demonstrated an increase in the factor of safety, effectively stabilizing the slope and preventing further failure. Based on the analysis results, a single-layer sheet pile with a shear strength of 15,000 lbf per unit length along the riverbank provides sufficient resistance against circular wedge failure but is inadequate for sliding block failure. To meet the factor of safety criteria for both failure mechanisms, a design incorporating sheet piles with a shear strength of 30,000 lbf per unit length is required, ensuring comprehensive slope stability.

Rip rap was also evaluated for its effectiveness in providing scour protection and overall stability. The analysis was based on a modeled section with an 18-inch thickness and a solid rock density unit weight of 165 pounds per cubic foot (PCF). For modeling, the bulk unit weight was reduced to 135 PCF to account for voids between stones and porosity. Standard rip rap specified by the Iowa Department of Transportation (IDOT) is Class E, characterized by a top size of 250 pounds, with 50% of the material exceeding 90 pounds and 90% exceeding 5 pounds. While the factor of safety showed improvement with this configuration, it was not enough to reach the minimum 1.5. It might provide some protection against scouring, but it would likely not prevent slope failure. Also, it is important to note that placing materials within the waterway would require regulatory approvals, including coordination with the U.S. Army Corps of Engineers (USACE). This process could be time-consuming and may present challenges that outweigh the potential benefits of implementation. Rip rap should be considered in combination with other mitigation concepts.

The outputs from the computer results of stability analyses are attached to this report in **Attachment B**.

7 Conclusions and Recommendations

The stability analyses indicate a clear potential for slope instability along the riverbank in the absence of adequate protective measures. Without intervention, there is a risk of further encroachment toward critical infrastructure, including the toe drain and the adjacent closed landfill waste slope.

The implementation of sheet piles as a riverbank protection measure may be an effective mitigation approach. Specifically, a single-layer sheet pile with a shear strength of 30,000 lbf per unit length appears to satisfy the factor of safety criteria for both circular wedge and sliding block failure mechanisms. This design provides sufficient resistance to reduce the likelihood of further slope movement and protect surrounding infrastructure. This preliminary evaluation does not constitute a final design; additional analyses and design development will be required.

7.1 Recommendations

It is recommended to continue development of the Emergency Action Plan (EAP) for this area and increase monitoring along the riverbank. This may involve a combination of geotechnical, hydrological, and visual observation techniques. Some strategies to be considered include:

1. Surveying and Topographic Monitoring
2. Inclinerometers and Extensometers
3. Settlement Monitoring
4. Piezometers and Groundwater Monitoring
5. Visual Inspections and Photographic Documentation
6. River Stage and Flow Monitoring
 - a. River gauges to track water level fluctuations that may influence bank saturation and erosion.
 - b. Hydrological modeling to predict encroachment scenarios based on flow rates and sediment transport.

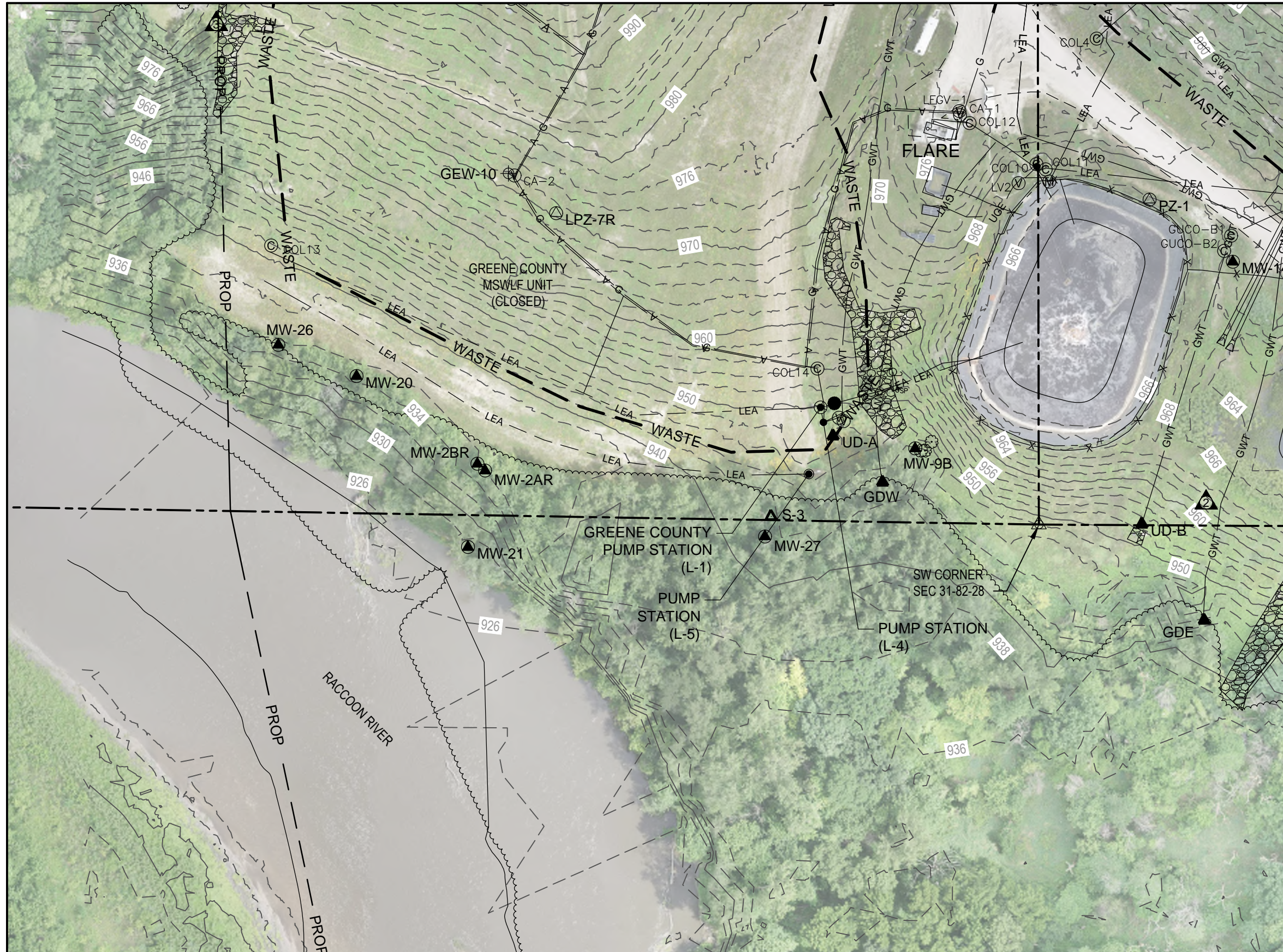
In addition to increasing monitoring, immediately proceeding with the design of mitigation measures along the riverbank is recommended. Start with a comprehensive evaluation of all feasible mitigation strategies, including sheet pile installation, hydraulic improvements, and slope stabilization, such as rip rap, to address the observed instability and prevent further encroachment toward critical infrastructure.



Figures

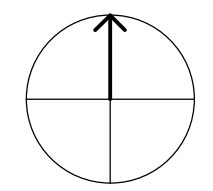


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NOTES

1. EXISTING TOPO PREPARED BY HDR INC. DATED JULY 2, 2025.

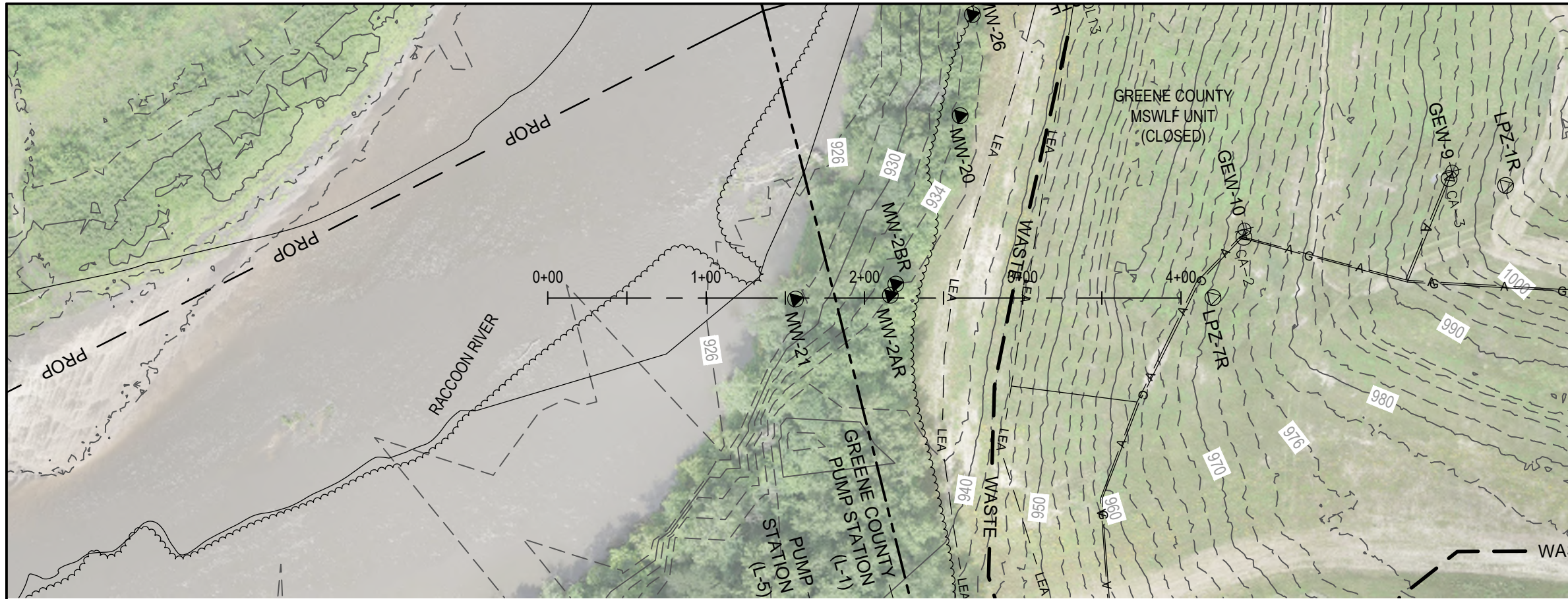


RIVER BANK ANALYSIS

METRO PARK WEST

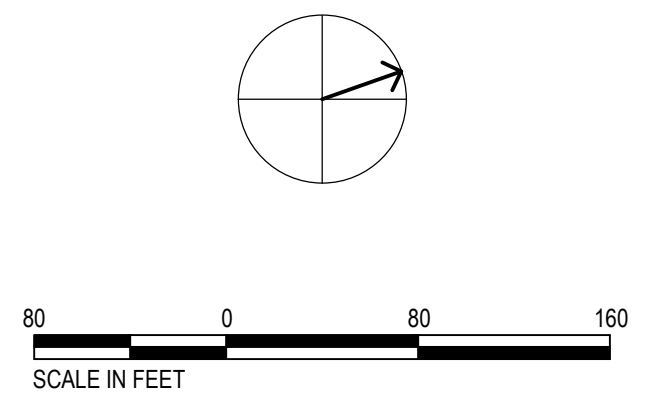
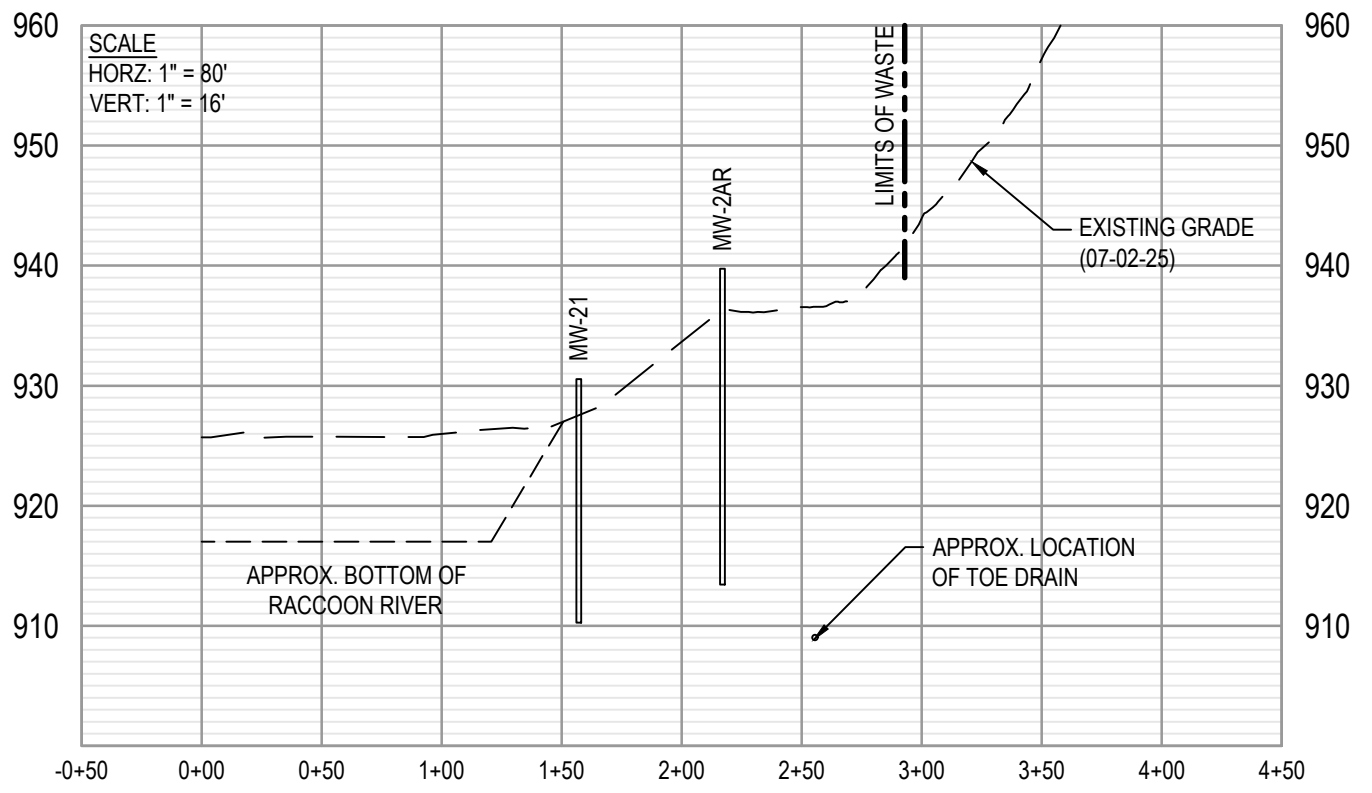
DATE
SEPTEMBER 2025

FIGURE
1



NOTES

- EXISTING TOPO PREPARED BY HDR INC. DATED JULY 2, 2025.



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RIVER BANK CROSS SECTION

METRO PARK WEST

DATE
OCTOBER 2025

FIGURE
2

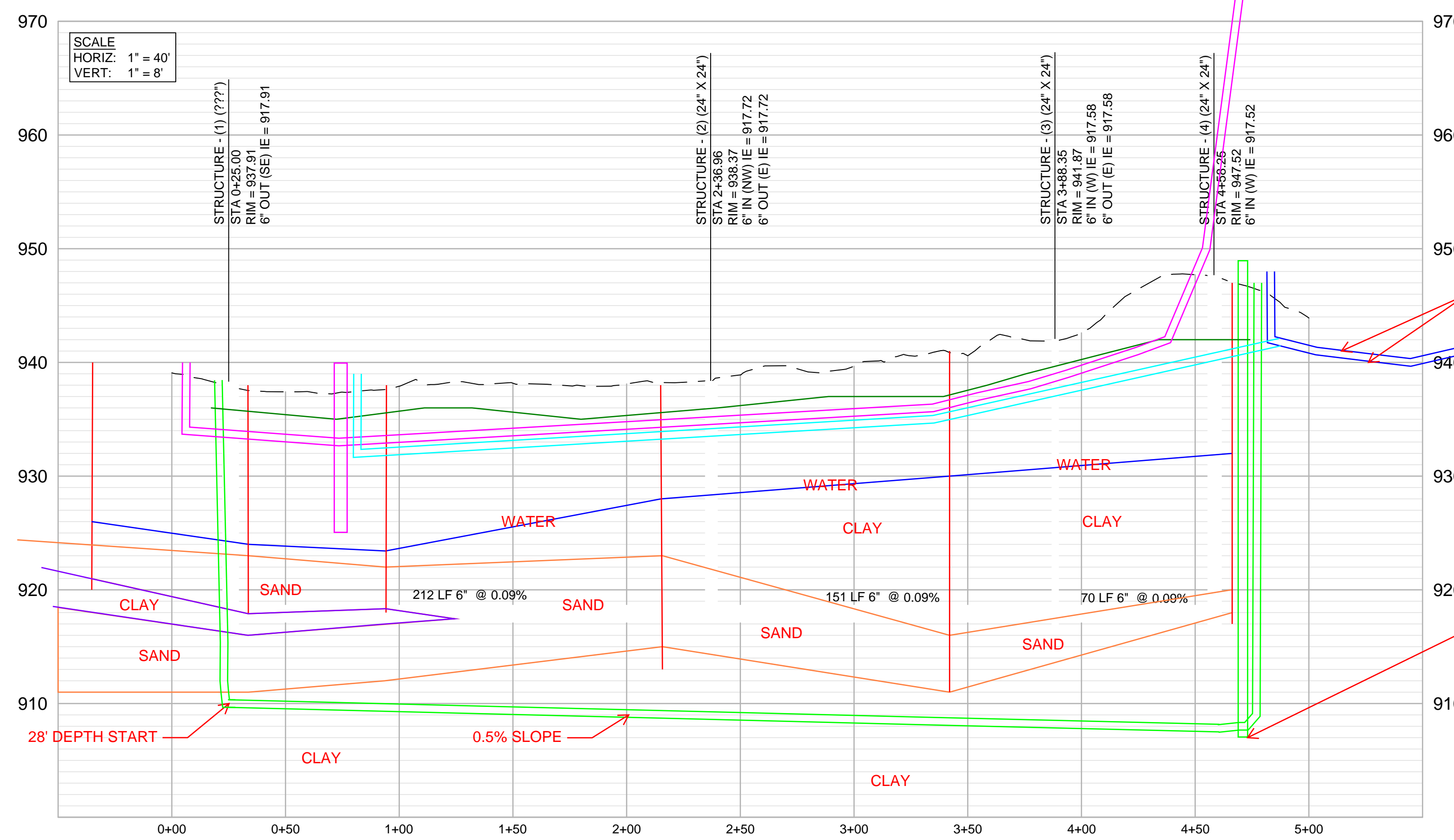
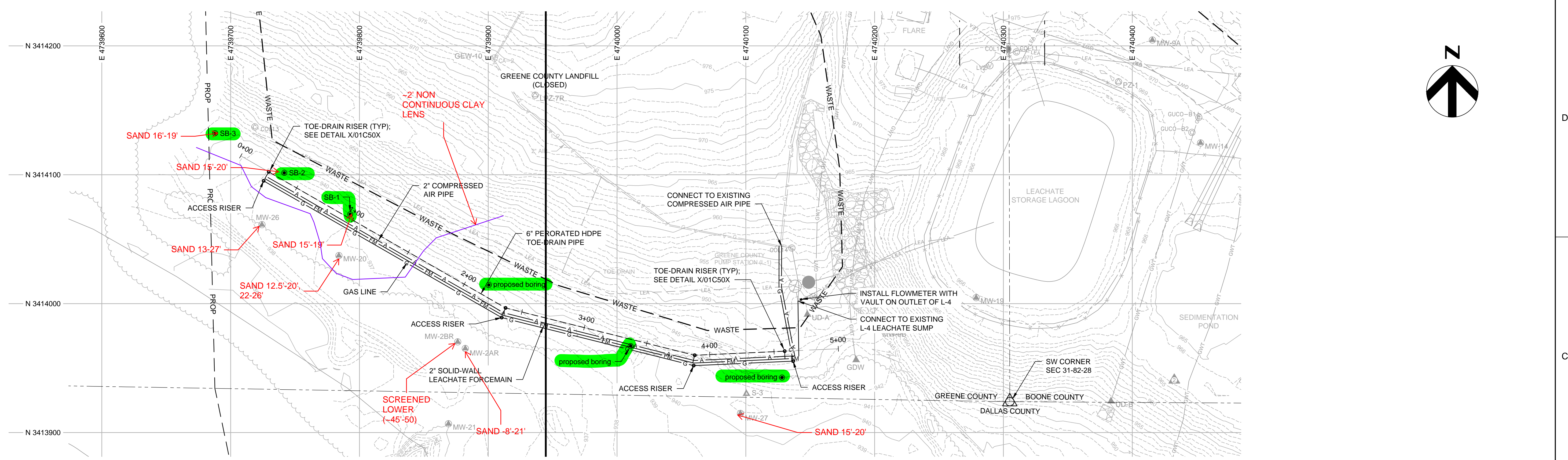


Attachment A

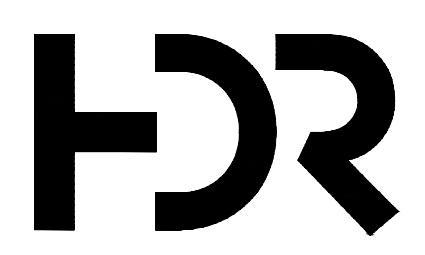
Plans, Cross Sections and
Soil Profiles



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ESTIMATE QUANTITY OF GROUNDWATER PUMPED
 ASSUME 1e-4 CM/S HORIZONTAL CONDUCTIVITY
 CROSS SECTIONAL AREA OF TOE DRAIN =
 LENGTH ~500'
 SAND THICKNESS ~8'
 =4000-SF = 3,716,122 CM^2
 *1E-4 CM/S = 371.61 CM^3/S
 =5.89 GPM



ISSUE	DATE	DESCRIPTION
1	01/19/2023	ISSUED FOR 90% REVIEW
0	12/23/2022	ISSUED FOR 60% REVIEW

PROJECT MANAGER	A. BROSHAR
CIVIL	A. BROSHAR
CIVIL	K. KINLEY
DRAWN BY	M. BICKFORD
PROJECT NUMBER	10359069

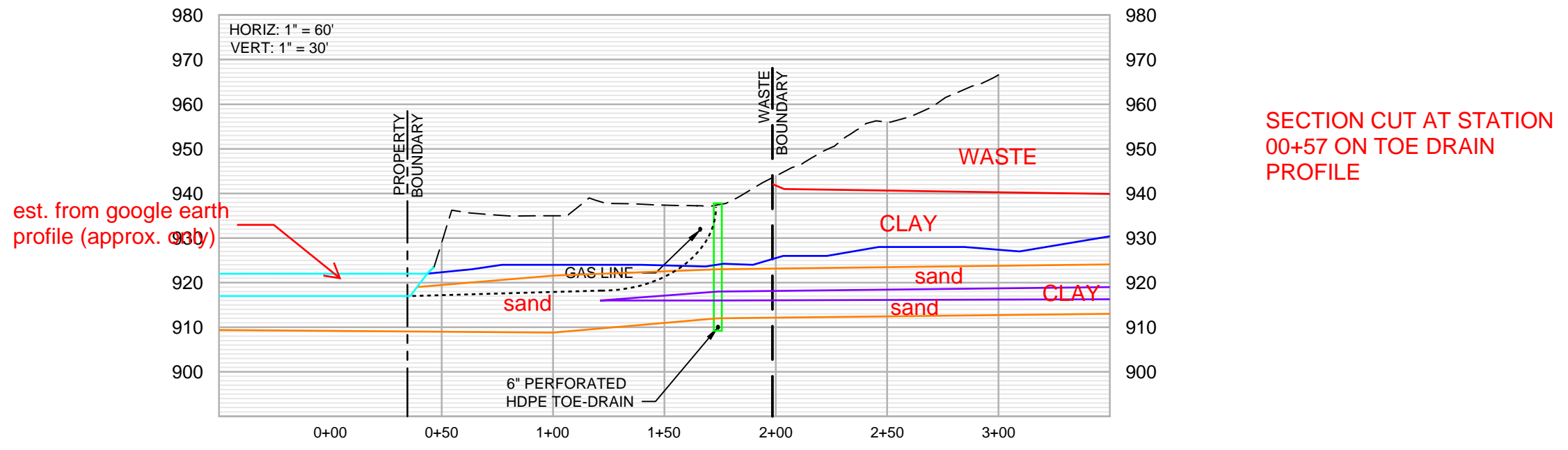
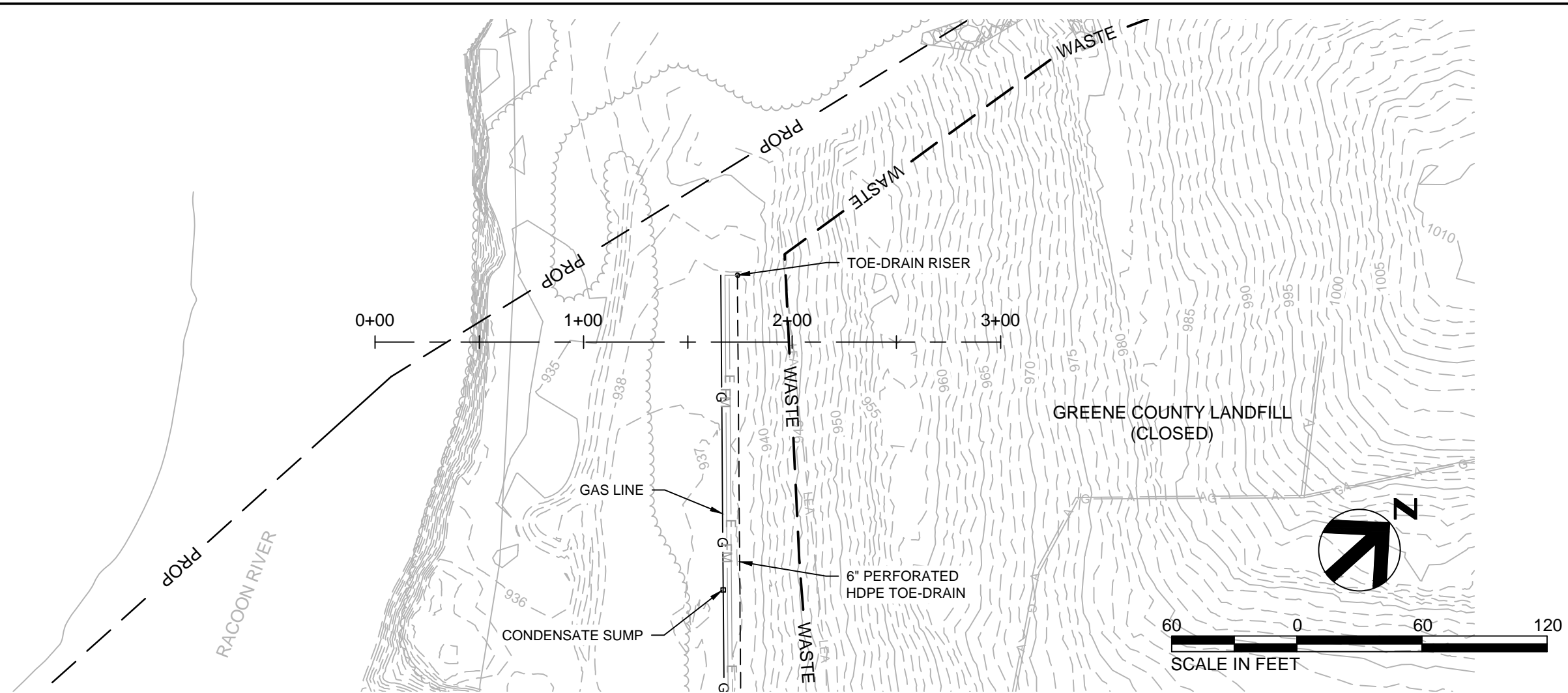
DRAFT

Metro Waste Authority
 METRO PARK WEST
 MWA PROJECT P-64
 CELL D LINER CONSTRUCTION AND
 GREENE CO. LANDFILL IMPROVEMENTS

TOE-DRAIN IMPROVEMENTS

FILENAME | 02C101.dwg
 SCALE | 1" = 40'
 SHEET | **02C101**

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SECTION CUT AT STATION 00+57 ON TOE DRAIN PROFILE



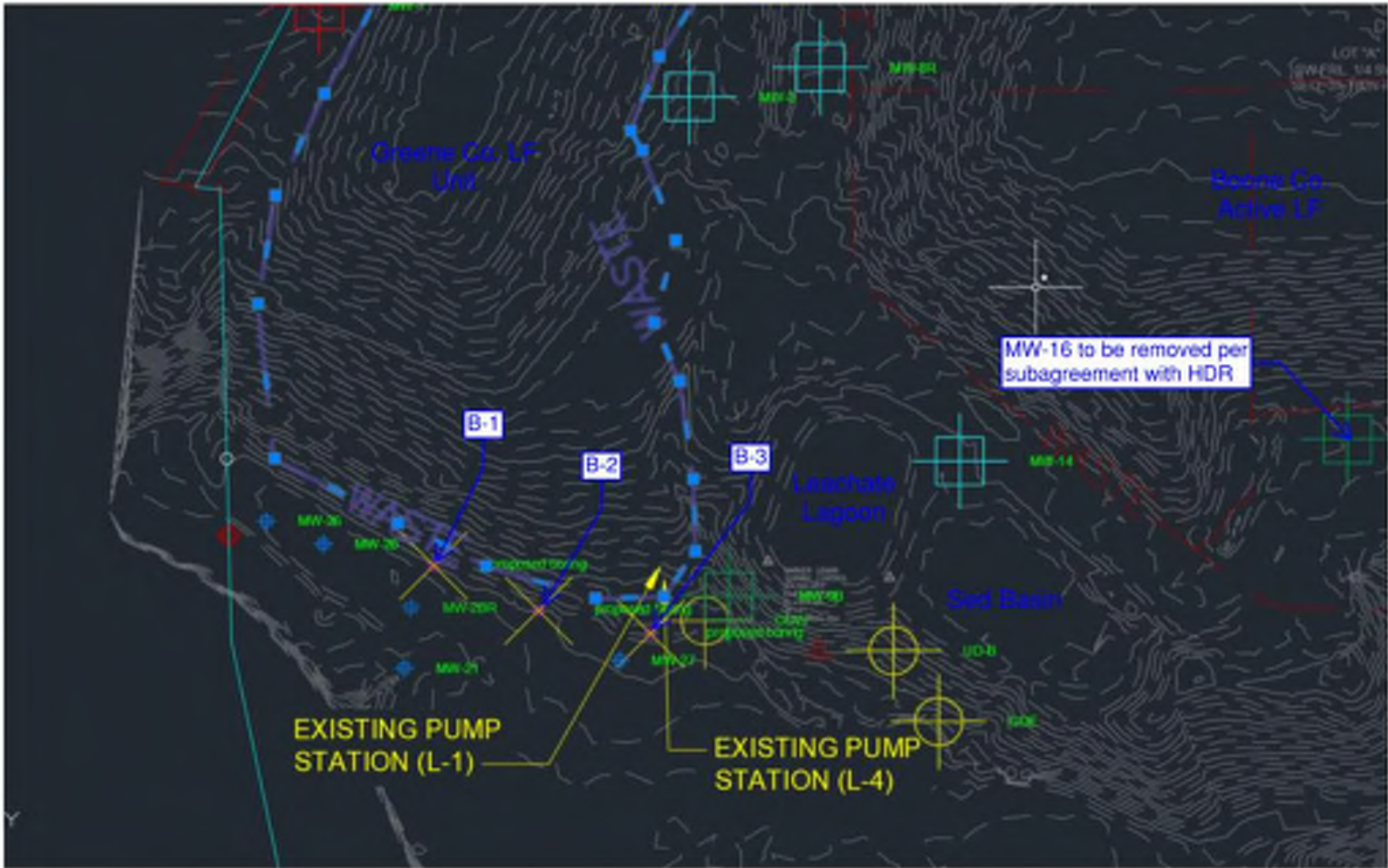
METRO WASTE AUTHORITY
METRO PARK WEST
MWA PROJECT P-64


GREENE COUNTY LANDFILL TOE-DRAIN CROSS SECTION


DATE
JANUARY 2023


FIGURE
1

Metro Park West

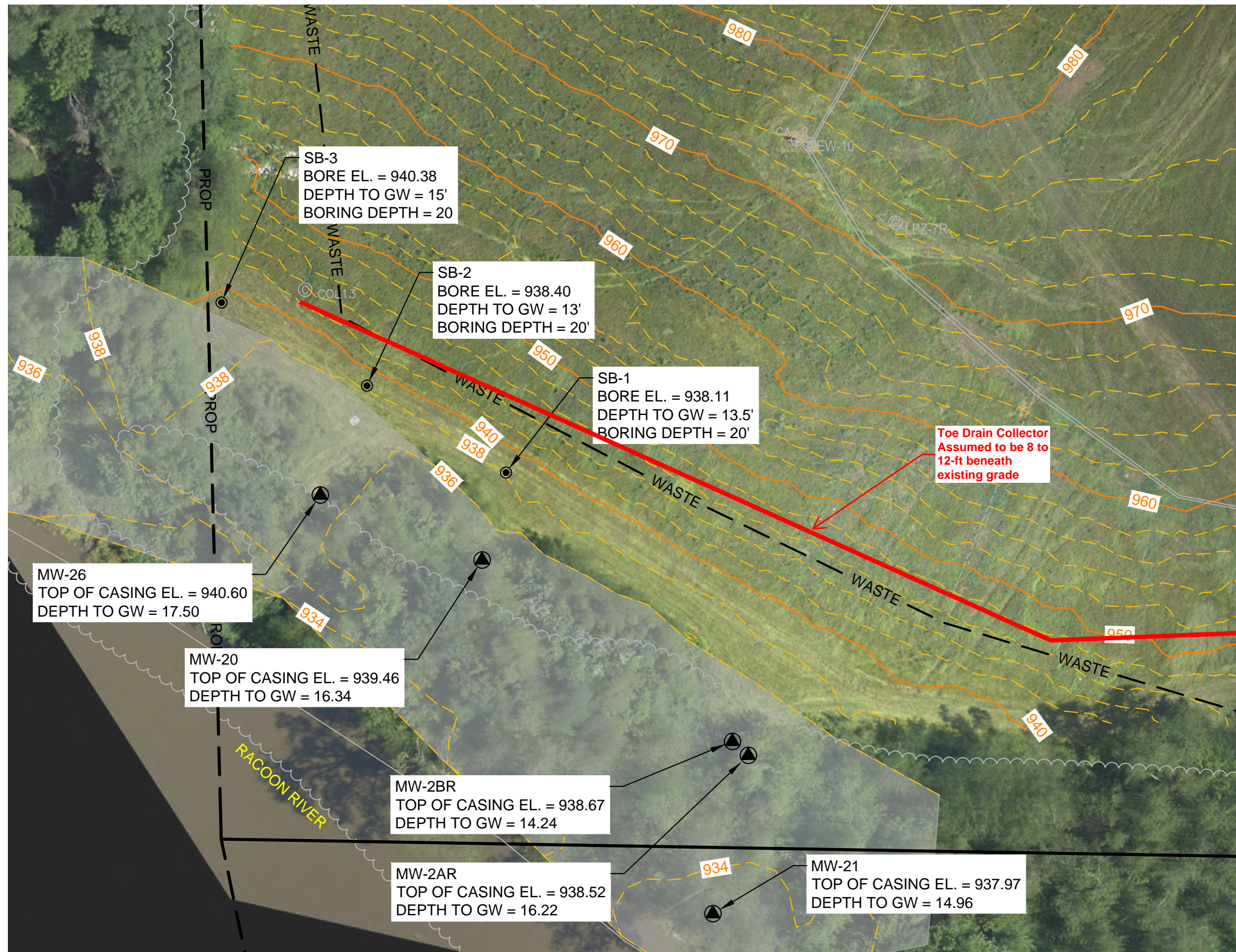


Soil Boring Log And Monitoring Well Construction Diagram for: B-1										
Facility Name: Metro Park West Landfill - Perry, Iowa					Northing: 676951.01000			Easting: 1459071.99		
Well Contractor Name: N/A				Drilling Method**: Direct Push						
Well Contractor Registration No: N/A				Boring Depth (ft) x Diameter (in): 25'						
Logged by: Cameron Lahn				Ground Surface Elevation (ASL): 947.25'						
Start Date: 12/20/2022		Finish Date: 12/20/2022		Top of Casing Elevation (ASL): -						
Depth (feet)	Well Construction Details		Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation		
			No.	Type						
0	Backfilled with bentonite upon completion →					100.0	CL	(0'-4') Brown Silty Sandy Clay (Trace Sand)		
1						100.0				
2						100.0				
3						100.0				
4						100.0	CL	(4'-16') Dark Gray Silty Clay		
5						100.0				
6						100.0				
7						100.0				
8						100.0				
9						100.0				
10						100.0				
11						100.0				
12						100.0				
13						100.0				
14						100.0				
15						100.0				
16						100.0	SC	(16'-20') Dark Gray Sandy Silt		
17						100.0				
18						100.0				
19						100.0				
20					B-1	CC	100.0	CL	(20'-25') Dark Gray Silty Clay	
21					B-1	CC	100.0			
22					B-1	CC	100.0			
23					B-1	CC	100.0			
24					B-1	CC	100.0			
25			B-1	CC	100.0					
26	End of boring									
27										
28										
29										
30										
31										
* Sample Types: Split Spoon (SS) Continuous Core (CC)			** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)				Symbols to Use: v – Static Water Level s – sample collected			
Observation Date:			N/A		Borehole Diameter:		3.25"		Location: MPW Landfill	
Time:			N/A		Well Casing Diameter:		-		SLF Permit No.: 80-SDP-03-84P	
Static Water Level (ASL):			N/A		Well Screen Size:		-		Project No.: 10310518	

Soil Boring Log And Monitoring Well Construction Diagram for: B-2											
Facility Name: Metro Park West Landfill - Perry, Iowa					Northing: 679603.62960			Easting: 1459182.155			
Well Contractor Name: N/A				Drilling Method**: Direct Push							
Well Contractor Registration No: N/A				Boring Depth (ft) x Diameter (in): 29'							
Logged by: Cameron Lahn				Ground Surface Elevation (ASL): 945.61'							
Start Date: 12/20/2022		Finish Date: 12/20/2022		Top of Casing Elevation (ASL): -							
Depth (feet)	Well Construction Details		Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation			
			No.	Type							
0	Backfilled with bentonite upon completion →					100.0	ML	(0'-2') Dark Brown Silty Sandy Clay			
1						100.0					
2						100.0			(2'-3') Wood Interference		
3						100.0	CL		(3'-7') Gray Silty Clay		
4						100.0					
5						100.0					
6						100.0					
7						100.0	CL		(7'-18') Dark Gray Silty Clay		
8						100.0			Wet at 8'		
9						100.0					
10						100.0					
11						100.0					
12						100.0					
13						100.0					
14						100.0					
15						100.0					
16						100.0					
17						100.0					
18						100.0	SM		(18'-22') Dark Gray Silty Sandy Clay		
19						100.0					
20						100.0					
21						100.0					
22						100.0	SW		(22'-23') Sand		
23						100.0	CL		(23'-26') Dark Gray Silty Clay		
24						100.0					
25						100.0					
26					B-2	CC		100.0	CL	(26'-29') Dark Gray Sandy Silty Clay Gray fine-med sand (per lab results)	
27					B-2	CC		100.0			
28					B-2	CC		100.0			
29					B-2	CC		100.0			
30			End of boring								
31											
* Sample Types:			** Drilling Method Options:				Symbols to Use:				
Split Spoon (SS)			Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger,				v – Static Water Level				
Continuous Core (CC)			Other (Describe)				s – sample collected				
Observation Date:			N/A		Borehole Diameter:		3.25"		Location:	MPW Landfill	
Time:			N/A		Well Casing Diameter:		-		SLF Permit No.:	80-SDP-03-84P	
Static Water Level (ASL):			N/A		Well Screen Size:		-		Project No.:	10310518	

Soil Boring Log And Monitoring Well Construction Diagram for: B-3											
Facility Name: Metro Park West Landfill - Perry, Iowa					Northing: 679579.26600			Easting: 1459299.656			
Well Contractor Name: N/A				Drilling Method**: Direct Push							
Well Contractor Registration No: N/A				Boring Depth (ft) x Diameter (in): 30'							
Logged by: Cameron Lahn				Ground Surface Elevation (ASL): 939.72'							
Start Date: 12/20/2022		Finish Date: 12/20/2022		Top of Casing Elevation (ASL): -							
Depth (feet)	Well Construction Details		Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation			
			No.	Type							
0	Backfilled with bentonite upon completion →					100.0	ML	(0'-4') Brown with Rust Silty Sandy Clay			
1						100.0					
2						100.0					
3						100.0					
4						100.0	CL	(4'-5') Gray Brown Silty Clay			
5						5.0		(5'-10') NR			
6						100.0					
7						100.0		Wet at 7'			
8						100.0					
9						100.0					
10						100.0	CL	(10'-22') Dark Gray Silty Clay			
11						100.0					
12						100.0					
13						100.0					
14						100.0					
15						100.0					
16						100.0					
17						100.0					
18						100.0					
19						100.0					
20						100.0					
21						100.0					
22						100.0	SW	(22'-22.5') Sand			
23						100.0	CL	(22.5'-25') Dark Gray Silty Clay			
24						100.0					
25					B-3	CC	100.0	SC	(25'-30') ^{27'} Gray Sandy Silty Clay		
26					B-3	CC	100.0				
27					B-3	CC	100.0		(27'-29') ^{27'} Dark Gray Sand		
28					B-3	CC	100.0				
29					B-3	CC	100.0				
30					B-3	CC	100.0				
31	End of boring										
* Sample Types: Split Spoon (SS) Continuous Core (CC)			** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)				Symbols to Use: v – Static Water Level s – sample collected				
Observation Date:			N/A		Borehole Diameter:		3.25"		Location:	MPW Landfill	
Time:			N/A		Well Casing Diameter:		-		SLF Permit No.:		80-SDP-03-84P
Static Water Level (ASL):			N/A		Well Screen Size:		-		Project No.:		10310518

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LEGEND

AREA OF ASSUMED GRADE
OUTSIDE OF JUNE 2021 SURVEY.

LEGEND

1. EXITING CONTOURS ARE A COMBINATION OF AERIAL SURVEY PROVIDED BY AEROVIEW SERVICES, DATED JUNE 30, 2021 AND ASSUMED GRADE CONTINUATION TOWARDS RACoon RIVER BANK.



Soil Boring Log And Monitoring Well Construction Diagram for: SB-1 (East)											
Facility Name: Metro Park West Landfill				X Coordinates: 41.863643			Y Coordinates: -94.166123				
Well Contractor Name: Jordan Lowry				Drilling Method**: Direct Push							
Well Contractor Registration No: 12145				Boring Depth (ft) x Diameter (in): 20' x 2.0'							
Logged by: Kris Sommer				Ground Surface Elevation (ASL): -							
Start Date: 6/8/2021		Finish Date: 6/8/2021		Top of Casing Elevation (ASL): -							
Depth (feet)	Well Construction Details			Sample		PID/FID (PPM)	USCS	Sample Descriptions: soil, color, classification, observation			
				No.	Type*						
0				1	CC			(0"-3") Grass and Root Zone			
1						0.0	MH CL SP	(3"-1') Dark Brown Silty Clay with Trace Sand			
2						0.0	SP	(1'-2') Brown Sand			
3						0.0	MH CL	(2'-3') Dark Brown, Dark Gray Silty Clay			
4						0.0	MH CL	(4'-7') Gray Silty Clay			
5						2	CC	0.0			
6								0.0			
7								0.0	SP MH CL	(7'-12') Dark Brown Sandy Silty Clay	
8								0.0			
9								0.0			
10						3	CC	0.0			
11								0.0			
12								0.0	SW CL	(12'-15') Dark Brown Fine Sandy Clay	
13								0.0		(v 13.5) Groundwater Encountered During Sampling Activities	
14								0.0			
15						4	CC	0.0	SP	(15'-16') Brown Sand	
16								0.0	SW	(16'-17') Gray Fine Sand	
17								0.0			
18								0.0			
19								0.0	CH SP	(19'-20') Gray Clay with Trace Sand	
20			5	CC	0.0						
21											
22											
23											
24											
25											
* Sample Types: Split Spoon (SS) Continuous Core (CC)				** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)				Symbols to Use: v – Static Water Level s – sample collected			
Observation Date:				-							
Time:				-							
Static Water Level (ASL):				-							

Soil Boring Log And Monitoring Well Construction Diagram for: SB-2 (Central)								
Facility Name: Metro Park West Landfill			X Coordinates: 41.863730		Y Coordinates: -94.166312			
Well Contractor Name: Jordan Lowry			Drilling Method**: Direct Push					
Well Contractor Registration No: 12145			Boring Depth (ft) x Diameter (in): 20' x 2.0'					
Logged by: Kris Sommer			Ground Surface Elevation (ASL): -					
Start Date: 6/8/2021		Finish Date: 6/8/2021		Top of Casing Elevation (ASL): -				
Depth (feet)	Well Construction Details		Sample		PID/FID (PPM)	USCS	Sample Descriptions: soil, color, classification, observation	
			No.	Type*				
0	<div style="border-left: 2px solid gray; border-right: 2px solid gray; padding: 5px;"> <p style="text-align: center;">← Backfilled with bentonite upon completion</p> <p style="text-align: right; margin-top: 100px;">End of boring</p> </div>		1	CC			(0'-3'') Grass and Root Zone	
1					0.0	SP MH CL	(3''-4') Brown Sandy Silty Clay	
2					0.0			
3					0.0			
4					0.0	SP CH	(4'-5') Gray Brown Sandy Clay	
5					2	CC	0.0	SP CH (5'-7') Dark Brown Sandy Clay
6							0.0	
7							0.0	CL CH (7'-19') Dark Brown Clay
8							0.0	
9							0.0	
10					3	CC	0.0	
11							0.0	
12							0.0	SW CL (12'-15') Dark Brown Fine Sandy Clay
13							0.0	(v 13.0) Groundwater Encountered During Sampling Activities
14							0.0	
15					4	CC	0.0	SP (15-16') Brown Sand
16							0.0	SW (16'-17) Gray Fine Sand
17							0.0	
18							0.0	
19							0.0	SP (19'-20') Brown Sand
20			5	CC	0.0			
21								
22								
23								
24								
25								
* Sample Types:			** Drilling Method Options:			Symbols to Use:		
Split Spoon (SS)			Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)			v – Static Water Level		
Continuous Core (CC)						s – sample collected		
Observation Date:			-					
Time:			-					
Static Water Level (ASL):			-					

Soil Boring Log And Monitoring Well Construction Diagram for: SB-3 (West)								
Facility Name: Metro Park West Landfill			X Coordinates: 41.863813		Y Coordinates: -94.166510			
Well Contractor Name: Jordan Lowry			Drilling Method**: Direct Push					
Well Contractor Registration No: 12145			Boring Depth (ft) x Diameter (in): 20' x 2.0'					
Logged by: Kris Sommer			Ground Surface Elevation (ASL): -					
Start Date: 6/8/2021		Finish Date: 6/8/2021		Top of Casing Elevation (ASL): -				
Depth (feet)	Well Construction Details		Sample		PID/FID (PPM)	USCS	Sample Descriptions: soil, color, classification, observation	
			No.	Type*				
0	<div style="border-left: 2px solid gray; border-right: 2px solid gray; padding: 5px;"> <p style="text-align: center;">← Backfilled with bentonite upon completion</p> <p style="text-align: center;">End of boring</p> </div>		1	CC			(0'-3") Grass and Root Zone	
1					0.0	MH CL	(3"-1') Brown Silty Clay	
2					0.0	SW	(1'-2') Light Brown Sand	
3					0.0	MH CL SP	(2'-3') Brown Silty Clay Trace Sand	
4					0.0	SP CH	(3'-8') Gray Brown Sandy Clay	
5					2	CC	0.0	
6							0.0	
7							0.0	
8							0.0	MH CL (8'-16') Brown Rust Silty Clay
9							0.0	
10					3	CC	0.0	
11							0.0	
12							0.0	
13							0.0	
14							0.0	
15					4	CC	0.0	SW (16'-19') Gray Sand
16							0.0	(v 15') Groundwater Encountered During Sampling Activities
17							0.0	
18							0.0	
19							0.0	CH SP (19'-20') Gray Clay with Trace Sand
20			5	CC	0.0			
21								
22								
23								
24								
25								
* Sample Types:			** Drilling Method Options:			Symbols to Use:		
Split Spoon (SS)			Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)			v – Static Water Level		
Continuous Core (CC)						s – sample collected		
Observation Date:			-					
Time:			-					
Static Water Level (ASL):			-					



January 12, 2023

Project No: 221571MWA

EcoSource, LLC
6424 University Ave
Windsor Heights, Iowa 50324

Re: Geotechnical Laboratory Testing
Metro Park West
Des Moines, Iowa

Dear Mr. Jordan Lowry:

As per your request, CMT has completed the laboratory testing for the above stated project. Enclosed you will find the results of the requested tests, as listed below.

Sample ID	Hydrometer Analysis, ASTM D422	Atterberg Limits, ASTM D4318	Permeability, ASTM D5084	Porosity, η
B-1 20-25 ft	X	X	X	0.423
B-2 25-30 ft	X	X	X	0.358
B-3 10-15 ft	X	X	X	0.493

Tests were conducted in general accordance with ASTM test methods and procedures noted. Please feel free to call should you have questions or if I may be of further assistance.

Sincerely,

Sybil K. Ferrier, P.E.
Principal Engineer

JH/SF



APPENDIX

GENERAL NOTES - BORING LOG DESCRIPTIONS

Soil descriptions stated on the Boring Logs are based on the Unified Soil Classification System as stated in ASTM Designations D-2487 and D-2488. The Unified Soil Classification group symbol listed in the table below correlate to the group symbols listed on the Boring Logs. The classification is mainly based on visual observations to define the soil characteristics. If a more detailed soil description is required, additional soil testing will be conducted to better define the soil characteristics.

Group Symbol	Group Name	Group Symbol	Group Name	Group Symbol	Group Name	Group Symbol	Group Name
SW	Well-graded Sand	GW	Well-graded Gravel	CL	Lean Clay	CH	Fat Clay
SP	Poorly-graded Sand	GP	Poorly-graded Gravel	ML	Silt	MH	Elastic Silt
SM	Silty Sand	GM	Silty Gravel	OL or OH	Organic Silt Organic Clay	Pt	Peat
SC	Clayey Sand	GC	Clayey Gravel				

RELATIVE DENSITY OF COARSE-GRANED SOILS		CONSISTENCY OF FINE-GRAINED SOILS		
<i>SPT, bpf</i>	<i>Relative Density</i>	<i>Unconfined Compressive Strength, Q_u, psf</i>	<i>Consistency</i>	<i>SPT, bpf</i>
0-3	Very Loose	< 500	Very Soft	0 – 2
4-9	Loose	500 - 1,000	Soft	2 – 4
10-29	Medium Dense	1,001 - 2,000	Medium Stiff	4 – 8
30-49	Dense	2,001 – 4,000	Stiff	8 – 15
50-80	Very Dense	4,001 – 8,000	Very Stiff	15 – 30
80+	Extremely Dense	8,001 – 16,000	Hard	30 – 100
		>16,000	Very Hard	>100

GRAIN SIZE TERMINOLOGY		RELATIVE PROPORTIONS		
<i>Major Component of Sample</i>	<i>Size Range</i>	<i>Descriptive Terms(s) (of components also present in sample)</i>	<i>Fines Percent of Dry Weight</i>	<i>Sand and Gravel Percent of Dry Weight</i>
Cobbles	12 in. to 3 in. (300 mm to 75 mm)	Trace	< 5	< 15
Gravel	3 in. to #4 sieve (75 mm to 4.75 mm)	With	5 – 12	15 – 29
Sand	#4 to #200 sieve (4.75 mm to 0.074 mm)	Modifier	> 12	> 30
Silt or Clay	Passing #200 sieve (> 0.074 mm)			

DRILLING AND SAMPLING ABBREVIATIONS

Drilling Methods

CFA – Continuous Flight Auger; typically, 4, 6, or 8 inches in diameter (ASTM D 1452)

HSA – Hollow Stem Auger; 6 or 8 inches in diameter, continuous flight auger remains in bore hole with undisturbed soil samples obtained from center of auger.

HA – Hand Auger; typically with a 4 inch or less diameter auger

Sample Types

SS - Split Spoon; samples obtained with a 140 lb manual hammer in accordance with ASTM D1586.

SSA – Split Spoon; samples obtained with a 140 lb automatic hammer in accordance with ASTM D 1586.

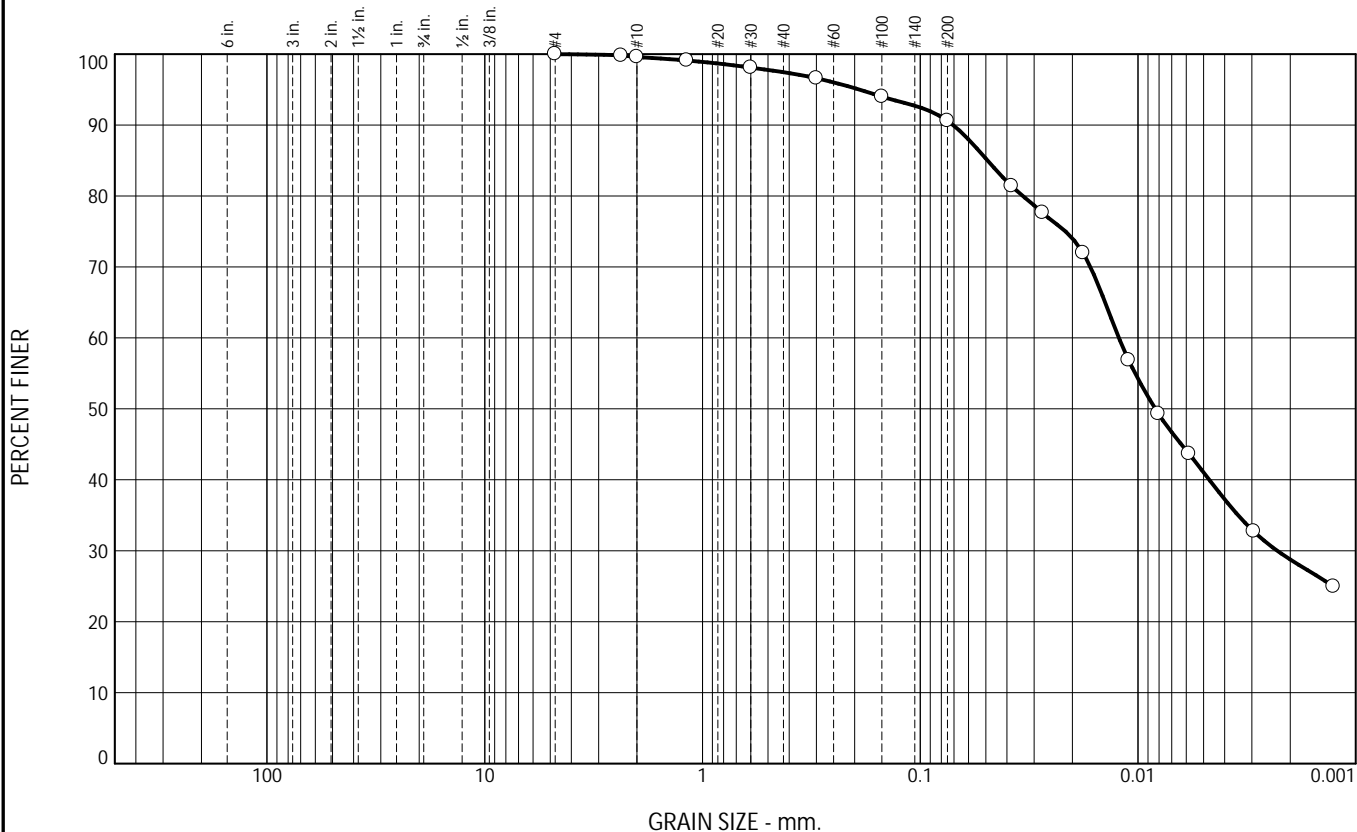
ST – Shelby Tube; thin walled tube samples, typically for cohesive soils, in accordance with ASTM D1587.

SPT- Standard Penetration Test: The number of blows required to drive a sampler, either split spoon or drive cone, into the soil with a 140 lb mass dropped a distance of 30 inches, in accordance with ASTM D 1586, and the number of blows are recorded in each 6 inch interval over a distance of 18 inches. Blow counts are reported for each 6 inch interval or the sum of the last two intervals is reported. The sum of the last two intervals is referred to as N, in blows per foot.

BS – Bulk Disturbed Sample

CPT – Cone Penetration Test; A device in which a 60° cone is pushed continuously into the soil and the cone end resistance is measured for skin friction and end bearing (ASTM D3441).

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.4	2.1	6.9	61.8	28.8

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	99.8		
#10	99.6		
#16	99.1		
#30	98.1		
#50	96.6		
#100	94.0		
#200	90.6		
0.0381 mm.	81.4		
0.0275 mm.	77.6		
0.0179 mm.	72.0		
0.0111 mm.	56.9		
0.0081 mm.	49.3		
0.0058 mm.	43.7		
0.0029 mm.	32.7		
0.0013 mm.	25.0		

* (no specification provided)

Soil Description

Dark grayish brown silty clay trace sand

Atterberg Limits

PL= 22 LL= 46 PI= 24

Coefficients

D₉₀= 0.0707 D₈₅= 0.0491 D₆₀= 0.0122
D₅₀= 0.0083 D₃₀= 0.0023 D₁₅=
D₁₀= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(24)

Remarks

Sampled by others.

Location: B-3
Sample Number: 1 Depth: 10 - 15 FT

Date: 12/27/22



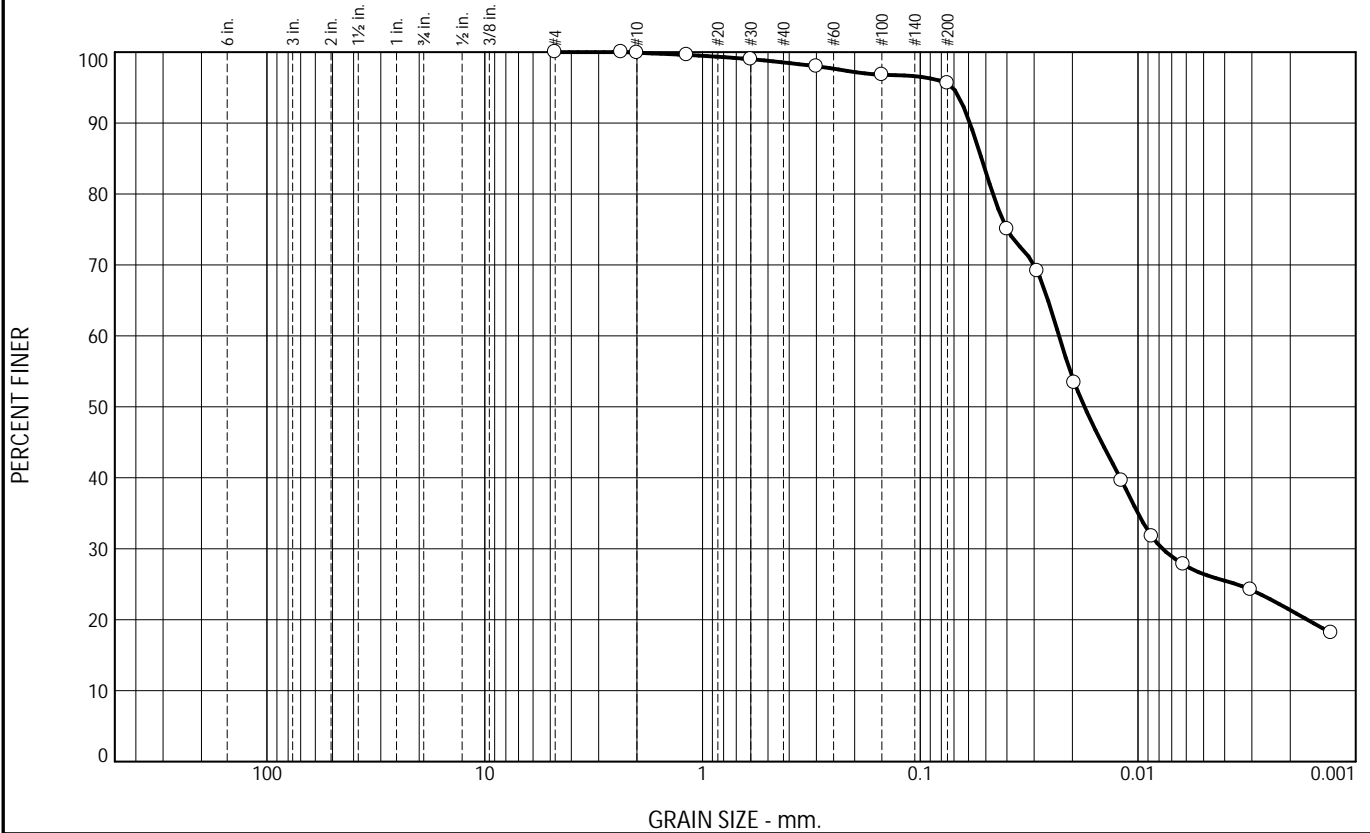
Client: EcoSource, LLC.
Project: Metro Waste Authority

Project No: 221571MWA

Figure

Tested By: J.Hopkins Checked By: S.Ferrier

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.4	2.9	74.3	21.3

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#8	100.0		
#10	99.9		
#16	99.6		
#30	99.0		
#50	98.0		
#100	96.8		
#200	95.6		
0.0400 mm.	75.1		
0.0290 mm.	69.1		
0.0196 mm.	53.4		
0.0119 mm.	39.6		
0.0087 mm.	31.8		
0.0062 mm.	27.8		
0.0030 mm.	24.2		
0.0013 mm.	18.1		

* (no specification provided)

Soil Description

Gray very silty clay trace sand

PL= 22 Atterberg Limits PI= 14
 LL= 36

Coefficients
 D₉₀= 0.0592 D₈₅= 0.0523 D₆₀= 0.0231
 D₅₀= 0.0176 D₃₀= 0.0077 D₁₅=
 D₁₀= C_u= C_c=

USCS= CL Classification AASHTO= A-6(14)

Remarks

Sampled by others.

Location: B-1
 Sample Number: 2 Depth: 20 - 25 FT

Date: 12/27/22



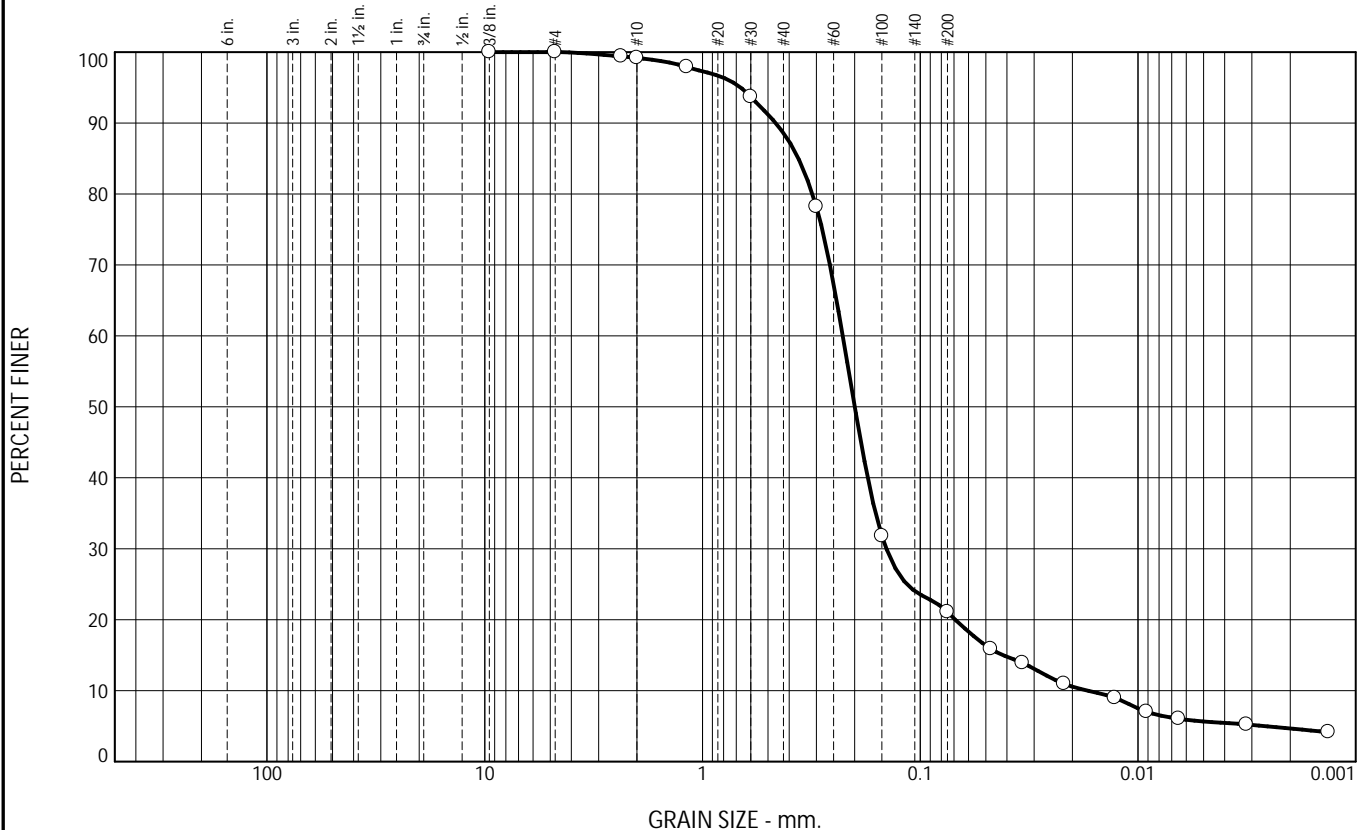
Client: EcoSource, LLC.
 Project: Metro Waste Authority

Project No: 221571MWA

Figure

Tested By: J.Hopkins Checked By: S.Ferrier

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	10.6	67.5	16.4	4.7

SIEVE SIZE OR DIAMETER	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8"	100.0		
#4	100.0		
#8	99.4		
#10	99.2		
#16	97.9		
#30	93.7		
#50	78.2		
#100	31.8		
#200	21.1		
0.0474 mm.	15.9		
0.0339 mm.	13.9		
0.0219 mm.	11.0		
0.0128 mm.	9.0		
0.0091 mm.	7.0		
0.0065 mm.	6.0		
0.0032 mm.	5.2		
0.0013 mm.	4.2		

Soil Description

Gray fine to medium sand trace silt

Atterberg Limits
 PL= NP LL= NV PI= NP

Coefficients
 D₉₀= 0.4607 D₈₅= 0.3630 D₆₀= 0.2269
 D₅₀= 0.1998 D₃₀= 0.1430 D₁₅= 0.0417
 D₁₀= 0.0170 C_u= 13.32 C_c= 5.29

Classification
 USCS= SM AASHTO= A-2-4(0)

Remarks

Sampled by others.

* (no specification provided)

Location: B-2
 Sample Number: 2 Depth: 25 - 30 FT

Date: 12/27/22



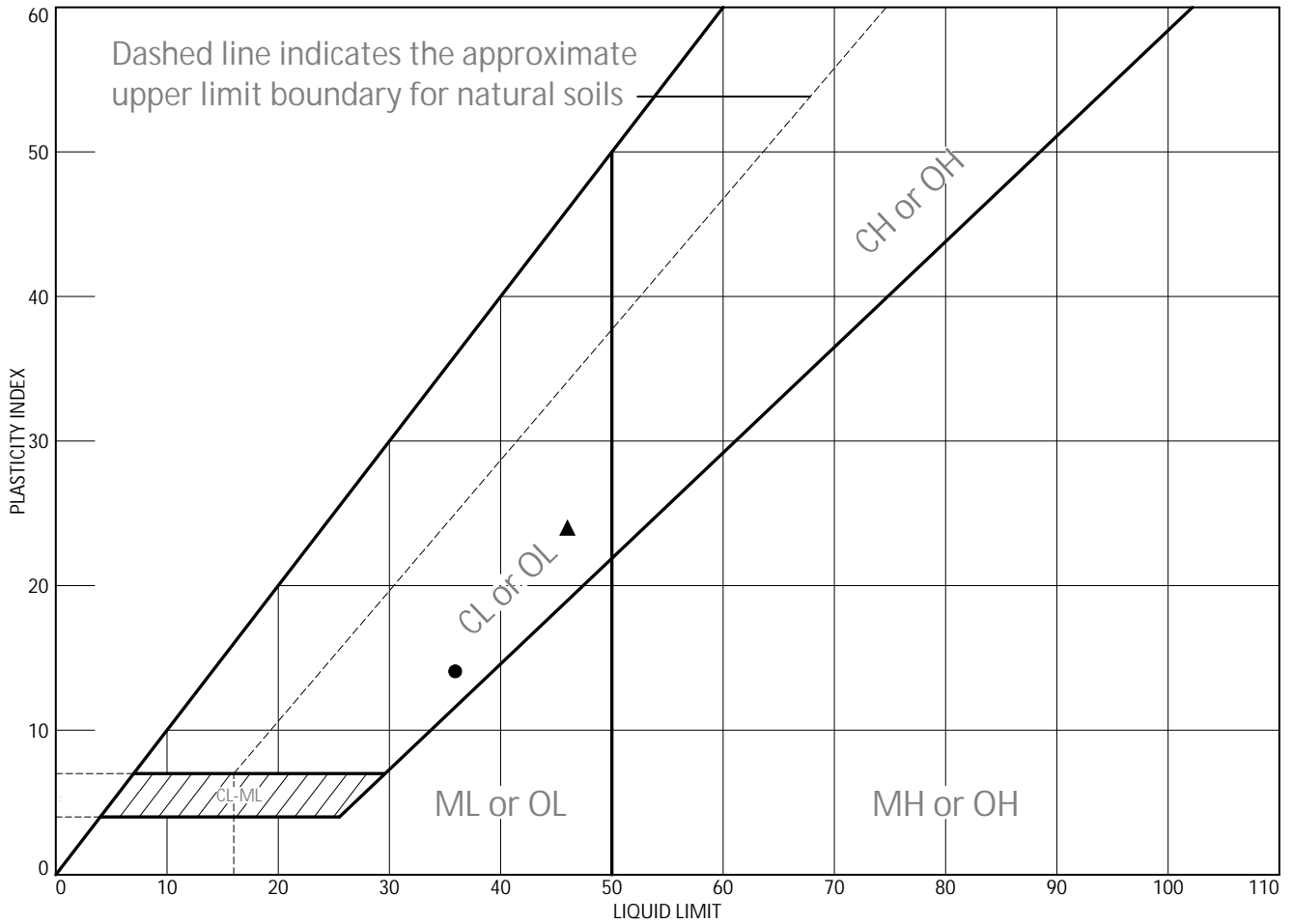
Client: EcoSource, LLC.
 Project: Metro Waste Authority

Project No: 221571MWA

Figure

Tested By: J.Hopkins Checked By: S.Ferrier

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Gray very silty clay trace sand	36	22	14	98.5	95.6	CL
■	Gray fine to medium sand trace silt	NV	NP	NP	88.6	21.1	SM
▲	Dark grayish brown silty clay trace sand	46	22	24	97.5	90.6	CL

Project No. 221571MWA Client: EcoSource, LLC.
 Project: Metro Waste Authority

● Location: B-1 Depth: 20 - 25 FT Sample Number: 2
 ■ Location: B-2 Depth: 25 - 30 FT Sample Number: 2
 ▲ Location: B-3 Depth: 10 - 15 FT Sample Number: 1

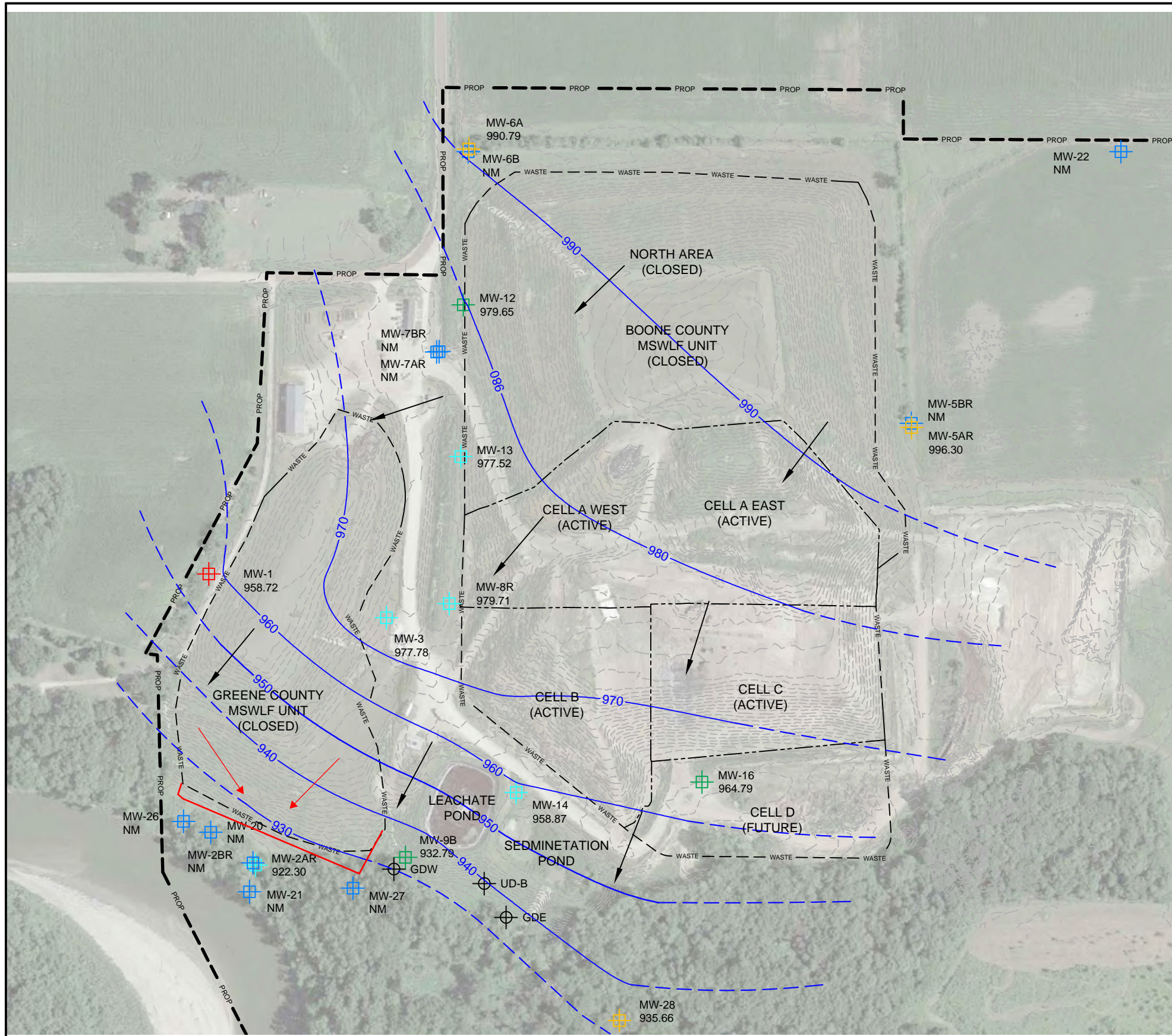
Remarks:

- As received moisture content - 22.5%
- As received moisture content - 20.2%
- ▲ As received moisture content - 33.8%



Figure

Tested By: D.Tarnow Checked By: S.Ferrier



GREENE COUNTY MSWLF UNIT WELL NETWORK	
WELL ID	CURRENT MONITORING PROGRAM
MW-1	ASSESSMENT
MW-2AR	PRE-CORECTIVE ACTION
MW-3	PRE-CORECTIVE ACTION
MW-6A	BACKGROUND / UPGRADIENT
MW-28	BACKGROUND / UPGRADIENT

BOONE COUNTY MSWLF UNIT WELL NETWORK	
WELL ID	CURRENT MONITORING PROGRAM
MW-5AR	BACKGROUND / UPGRADIENT
MW-8R	PRE-CORECTIVE ACTION
MW-9B	DETECTION
MW-12	DETECTION
MW-13	PRE-CORECTIVE ACTION
MW-14	PRE-CORECTIVE ACTION
MW-16	DETECTION
GDE	DETECTION
GDW	DETECTION
UD-B	TREATED AS LEACHATE

LEGEND

- PERMITTED EDGE OF WASTE
- CELL BOUNDARY
- PROPERTY LINE
- 990 GROUNDWATER CONTOUR
- INFERRED GROUNDWATER CONTOUR
- GROUNDWATER FLOW DIRECTION
- ASSESSMENT MONITORING WELL
- BACKGROUND MONITORING WELL
- DETECTION MONITORING WELL
- PRE CORRECTIVE ACTION WELL
- WELL - WATER LEVEL ONLY
- GROUNDWATER UNDERDRAIN

NOTES:

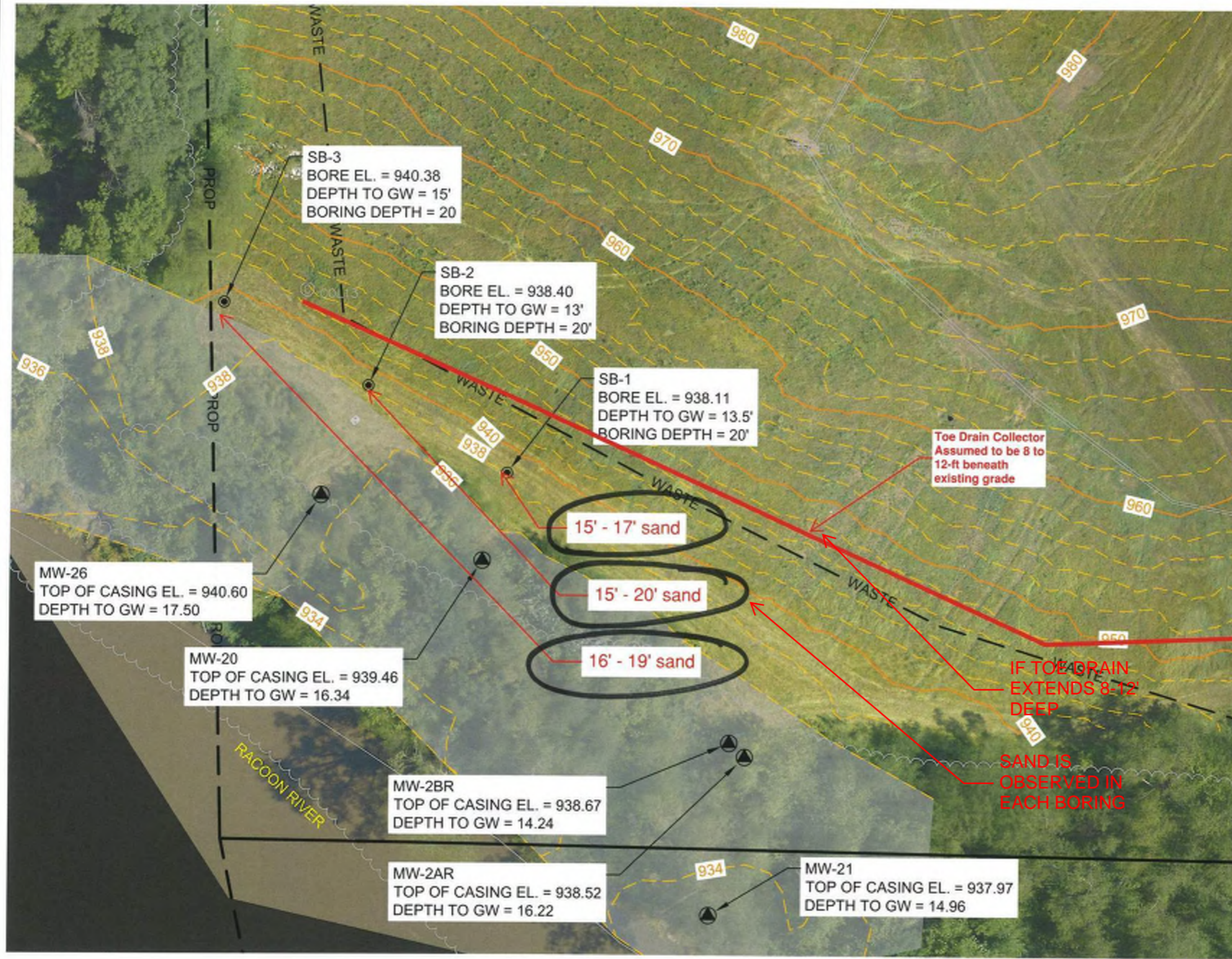
1. THE COORDINATE SYSTEM USED FOR THIS MAP IS THE NAD IOWA STATE PLANE SOUTH ZONE (1042).
2. GROUND SURFACE TOPOGRAPHY PROVIDED ON JUNE 30, 2021.
3. NM - STATIC WATER LEVEL MEASUREMENT WAS NOT OBTAINED.




**METRO WASTE AUTHORITY
METRO PARK WEST
GREENE & BOONE COUNTY MSWLF UNITS**

GROUNDWATER CONTOUR MAP - MARCH 2022

DATE
JULY 2022
FIGURE
2



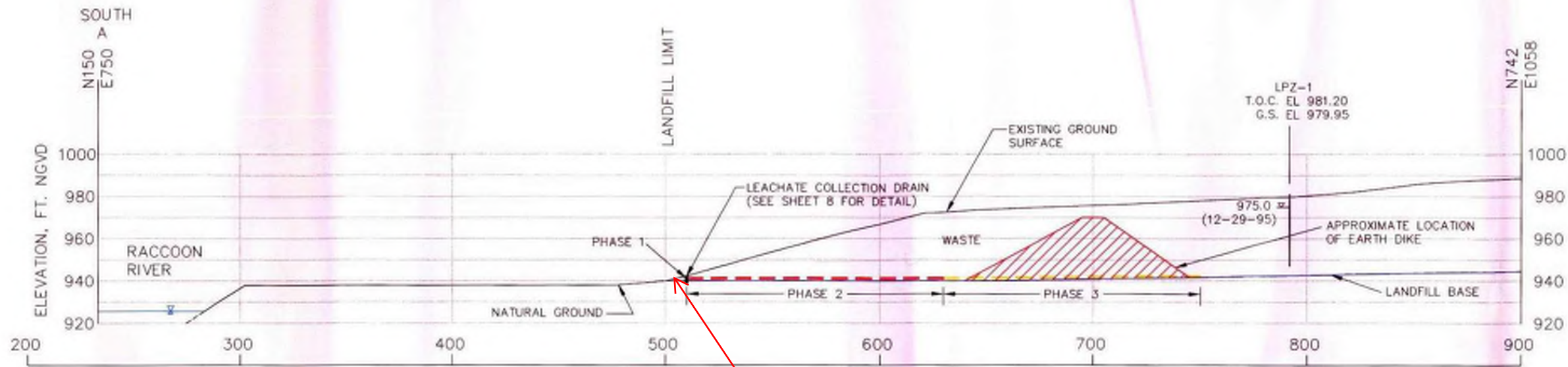
LEGEND

 AREA OF ASSUMED GRADE OUTSIDE OF JUNE 2021 SURVEY.

LEGEND

1. EXITING CONTOURS ARE A COMBINATION OF AERIAL SURVEY PROVIDED BY AEROVIEW SERVICES, DATED JUNE 30, 2021 AND ASSUMED GRADE CONTINUATION TOWARDS RACCOON RIVER BANK.

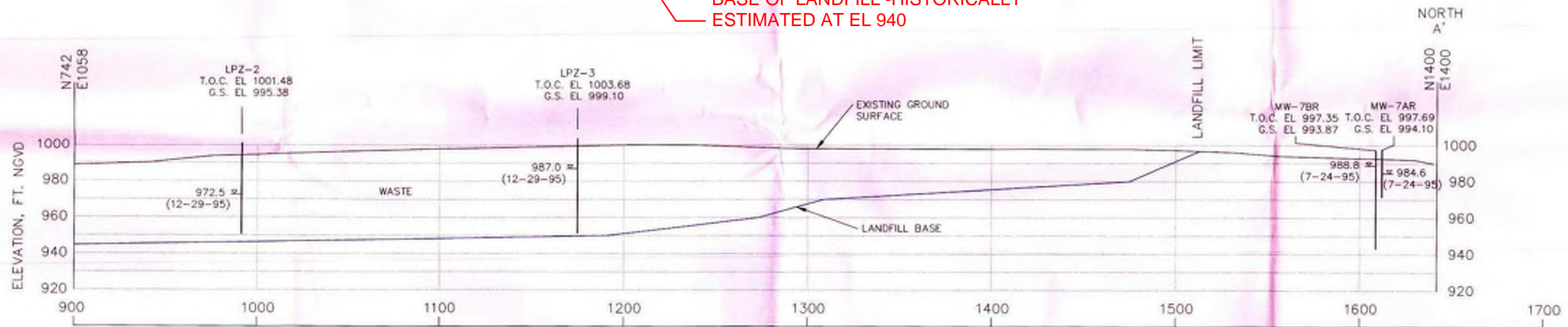




WELL LEGEND

± FLUID ELEVATION
 (7-24-95) - DATE OF FLUID MEASUREMENT
 T.O.C. - TOP OF CASING ELEVATION, (FT.)
 G.S. - GROUND SURFACE ELEVATION, (FT.)

BASE OF LANDFILL - HISTORICALLY ESTIMATED AT EL 940



1 SECTION A-A'
 4 HORIZONTAL SCALE: 1"=30'
 VERTICAL SCALE: 1"=30'

NOTE: LANDFILL BASE ELEVATIONS ARE APPROXIMATE. ACTUAL IN-SITU CONDITIONS MAY VARY.
 THE ABOVE REPRESENTS A CONTINUOUS SECTION BROKEN AT STATION N742,E1058
 REFERENCE: McCLURE ENGINEERING CO. LANDFILL DESIGN PLANS, DECEMBER 17, 1980, SHEET UNTITLED.

Filename: SHEET4.DWG
 Project No.: 896010
 Drawn By: JSH
 Reviewed By:



Barker Environmental Service
 A TEAM Services Organization
 1900 Cummins Road - Suite 201
 Des Moines, Iowa 50315
 Phone: (515) 266-0814 Fax: (515) 266-0182

**North Dallas Sanitary Landfill
 Leachate Control Plan**







Section A - A'

Con 12-1-1
 Doc # 41653

SHEET NO. 4


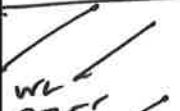
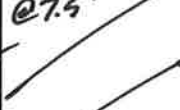




HDR

Boring Log

Project Name		Project Number		Drilling Company			
MPW Toe Borings				Array Env. / EcoSource			
Boring No.	Location	Casing El.		Drilling Rig Type and Drilling Method			
B 1-2022-ALM	MPW			Geoprobe 7822 DT			
Sample No.	HNU Reading (ppm)	Depth (feet)	Completion	Description	Elevation (feet)	Remarks	
				Brown sandy lean clay (SCL)	3'		
	0	5		Gray sandy lean clay trace gravel (SCL)	5		
	0	10		Glacial Till	10		
	0	15		- dark gray after 10'	15		
	0	16'			16'		
	0	20		Gray medium-coarse SAND trace gravel	20		
	0	22.5'			22.5'		
	0	25		sandy lean clay Dark gray SCL (GT)	25		
	0	30		Bottom of Boring @ 25'	30		
	0	35			35		
	0	40			40		
Water Level				Logged By		Sampled By	
While Drilling:	After Drilling:	# Days After Drilling:					
8'	NA			Date Started:		Date Completed	










HDR

Boring Log

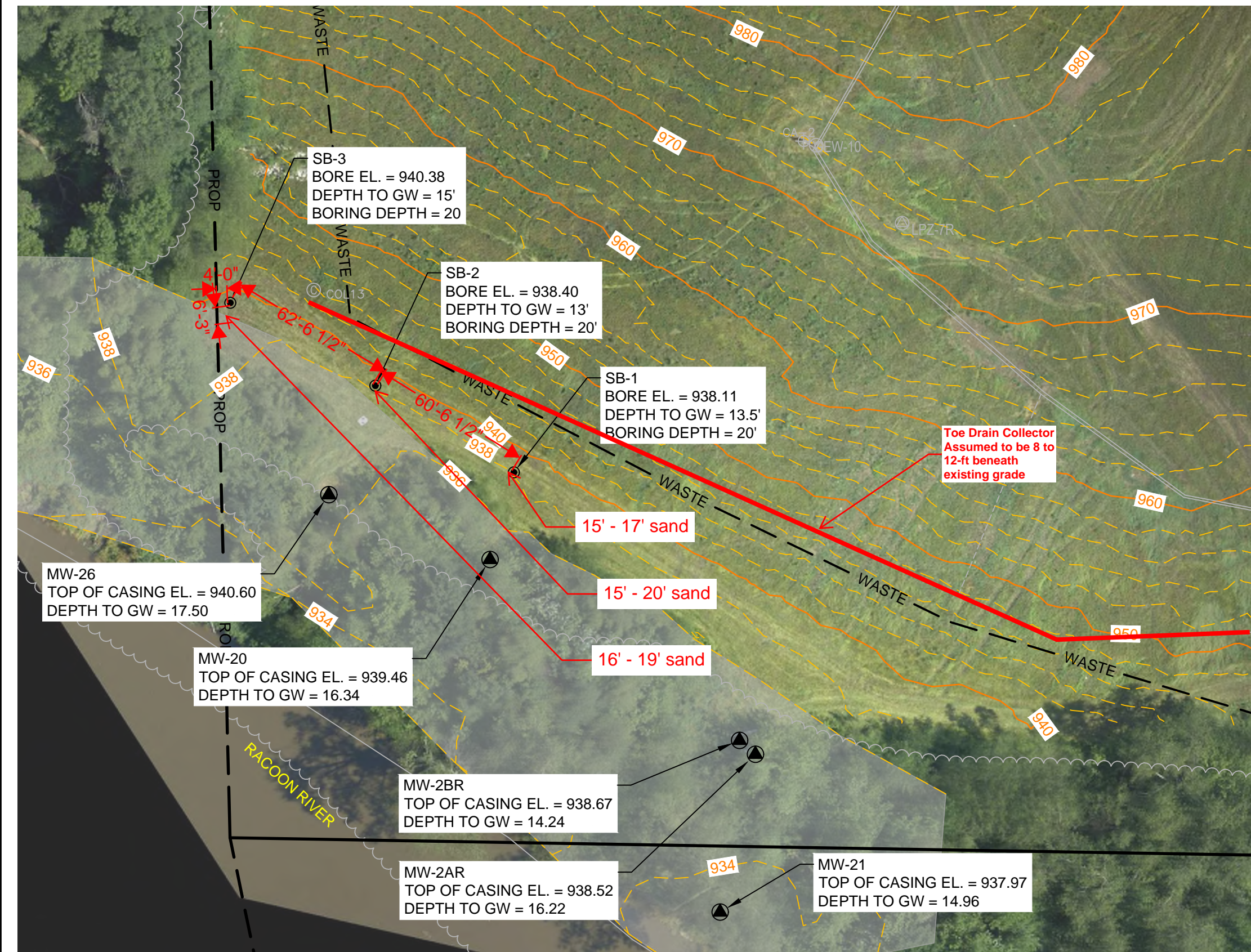
Project Name		Project Number		Drilling Company		
Boring No.	Location	Casing El.		Drilling Rig Type and Drilling Method		
Sample No.	HNU Reading (ppm)	Depth (feet)	Completion	Description	Elevation (feet)	Remarks
MPW Tol Boring 5				Array Env / EcoSource		
B2.2022.ACM	MPW			Geoprobe 7822 DT		
	0	5		Brown-dark brown sandy lean clay SCL	25'	
	0	10		Gray sand lean clay trace gravel (SCL) (Glacial Till)	5	
	0	15		- dark gray after 8'	10	
	0	20			15	
	0	25		Gray coarse sand (outwashy layer)	20	key in through this layer
	0	30		Dark gray sandy lean clay, trace gravel (Glacial Till)	22'	
	0	35		Dark Gray medium-coarse SAND	23'	do not disturb this layer
	0	40		Bottom of Boring @ 30'	27'	
	0	35			30	
	0	40			35	
Water Level				Logged By	Sampled By	
While Drilling:	After Drilling:	# Days After Drilling:				
7.5'	NA			Date Started:	Date Completed	

HDR

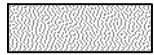
Boring Log

Project Name		Project Number		Drilling Company			
Boring No.	Location	Casing El.		Drilling Rig Type and Drilling Method			
MPW Toe Borings				Array Env/EcoSource			
83.2022.ACM	MPW			Geoprobe 7822 DT			
Sample No.	HNU Reading (ppm)	Depth (feet)	Completion	Description	Elevation (feet)	Remarks	
				Dark brown sandy lean clay (SCL)	2.5'		
	0	5		Gray sandy lean clay, trace gravel (Glacial T.11)	5		
	0	10		- dark gray after 8'	10	7' - debris obstruction encountered @ 7' and 9'	
	0	15			15		
	0	20			20		
	0	25			25		
	0	27			27		
	0	30		Dark gray medium-coarse SAND	29'	is this connected to anything?	
	0	30		Dark gray Sandy lean clay	30		
	0	35		Bottom of Boring @ 30'	35		
	0	40			40		
Water Level				Logged By		Sampled By	
While Drilling:	After Drilling:	# Days After Drilling:					
8'	NA			Date Started:		Date Completed	

C:\pwworking\central01\03083959\Fig 1 - Phytoremediation Analysis.dwg, Layout1, 7/12/2022 10:54:15 AM, MBICKFORD



LEGEND

 AREA OF ASSUMED GRADE OUTSIDE OF JUNE 2021 SURVEY.

LEGEND

1. EXITING CONTOURS ARE A COMBINATION OF AERIAL SURVEY PROVIDED BY AEROVIEW SERVICES, DATED JUNE 30, 2021 AND ASSUMED GRADE CONTINUATION TOWARDS RACOON RIVER BANK.



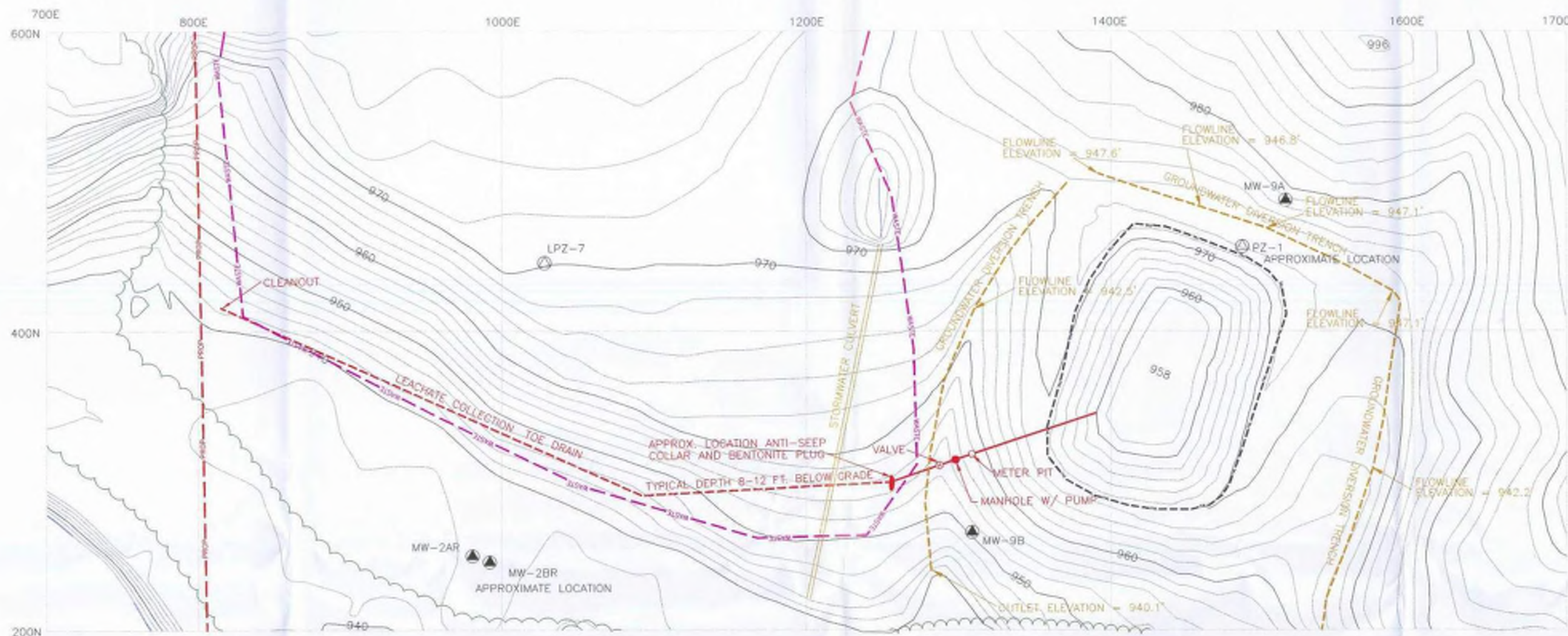
SCALE
0 40 FEET
2 FOOT CONTOUR INTERVAL

LEGEND

- MW-1 MONITORING WELL
- EXISTING FML LINER BOUNDARY
- LAGOON SECURITY FENCE
- GROUNDWATER DRAIN TRENCH ALIGNMENT

LAGOON DESIGN TABLE

LAGOON PARAMETER	
LINER PERIMETER, FT.	525
MAXIMUM ELEVATION (ME), FT.	968
OPERATING ELEVATION (OE), FT.	966
OPERATING FREE BOARD, FT.	2
OPERATING CAPACITY, GAL.	529,000
MAXIMUM CAPACITY, GAL.	766,000
RAIN CAPTURE AREA, FT. ²	22,152
EVAPORATION AREA @ ME, FT. ²	17,418
EVAPORATION AREA @ OE, FT. ²	14,185
AVE. PAN EVAPORATION, IN./YR.	40
AVE. RAINFALL, IN./YR.	32



LEACHATE TOE DRAIN EXCAVATION (LOOKING WEST)



BACKFILLING WITH SHREDDED TIRES (LOOKING WEST)



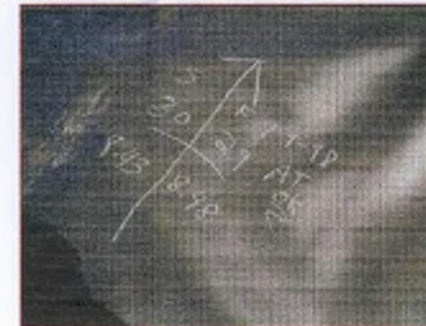
CONNECTING 6 INCH ADS DRAINAGE TILE



HOT WELDING TWO HDPE LINER SHEETS TOGETHER



RESULTS OF A PRESSURE TEST ON A SEAM



RESULTS OF A VACUUM TEST ON EXTRUSION WELD



LEACHATE TOE DRAIN AND LAGOON PLAN
NORTH DALLAS SANITARY LANDFILL
PERRY, IOWA
PROJECT NO. 99018

Con 12-1-1
Doc # 41623



Barker, Lemar & Associates, Inc.
1300 Cummins Road - Suite 201
Des Moines, Iowa 50315
Phone: (515) 256-8814
Fax: (515) 256-0152

SHEET

2

Soil Boring Log And Monitoring Well Construction Diagram for: SB-1 (East)											
Facility Name: Metro Park West Landfill				X Coordinates: 41.863643			Y Coordinates: -94.166123				
Well Contractor Name: Jordan Lowry				Drilling Method**: Direct Push							
Well Contractor Registration No: 12145				Boring Depth (ft) x Diameter (in): 20' x 2.0'							
Logged by: Kris Sommer				Ground Surface Elevation (ASL): -							
Start Date: 6/8/2021		Finish Date: 6/8/2021		Top of Casing Elevation (ASL): -							
Depth (feet)	Well Construction Details			Sample		PID/FID (PPM)	USCS	Sample Descriptions: soil, color, classification, observation			
				No.	Type*						
0				1	CC			(0"-3") Grass and Root Zone			
1						0.0	MH CL SP	(3"-1') Dark Brown Silty Clay with Trace Sand			
2						0.0	SP	(1'-2') Brown Sand			
3						0.0	MH CL	(2'-3') Dark Brown, Dark Gray Silty Clay			
4						0.0	MH CL	(4'-7') Gray Silty Clay			
5						2	CC	0.0			
6								0.0			
7								0.0	SP MH CL	(7'-12') Dark Brown Sandy Silty Clay	
8								0.0			
9								0.0			
10						3	CC	0.0			
11								0.0			
12								0.0	SW CL	(12'-15') Dark Brown Fine Sandy Clay	
13								0.0		(v 13.5) Groundwater Encountered During Sampling Activities	
14								0.0			
15						4	CC	0.0	SP	(15'-16') Brown Sand	
16								0.0	SW	(16'-17') Gray Fine Sand	
17								0.0			
18								0.0			
19								0.0	CH SP	(19'-20') Gray Clay with Trace Sand	
20			5	CC	0.0						
21											
22											
23											
24											
25											
* Sample Types: Split Spoon (SS) Continuous Core (CC)				** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)				Symbols to Use: v – Static Water Level s – sample collected			
Observation Date:				-							
Time:				-							
Static Water Level (ASL):				-							

Soil Boring Log And Monitoring Well Construction Diagram for: SB-2 (Central)								
Facility Name: Metro Park West Landfill				X Coordinates: 41.863730		Y Coordinates: -94.166312		
Well Contractor Name: Jordan Lowry				Drilling Method**: Direct Push				
Well Contractor Registration No: 12145				Boring Depth (ft) x Diameter (in): 20' x 2.0'				
Logged by: Kris Sommer				Ground Surface Elevation (ASL): -				
Start Date: 6/8/2021		Finish Date: 6/8/2021		Top of Casing Elevation (ASL): -				
Depth (feet)	Well Construction Details		Sample		PID/FID (PPM)	USCS	Sample Descriptions: soil, color, classification, observation	
			No.	Type*				
0	<div style="border-left: 2px solid gray; border-right: 2px solid gray; padding: 5px;"> <p style="text-align: center;">← Backfilled with bentonite upon completion</p> <p style="text-align: right; margin-top: 100px;">End of boring</p> </div>		1	CC			(0'-3") Grass and Root Zone	
1					0.0	SP MH CL	(3"-4') Brown Sandy Silty Clay	
2					0.0			
3					0.0			
4					0.0	SP CH	(4'-5') Gray Brown Sandy Clay	
5					2	CC	0.0	SP CH (5'-7') Dark Brown Sandy Clay
6							0.0	
7							0.0	CL CH (7'-19') Dark Brown Clay
8							0.0	
9							0.0	
10					3	CC	0.0	
11							0.0	
12							0.0	SW CL (12'-15') Dark Brown Fine Sandy Clay
13							0.0	(v 13.0) Groundwater Encountered During Sampling Activities
14							0.0	
15					4	CC	0.0	SP (15-16') Brown Sand
16							0.0	SW (16'-17') Gray Fine Sand
17							0.0	
18							0.0	
19							0.0	SP (19'-20') Brown Sand
20			5	CC	0.0			
21								
22								
23								
24								
25								
* Sample Types:			** Drilling Method Options:			Symbols to Use:		
Split Spoon (SS)			Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)			v – Static Water Level		
Continuous Core (CC)						s – sample collected		
Observation Date:			-					
Time:			-					
Static Water Level (ASL):			-					

Soil Boring Log And Monitoring Well Construction Diagram for: SB-3 (West)											
Facility Name: Metro Park West Landfill					X Coordinates: 41.863813			Y Coordinates: -94.166510			
Well Contractor Name: Jordan Lowry					Drilling Method**: Direct Push						
Well Contractor Registration No: 12145					Boring Depth (ft) x Diameter (in): 20' x 2.0'						
Logged by: Kris Sommer					Ground Surface Elevation (ASL): -						
Start Date: 6/8/2021			Finish Date: 6/8/2021		Top of Casing Elevation (ASL): -						
Depth (feet)	Well Construction Details			Sample		PID/FID (PPM)	USCS	Sample Descriptions: soil, color, classification, observation			
				No.	Type*						
0	<div style="border-left: 2px solid gray; border-right: 2px solid gray; padding: 5px;"> <p style="text-align: center;">← Backfilled with bentonite upon completion</p> <p style="text-align: center;">End of boring</p> </div>			1	CC			(0'-3") Grass and Root Zone			
1						0.0	MH CL	(3"-1') Brown Silty Clay			
2						0.0	SW	(1'-2') Light Brown Sand			
3						0.0	MH CL SP	(2'-3') Brown Silty Clay Trace Sand			
4						0.0	SP CH	(3'-8') Gray Brown Sandy Clay			
5						2	CC	0.0			
6								0.0			
7								0.0			
8								0.0	MH CL	(8'-16') Brown Rust Silty Clay	
9								0.0			
10						3	CC	0.0			
11								0.0			
12								0.0			
13								0.0			
14								0.0			
15						4	CC	0.0	SW	(16'-19') Gray Sand	
16								0.0		(v 15') Groundwater Encountered During Sampling Activities	
17								0.0			
18								0.0			
19								0.0	CH SP	(19'-20') Gray Clay with Trace Sand	
20			5	CC	0.0						
21											
22											
23											
24											
25											
* Sample Types:				** Drilling Method Options:				Symbols to Use:			
Split Spoon (SS)				Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)				v – Static Water Level			
Continuous Core (CC)								s – sample collected			
Observation Date:				-							
Time:				-							
Static Water Level (ASL):				-							

**TABLE 5
GROUNDWATER ELEVATIONS
NORTH DALLAS SANITARY LANDFILL
PERRY, IOWA
BARKER-LEMAR PROJECT NO. E97011**

Monitoring Well	Easting Coordinate (feet)	Northing Coordinate (feet)	Top of Casing Elevation (feet)	Ground Water Elevation (feet)
MW-1	877.8	887.0	1003.85	959.41
MW-2AR	980.7	249.6	942.35	925.88
MW-2BR	992.1	245.5	942.53	925.69
MW-3	1267.5	790.3	979.39	976.08
MW-4	1789.5	978.6	997.89	986.02
MW-4R1	1787.6	685.4	1006.37	998.12
MW-4R2	1790.8	451.2	1000.23	992.22
MW-5AR	2421.6	1202.4	1006.33	998.76
MW-5BR	2421.3	1211.1	1005.83	998.84
MW-6A	1449.3	1815.8	1000.60	987.89
MW-6B	1449.8	1807.8	1000.16	988.75
MW-7AR	1382.0	1372.0	997.35	985.65
MW-7BR	1387.5	1373.0	997.69	987.63
MW-8	1415.5	740.0	986.86	981.45
MW-9A	1515.3	487.2	982.77	975.16
MW-9B	1308.9	265.5	950.07	935.42
MW-11	2423.9	605.4	1007.73	993.38

Note: Groundwater elevations measured on December 15, 1997.

LOG OF BORING NO. MW-1

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 1000.74 ft GROUND SURFACE ELEV.: 997.7 ft									
4.0	SANDY LEAN CLAY, TRACE GRAVEL Brown	993.7	5		1	SS				
17.0	SANDY LEAN CLAY WITH GRAVEL Gray to Brown	980.7	10		2	ST				
			15		3	SS				
			20		4	SS				
			25		5	SS				
			30		6	ST				

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.	BOREHOLE DIA.: 7.5 in WELL DIA.: 2 in
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WATER LEVEL OBSERVATIONS		BORING STARTED 10-20-91 BORING COMPLETED 10-20-91 RIG 37 FOREMAN TSL APPROVED TSL JOB # 45905038
WL DRY W.D.		
WL		
WL		

LOG OF BORING NO. MW-1

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER						
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT						
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES			TESTS	
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.
			35		7	SS		
			40		8	SS		
			45		9	SS		
			50		10	ST		
			55		11	SS		
	59.0	938.7						
BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			BORING STARTED 10-20-91	
WL	▽	DRY W.D.	▽	BORING COMPLETED 10-20-91
WL				RIG 37 FOREMAN TSL
WL				APPROVED TSL JOB # 45905038



LOG OF BORING NO. MW-2A

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 943.67 ft GROUND SURFACE ELEV.: 939.6 ft									
8.0	SANDY LEAN CLAY Dark Brown		5		1	SS				
	931.6									
	FINE TO MEDIUM SAND Brown		10		2	SS				
			15		3	SS				
			20		4	SS				
21.0	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.									
		918.6								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

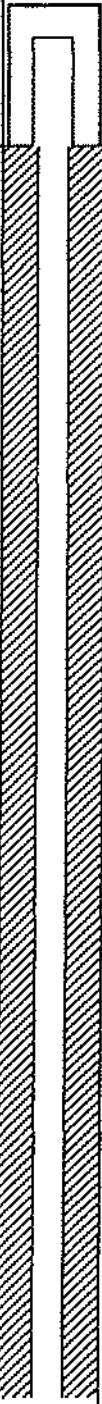
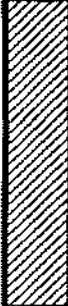

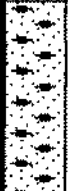

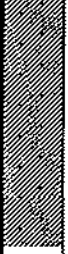
WATER LEVEL OBSERVATIONS			
WL	▽	8	W.D. ▽
WL			
WL			



BORING STARTED		10-21-91	
BORING COMPLETED		10-21-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

LOG OF BORING NO. MW-2B

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 943.67 ft GROUND SURFACE ELEV.: 939.6 ft									
8.0	SANDY LEAN CLAY Brown		5			HS				
19.0	FINE TO MEDIUM SAND Brown		10			HS				
24.0	FINE TO MEDIUM SAND WITH GRAVEL Brown		20	1	SS					
26.0	FINE TO VERY COARSE SAND WITH GRAVEL Brown		25	2	SS					
	SANDY LEAN CLAY Gray		30	3	SS					
						HS				

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.	BOREHOLE DIA.: 4.5 in WELL DIA.: 2" in
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WATER LEVEL OBSERVATIONS			
WL	▽	6	W.D. ▽
WL			
WL			



BORING STARTED	12-6-91
BORING COMPLETED	12-6-91
RIG 37	FOREMAN TSL
APPROVED TSL	JOB # 45905038

LOG OF BORING NO. MW-2B

OWNER <p style="text-align: center;">RINEHART CONSTRUCTION</p>	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT <p style="text-align: center;">HYDROGEOLOGICAL ASSESSMENT REPORT</p>

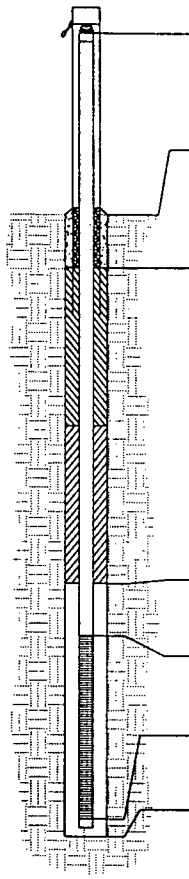
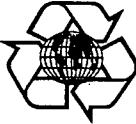
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS	
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %
			35		4	SS			
						HS			
			40		5	SS			
						HS			
			45		6	SS			
						HS			
	48.0	891.6							
	49.0	890.6							
	SHALE Gray, highly weathered				7	SS			
	SHALE Black, highly weathered					HS			
	54.0	885.6							
	SHALE Gray				8	SS			
						HS			
	58.0	881.6							
	BOTTOM OF BORING AUGER REFUSAL AT 58.0 FT NOTE: Soil classifications are based on observations made by the field crew.								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			BORING STARTED 12-6-91			
WL	▽	6	W.D.	▽	BORING COMPLETED 12-6-91	
WL					RIG 37	FOREMAN TSL
WL					APPROVED TSL	JOB # 45905038



BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description	
		Depth							
	TOC	940.00							
	Ground	940							
	Concrete	1		ST	4 - 6 ft	HS	16"	24"	Dark Gray Sandy Lean Clay
				SS	6 - 8 ft	HS	8"		Gray Silty Clay
	Bentonite Seal	40.6		SS	9 - 11 ft	HS	8"		Gray Med. Sand @ 8 ft. Gray Med. Coarse Sand, Trace Gravel to 26 ft.
				SS	29 - 31 ft	HS	18"		Gray Sandy Lean Clay
				ST	34 - 36 ft	HS	20"	24"	Gray Sandy Lean Clay, Trace Gravel
				SS	39 - 41 ft	HS	18"		Gray Sandy Lean Clay
	Sand Pack	45.6		SS	44 - 46 ft	HS	20"		Gray Sandy Lean Clay
	Well Screen	50.6		SS	49 - 51 ft	HS	20"		Gray Shale @ 49.5 ft.
	Well Bottom	51							Bottom of Boring @ 51.0 ft.
	Bottom of Boring	51							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) CS-Continuous Sampler SS-Split Spoon HA-Hand Auger ST-Shelby Tube			Date:	3/23/99	3/30/99			Driller:	Barker-Lemar
			Time:	10:00	10:15			Logged By:	K. Sperflage
			Water Level:	6.0	21.72			Date/Time Start:	3/23/99
			Elevation:		918.28			Date/Time End:	3/23/99
 Barker, Lemar & Associates 1300 Cummins Road - Suite 201 Des Moines, Iowa 50315 Phone: 515-256-8814 Fax: 515-256-0152			Borehole Diameter:		8.25"		Project:		Project No. 99018
			Well Casing Diameter:		2"		Location:		Perry, Iowa
			Well Screen Size:		0.010"		Client:		North Dallas SLF
							Owner:		North Dallas SLF
							Boring/Well No:		MW-2BR

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name North Dallas Sanitary Landfill Permit # 8-SDP-3-84P
 Well or Piezometer # MW-2BR Date Started 3/23/99 Date Completed 3/23/99

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):
 Specify corner of site NE Fence Corner
 Distance and Direction 1425 ft West
 along boundary

 Distance and Direction 1550 ft South
 from boundary to well

Elevation(+/-0.01 ft. MSL):
 Ground surface Approx. 940
 Top of Protective Casing Approx. 943
 Top of Well Casing Approx. 940
 Benchmark Elevation 1004.66
 Benchmark Description RR spike in the
NE face of the power pole at west approach

B. Soil Boring Information

Name and Address of Construction Company
Barker, Lemar & Associates, Inc.
1300 Cummins Rd. Suite 201
Des Moines, IA 50315
 Name of Driller Kevin Sperfslage
 Drilling Method Hollow Stem Augers
 Drilling Fluid none
 Bore hole Diameter 8.25 inch
 Soil Sampling Method CS and ST
 Depth of Boring 51 ft

C. Monitoring Well Installation

Casing Material PVC
 Length of Casing 51.0 ft
 Outside Casing Diameter 2.375 inch
 Inside Casing Diameter 2.0 inch
 Casing Joint Type threaded
 Casing/Screen joint type threaded
 Screen material PVC
 Screen opening size 0.010 inch
 Screen length 5.0 ft
 Depth of Well 51.0 ft

Well Installation, continued:

Filter pack:
 Material Northern
 Grain Size #0
 Volume 3.0 ft³

Seal (minimum 3 ft. length above filter pack):
 Material Bentonite
 Placement Method poured
 Volume 0.5 ft³

Backfill (if different from seal):
 Material
 Placement Method
 Volume

Surface seal design:

Material of Protective Casing:
steel
 Material of grout between protective casing
 and well casing
concrete
 Protective cap material
steel
 Vented? (Y/N) Y Locking? (Y/N) Y
 Well cap material
PVC
 Vented? (Y/N) Y

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner
 well casing) 21.72
 Stabilization time 6 days
 Well development method
Bailing

 Upgradient or downgradient well?
downgradient
 Average Depth of Frostline
 4-feet

LOG OF BORING NO. MW-3

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER							
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT							
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	SAMPLES				TESTS		
			USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 976.37 ft GROUND SURFACE ELEV.: 973.4 ft		DEPTH (FT.)						
1.0	SANDY LEAN CLAY, TRACE GRAVEL Brown	972.4	5	1	SS				
	SANDY LEAN CLAY, TRACE GRAVEL Gray		10	2	SS				
			15	3	SS				
			20	4	SS				
			25	5	SS				
26.0	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.	947.4							

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

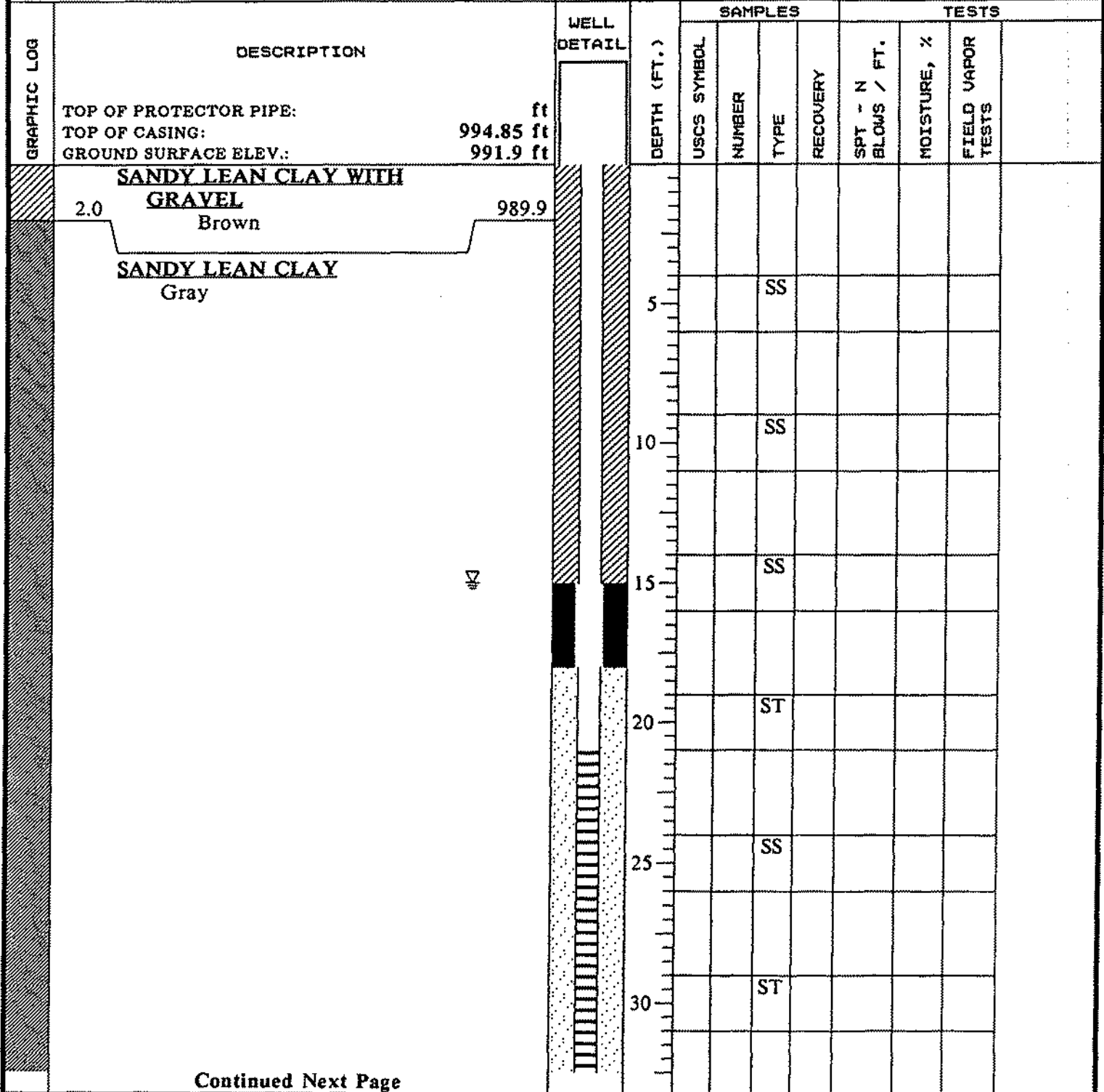
WATER LEVEL OBSERVATIONS		
WL	▽	DRY W.D. ▼
WL		
WL		

Terracon

BORING STARTED	10-21-91
BORING COMPLETED	10-21-91
RIG 37	FOREMAN TSL
APPROVED TSL	JOB # 45905038

LOG OF BORING NO. MW-4

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT



Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

WATER LEVEL OBSERVATIONS		
WL	15	W.S.
WL		
WL		



BORING STARTED		10-21-91	
BORING COMPLETED		10-21-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

LOG OF BORING NO. MW-4

OWNER <p style="text-align: center;">RINEHART CONSTRUCTION</p>	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT <p style="text-align: center;">HYDROGEOLOGICAL ASSESSMENT REPORT</p>

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
36.0	Shale observed at bottom of boring	955.9	35			SS				
	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			Terracon	BORING STARTED 10-21-91	
WL	15	w.s.		BORING COMPLETED 10-21-91	
WL				RIG 37	FOREMAN TSL
WL				APPROVED TSL	JOB # 45905038

LOG OF BORING NO. MW-5A

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 1004.35 ft GROUND SURFACE ELEV.: 1001.4 ft									
1.5	SANDY LEAN CLAY Dark Brown	999.9	5		1	SS				
7.0	SANDY LEAN CLAY, TRACE GRAVEL Gray to Brown	994.4	10		2	SS				
13.0	SANDY LEAN CLAY Brown	988.4	15		3	ST				
15.0	SANDY LEAN CLAY WITH GRAVEL Gray	986.4								
	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

WATER LEVEL OBSERVATIONS		
WL	▽	DRY W.D. ▽
WL		
WL		

Terracon		BORING STARTED	10-21-91
		BORING COMPLETED	10-21-91
	RIG 37	FOREMAN	TSL
	APPROVED TSL	JOB #	45905038

LOG OF BORING NO. MW-5B

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 1004.33 ft GROUND SURFACE ELEV.: 1001.3 ft									
1.5	SANDY LEAN CLAY Dark Brown		999.8							
7.0	SANDY LEAN CLAY, TRACE GRAVEL Gray to Brown		994.3		1	SS				
13.0	SANDY LEAN CLAY Brown		988.3		2	SS				
	SANDY LEAN CLAY WITH GRAVEL Gray				3	ST				
					4	SS				
					5	SS				
					6	ST				

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

WATER LEVEL OBSERVATIONS		
WL	▽	DRY W.D. ▽
WL		
WL		



BORING STARTED		10-21-91	
BORING COMPLETED		10-21-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

LOG OF BORING NO. MW-5B

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER								
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT								
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
34.7	966.6	[Symbol]	35		7	SS				
35.0	966.3									
	SHALE									
	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.									


THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS	
WL	☒ DRY W.D. ☒
WL	
WL	




BORING STARTED	10-21-91
BORING COMPLETED	10-21-91
RIG 37	FOREMAN TSL
APPROVED TSL	JOB # 45905038

LOG OF BORING NO. MW-6

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER					
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT					
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES		TESTS	
				USCS SYMBOL	NUMBER	TYPE	RECOVERY
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 998.97 ft GROUND SURFACE ELEV.: 992.8 ft		0				
1.5	SANDY LEAN CLAY Dark Brown		991.3				
	SANDY LEAN CLAY, TRACE GRAVEL Gray to Brown		5	1	SS		
			10	2	SS		
13.0	SANDY LEAN CLAY WITH GRAVEL Gray		979.8	3	ST	14.8	
21.0	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.		971.8	4	SS		

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

WATER LEVEL OBSERVATIONS		
WL	☒	DRY W.D. ☒
WL		
WL		



BORING STARTED	10-21-91
BORING COMPLETED	10-21-91
RIG 37	FOREMAN TSL
APPROVED TSL	JOB # 45905038

LOG OF BORING NO. MW-7A

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER					
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT					
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES		TESTS	
				USCS SYMBOL	NUMBER	TYPE	RECOVERY
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 993.18 ft GROUND SURFACE ELEV.: 990.2 ft						
	MEDIUM SAND [FILL] Dark Brown 3.0 _____ 987.2						
	SANDY LEAN CLAY WITH GRAVEL Gray to Brown _____ 20.0 _____ 970.2						
	BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.						

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 7.5 in
WELL DIA.: 2 in

WATER LEVEL OBSERVATIONS	
WL	DRY W.D.
WL	
WL	



BORING STARTED		10-20-91	
BORING COMPLETED		10-20-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

LOG OF BORING NO. MW-7B

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 992.92 ft GROUND SURFACE ELEV.: 989.9 ft									
3.0	MEDIUM SAND [FILL] Dark Brown _____ 986.9	5	1	SS						
	SANDY LEAN CLAY WITH GRAVEL Gray to Brown _____ 966.9	10	2	SS						
		15	3	SS						
		20	4	ST						
23.0	SANDY LEAN CLAY WITH GRAVEL Gray _____ 966.9	25	5	SS						
		30	6	SS						

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.	BOREHOLE DIA.: 7.5 in WELL DIA.: 2 in
--	--

WATER LEVEL OBSERVATIONS			BORING STARTED 10-20-91	
WL	∇	DRY W.D. ∇	BORING COMPLETED	10-20-91
WL			RIG 37	FOREMAN TSL
WL			APPROVED TSL	JOB # 45905038



LOG OF BORING NO. MW-7B

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER								
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT								
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES			TESTS			
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
					7	SS				
					8	SS				
			45	9	ST		14.6			
	49.0	940.9								
BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS	
WL DRY W.D.	
WL	
WL	



BORING STARTED		10-20-91	
BORING COMPLETED		10-20-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

LOG OF BORING NO. RW-1A

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: _____ N.S. ft GROUND SURFACE ELEV.: _____ 975.4 ft									
	LEAN CLAY Brown 4.0 _____ 971.4									
	REFUSE 									
					1	SS				
					2	SS				
					3	SS				
					4	SS				

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.	BOREHOLE DIA.: 6.5 in WELL DIA.: 4 in
--	--

WATER LEVEL OBSERVATIONS		
WL	6	W.D.
WL		
WL		



BORING STARTED	12-9-91
BORING COMPLETED	12-9-91
RIG 37	FOREMAN TSL
APPROVED TSL	JOB # 45905038

LOG OF BORING NO. RW-1A

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER							
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT							
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS	
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %
33.5	941.9	[Symbol]	35		5	SS			
35.0	940.4								
BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.									

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			BORING STARTED 12-9-91	
WL	6	W.D.	BORING COMPLETED 12-9-91	
WL			RIG 37	FOREMAN TSL
WL			APPROVED TSL	JOB # 45905038



LOG OF BORING NO. RW-2

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 998.92 ft GROUND SURFACE ELEV.: 993.4 ft									
	LEAN CLAY Brown 3.0 _____ 990.4									
	REFUSE _____									

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 6.5 in
WELL DIA.: 4 in

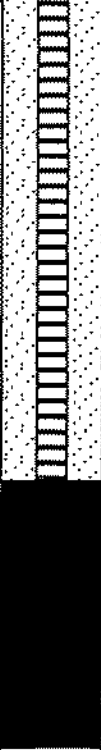
WATER LEVEL OBSERVATIONS			
WL	8	W.D.	
WL			
WL			



BORING STARTED	12-4-91
BORING COMPLETED	12-4-91
RIG 37	FOREMAN TSL
APPROVED TSL	JOB # 45905038

LOG OF BORING NO. RW-2

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
			35							
			40							
			45							
	50.0 943.4 SANDY LEAN CLAY WITH GRAVEL Gray		50		1	SS				
	52.0 941.4									
<p style="text-align: center;">BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.</p>										

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS				BORING STARTED 12-4-91	
WL	▽	8	W.D.	▽	BORING COMPLETED 12-4-91
WL					RIG 37 FOREMAN TSL
WL					APPROVED TSL JOB # 45905038



LOG OF BORING NO. RW-3

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER							
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT							
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES			TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: _____ N.S. ft GROUND SURFACE ELEV.: _____ 996.4 ft								
	LEAN CLAY Brown 3.0 _____ 993.4								
	REFUSE 								

Continued Next Page

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

BOREHOLE DIA.: 6.5 in
WELL DIA.: 4 in

WATER LEVEL OBSERVATIONS		
WL	7	W.D.
WL		
WL		



BORING STARTED		12-5-91	
BORING COMPLETED		12-5-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

LOG OF BORING NO. RW-3

OWNER RINEHART CONSTRUCTION		ARCHITECT/ENGINEER							
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA		PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT							
GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES			TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %
			35						
			40		1	SS			
			42		2	SS			
			44		3	SS			
			46		4	SS			
			48		5	SS			
	48.5 49.0 SANDY LEAN CLAY Gray								
	947.9 947.4 BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL.

WATER LEVEL OBSERVATIONS			BORING STARTED 12-5-91	
WL	7	W.D.	BORING COMPLETED 12-5-91	
WL			RIG 37	FOREMAN TSL
WL			APPROVED TSL	JOB # 45905038



LOG OF BORING NO. RW-4

OWNER RINEHART CONSTRUCTION	ARCHITECT/ENGINEER
SITE NORTH DALLAS SANITARY LANDFILL PERRY, IOWA	PROJECT HYDROGEOLOGICAL ASSESSMENT REPORT

GRAPHIC LOG	DESCRIPTION	WELL DETAIL	DEPTH (FT.)	SAMPLES				TESTS		
				USCS SYMBOL	NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	FIELD VAPOR TESTS
	TOP OF PROTECTOR PIPE: _____ ft TOP OF CASING: 1011.54 ft GROUND SURFACE ELEV.: 1004.5 ft									
	LEAN CLAY Brown 5.0 _____ 999.5									
	REFUSE 24.0 _____ 980.5									
	SANDY LEAN CLAY Gray to Brown 26.0 _____ 978.5 BOTTOM OF BORING NOTE: Soil classifications are based on observations made by the field crew.									

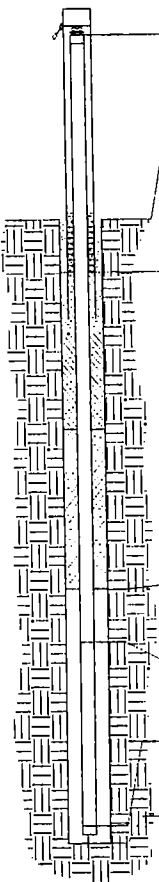
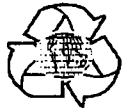
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. BOREHOLE DIA.: 6.5 in
WELL DIA.: 4 in

WATER LEVEL OBSERVATIONS		
WL	▽	DRY W.D. ▽
WL		
WL		



BORING STARTED		12-3-91	
BORING COMPLETED		12-3-91	
RIG	37	FOREMAN	TSL
APPROVED	TSL	JOB #	45905038

BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description	
		TOC	1006.37						
		Ground	1003.3						
		Concrete	1	CS	0 - 15 ft	HS		0 - 1.5 ft	Brown Sandy Lean Clay, trace of Gravel
		Bentonite Seal	8.5					1.5 - 2 ft	Fine Sand
								2 - 14 ft	Brown Sandy Lean Clay, trace of Gravel
				3" ST	15 - 17 ft		2 ft	14 - 16 ft	Brown to Gray Sandy Lean Clay trace of Gravel
				Sand Pack	9.2	CS	17 - 20 ft		
		Well Screen	19.2						
		Well Bottom	20						
	Bottom of Boring	20							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) CS-Continuous Sampler SS-Split Spoon HA-Hand Auger ST-Shelby Tube			Date:	8/26/97				Driller: Shirley Environmental	
			Time:	12:00				Logged By: Krumel	
			Water Level:	dry				Date/Time Start: 8/26/97 10:45	
			Elevation:					Date/Time End: 8/26/97 11:30	
 Barber Environmental Services, Inc. 1640 Cummins Road - Suite 211 Des Moines, Iowa 50316 Phone: 515-281-5214 Fax: 515-281-5210			Borehole Diameter:		8.25"		Project: BES Project No. E97011		
			Well Casing Diameter:		2"		Location: Perry, Iowa		
			Well Screen Size:		0.010"		Client: North Dallas SLF		
							Owner: North Dallas SLF		
							Boring/Well No: MW-4R1		

BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description	
		TOC	1000.23						
Ground		997.5							
				CS	0 - 25 ft	HS		0 - 3 ft	Dark Brown Sandy Lean Clay
Concrete		1					3 - 5 ft	Brown to Gray Sandy Lean Clay, trace of Gravel	
Bentonite Seal							5 - 17.5 ft	Brown to Gray Sandy Lean Clay, trace of Gravel (moist)	
		19							
Sand Pack		19.7					17.5 - 30 ft	Gray Sandy Lean Clay, trace of Gravel (wet @ 17.5 ft)	
Well Screen		29.7		ST	25 - 27 ft		2 ft		
Well Bottom		30		CS	27 - 30 ft				
Bottom of Boring		30							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) CS-Continuous Sampler SS-Split Spoon HA-Hand Auger ST-Shelby Tube			Date:	8/26/97				Driller: Shirley Environmental	
			Time:	13:40				Logged By: Krumel	
			Water Level:	27.2				Date/Time Start: 8/26/97 11:45	
			Elevation:	973.03				Date/Time End: 8/26/97 12:35	
Barker Environmental Services, Inc. 1603 Cummins Road - Suite 201 Des Moines, Iowa 50315 Phone: (515) 281-9514 Fax: (515) 288-0152			Borehole Diameter:		8.25"		Project: BES Project No. E97011		
			Well Casing Diameter:		2"		Location: Perry, Iowa		
			Well Screen Size:		0.010"		Client: North Dallas SLF		
							Owner: North Dallas SLF		
							Boring/Well No: MW-4R2		

LOG OF BORING NO. MW6A

OWNER Rienhart Construction		ARCHITECT/ENGINEER								
SITE Perry, Iowa		PROJECT North Dallas Sanitary Landfill								
GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES				TESTS		
				NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF	UNCONFINED STRENGTH PSF
	Approx. Surface Elev.: 999.8 ft.									
▲▲▲▲	Topsoil -- <u>sandy lean CLAY</u> , dark brown	3.0		1	HS	4'				
▨▨▨▨	<u>Sandy lean CLAY</u> , brown -- color changes to brown-gray at 5' -- trace gravel at 7' -- becomes stiff at 10' -- becomes very stiff at 15'	20.0		2	HS	5'				
				3	HS	4.5'				
				4	HS	5'				
	Bottom of Monitoring Well	979.8								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS			TEAM Services, Inc.	BORING STARTED 3-19-96	
WL	☒ Dry	WD		BORING COMPLETED 3-19-96	
WL	19' 2 hrs AD			RIG 12-ATV	FOREMAN J&R
WL				APPROVED RAK	JOB # E96016

TOP OF PROTECTIVE CASING
ELEVATION: 1003.93

TOP OF WELL CASING
ELEVATION: 1003.63

GROUND SURFACE
ELEVATION: 999.81

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION: 997.81

DEPTH: -2.0

BASE OF PROTECTIVE CASING
ELEVATION: 997.81

DEPTH: -2.0

BASE OF BACKFILL
TOP OF SEAL
ELEVATION: NA

DEPTH: NA

BASE OF SEAL
TOP OF FILTER PACK
ELEVATION: 991.81

DEPTH: -8.0

TOP OF SCREEN
ELEVATION: 990.41

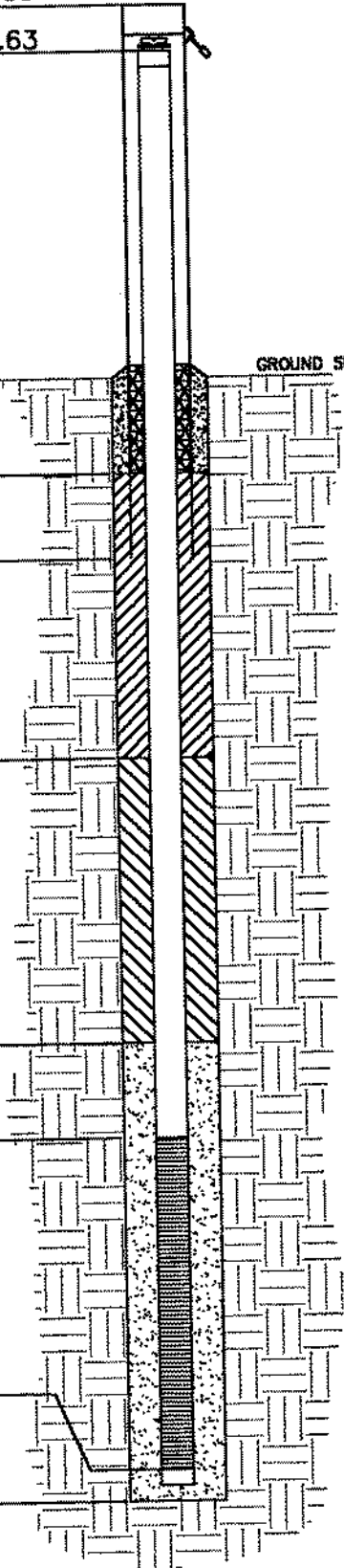
DEPTH: -9.4

BOTTOM OF SCREEN
ELEVATION: 980.41

DEPTH: -19.4

BASE OF FILTER PACK
ELEVATION: 980.41

DEPTH: -19.4



MW-6A Detail
North Dallas Sanitary Landfill
Perry, Iowa
BES Project No. E97011



Barker Environmental Services, Inc.
1800 Cummins Road - Suite 201
Des Moines, Iowa 50315
Phone: (515) 255-8814 Fax (515) 255-0182

**WELL
DETAIL**

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>North Dallas Sanitary Landfill</u>	Permit # <u>8-SDP-3-84P</u>
Well or Piezometer #	<u>MW-6A</u>	Date Started <u>3/19/96</u> Date Completed <u>3/19/96</u>

<p>A. Surveyed Locations and Elevations</p> <p>Locations (+/-0.5 ft.):</p> <p style="margin-left: 20px;">Specify corner of site <u>SE</u></p> <p style="margin-left: 20px;">Distance and Direction along boundary <u>1450-feet east, 1810-feet north</u></p> <p style="margin-left: 20px;">Distance and Direction from boundary to well <u>Well at NW corner of Boone County site</u></p> <p>Elevation(+/-0.01 ft. MSL):</p> <table style="margin-left: 20px;"> <tr><td>Ground surface</td><td style="text-align: right;"><u>999.81ft.</u></td></tr> <tr><td>Top of Protective Casing</td><td style="text-align: right;"><u>1003.93 ft.</u></td></tr> <tr><td>Top of Well Casing</td><td style="text-align: right;"><u>1003.63 ft.</u></td></tr> <tr><td>Benchmark Elevation</td><td style="text-align: right;"><u>997.69 ft.</u></td></tr> <tr><td>Benchmark Description</td><td style="text-align: right;"><u>TOC of MW-7AR</u></td></tr> </table> <hr style="width: 30%; margin-left: 20px;"/> <p>B. Soil Boring Information</p> <p>Name and Address of Construction Company <u>J&R Drilling</u> <u>7922 NW 114th Street</u> <u>Grime, Iowa 50111</u></p> <p>Name of Driller <u>Rick</u></p> <p>Drilling Method <u>HS auger</u></p> <p>Drilling Fluid <u>none</u></p> <p>Bore hole Diameter <u>7 & 3/4-inch</u></p> <p>Soil Sampling Method <u>continuous</u></p> <p>Depth of Boring <u>19.4 ft.</u></p> <p>C. Monitoring Well Installation</p> <p>Casing Material <u>PVC</u></p> <p>Length of Casing <u>12.4 ft.</u></p> <p>Outside Casing Diameter <u>2.2-inch</u></p> <p>Inside Casing Diameter <u>2-inch</u></p> <p>Casing Joint Type <u>threaded</u></p> <p>Casing/Screen joint type <u>threaded</u></p> <p>Screen material <u>PVC</u></p> <p>Screen opening size <u>0.010-inch</u></p> <p>Screen length <u>10 ft.</u></p> <p>Depth of Well <u>19.4 ft.</u></p>	Ground surface	<u>999.81ft.</u>	Top of Protective Casing	<u>1003.93 ft.</u>	Top of Well Casing	<u>1003.63 ft.</u>	Benchmark Elevation	<u>997.69 ft.</u>	Benchmark Description	<u>TOC of MW-7AR</u>	<p>Well Installation, continued:</p> <p>Filter pack:</p> <table style="margin-left: 20px;"> <tr><td>Material</td><td style="text-align: right;"><u>Muscatine gravel</u></td></tr> <tr><td>Grain Size</td><td style="text-align: right;"><u>#00</u></td></tr> <tr><td>Volume</td><td style="text-align: right;"><u>200 lbs.</u></td></tr> </table> <p>Seal (minimum 3 ft. length above filter pack):</p> <table style="margin-left: 20px;"> <tr><td>Material</td><td style="text-align: right;"><u>bentonite grout</u></td></tr> <tr><td>Placement Method</td><td style="text-align: right;"><u>poured</u></td></tr> <tr><td>Volume</td><td style="text-align: right;">_____</td></tr> </table> <p>Backfill (if different from seal):</p> <table style="margin-left: 20px;"> <tr><td>Material</td><td style="text-align: right;"><u>none</u></td></tr> <tr><td>Placement Method</td><td style="text-align: right;">_____</td></tr> <tr><td>Volume</td><td style="text-align: right;">_____</td></tr> </table> <p>Surface seal design:</p> <p>Material of Protective Casing: <u>4-inch steel protector w/ locking lid</u></p> <p>Material of grout between protective casing and well casing <u>concrete</u></p> <p>Protective cap material <u>steel</u></p> <p>Vented? (Y/N) <u>N</u> Locking? (Y/N) <u>Y</u></p> <p>Well cap material <u>expanding rubber cap</u></p> <p>Vented? (Y/N) <u>N</u></p> <p>D. Groundwater Measurement</p> <p>Water level (+/-0.01 ft. below top of inner well casing) <u>10.60</u></p> <p>Stabilization time <u>3 weeks</u></p> <p>Well development method <u>Waterra dedicated pump</u></p> <hr style="width: 30%; margin-left: 20px;"/> <p>Upgradient or downgradient well? (see piezometric map from Hydrogeological study) <u>upgradient-shallow</u></p> <p>Average Depth of Frostline <u>4-feet</u></p>	Material	<u>Muscatine gravel</u>	Grain Size	<u>#00</u>	Volume	<u>200 lbs.</u>	Material	<u>bentonite grout</u>	Placement Method	<u>poured</u>	Volume	_____	Material	<u>none</u>	Placement Method	_____	Volume	_____
Ground surface	<u>999.81ft.</u>																												
Top of Protective Casing	<u>1003.93 ft.</u>																												
Top of Well Casing	<u>1003.63 ft.</u>																												
Benchmark Elevation	<u>997.69 ft.</u>																												
Benchmark Description	<u>TOC of MW-7AR</u>																												
Material	<u>Muscatine gravel</u>																												
Grain Size	<u>#00</u>																												
Volume	<u>200 lbs.</u>																												
Material	<u>bentonite grout</u>																												
Placement Method	<u>poured</u>																												
Volume	_____																												
Material	<u>none</u>																												
Placement Method	_____																												
Volume	_____																												

LOG OF BORING NO. MW6B

OWNER Rienhart Construction		ARCHITECT/ENGINEER							
SITE Perry, Iowa		PROJECT North Dallas Sanitary Landfill							
GRAPHIC LOG	DESCRIPTION	DEPTH (FT.)	USCS SYMBOL	SAMPLES				TESTS	
				NUMBER	TYPE	RECOVERY	SPT - N BLOWS / FT.	MOISTURE, %	DRY DENSITY PCF
	-- sand seam at 32'	35		3	HS	4.5'			
		40		4	HS	4.5'			
		45		5	HS	4.5'			
	44.0	955.8							
	45.0	954.8							
	Bottom of Monitoring Well								

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL AND ROCK TYPES: IN-SITU, THE TRANSITION MAY BE GRADUAL. Calibrated Hand Penetrometer*

WATER LEVEL OBSERVATIONS				TEAM Services, Inc.	BORING STARTED		3-19-96		
WL	▼	Dry	WD		▼	BORING COMPLETED		3-19-96	
WL		Dry 2 hrs AD				RIG	12-ATV	FOREMAN	J&R
WL						APPROVED	RAK	JOB #	E96016

TOP OF PROTECTIVE CASING
ELEVATION: 1003.46

TOP OF WELL CASING
ELEVATION: 1003.16

GROUND SURFACE
ELEVATION: 999.83

GROUND SURFACE

TOP OF BACKFILL
BASE OF CONCRETE PLUG
AND BENTONITE GROUT
ELEVATION: 997.83
DEPTH: -2.0

BASE OF PROTECTIVE CASING
ELEVATION: 997.83
DEPTH: -2.0

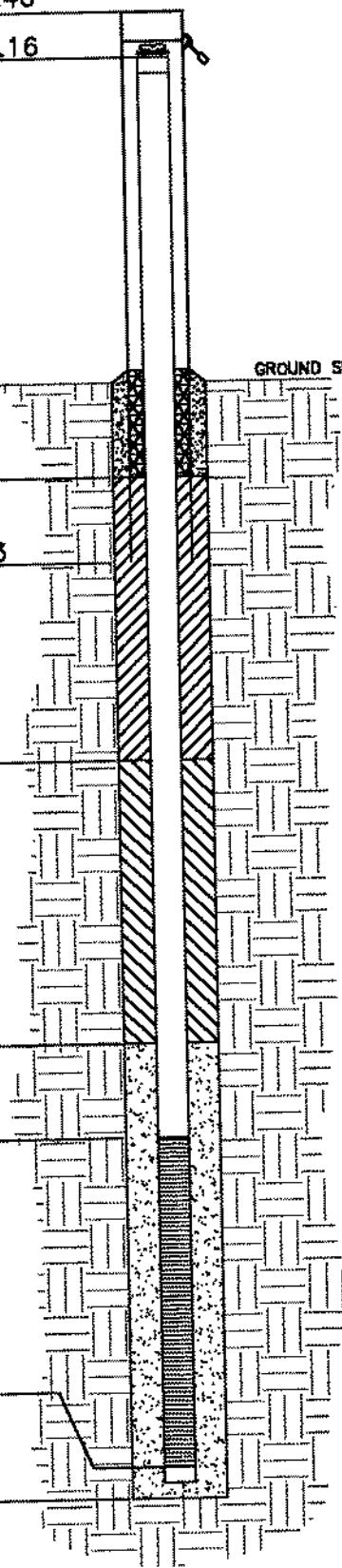
BASE OF BACKFILL
TOP OF SEAL
ELEVATION: NA
DEPTH: NA

BASE OF SEAL
TOP OF FILTER PACK
ELEVATION: 966.83
DEPTH: -33.0

TOP OF SCREEN
ELEVATION: 965.83
DEPTH: -34.0

BOTTOM OF SCREEN
ELEVATION: 955.83
DEPTH: -44.0

BASE OF FILTER PACK
ELEVATION: 955.83
DEPTH: -44.0



MW-6B Detail
North Dallas Sanitary Landfill
Perry, Iowa
BES Project No. E97011



Barker Environmental Services, Inc.

1300 Cummins Road - Suite 201
Des Moines, Iowa 50316
Phone: (515) 255-6814 Fax: (515) 255-0182

**WELL
DETAIL**

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

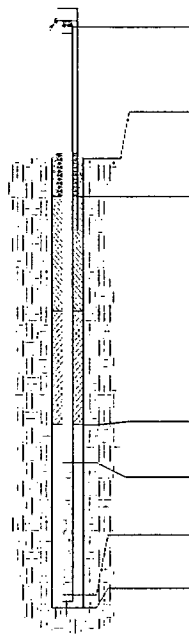

Disposal Site Name	<u>North Dallas Sanitary Landfill</u>	Permit # <u>8-SDP-3-84P</u>
Well or Piezometer #	<u>MW-6B</u>	Date Started <u>3/19/96</u> Date Completed <u>3/19/96</u>

<p>A. Surveyed Locations and Elevations</p> <p>Locations (+/-0.5 ft.):</p> <p style="margin-left: 20px;">Specify corner of site <u>SE</u></p> <p style="margin-left: 20px;">Distance and Direction along boundary <u>1450-feet east, 1803-feet north</u></p> <p style="margin-left: 20px;">Distance and Direction from boundary to well <u>Well at NW corner of Boone County site</u></p> <p>Elevation(+/-0.01 ft. MSL):</p> <table style="margin-left: 20px;"> <tr><td>Ground surface</td><td><u>999.81 ft.</u></td></tr> <tr><td>Top of Protective Casing</td><td><u>1003.46 ft.</u></td></tr> <tr><td>Top of Well Casing</td><td><u>1003.16 ft.</u></td></tr> <tr><td>Benchmark Elevation</td><td><u>997.69 ft.</u></td></tr> <tr><td>Benchmark Description</td><td><u>TOC of MW-7AR</u></td></tr> </table> <hr/> <p>B. Soil Boring Information</p> <p>Name and Address of Construction Company <u>J&R Drilling</u> <u>7922 NW 114th Street</u> <u>Grime, Iowa 50111</u></p> <table style="margin-left: 20px;"> <tr><td>Name of Driller</td><td><u>Rick</u></td></tr> <tr><td>Drilling Method</td><td><u>HS auger</u></td></tr> <tr><td>Drilling Fluid</td><td><u>none</u></td></tr> <tr><td>Bore hole Diameter</td><td><u>7 & 3/4-inch</u></td></tr> <tr><td>Soil Sampling Method</td><td><u>continuous</u></td></tr> <tr><td>Depth of Boring</td><td><u>44 ft.</u></td></tr> </table> <p>C. Monitoring Well Installation</p> <table style="margin-left: 20px;"> <tr><td>Casing Material</td><td><u>PVC</u></td></tr> <tr><td>Length of Casing</td><td><u>37 ft.</u></td></tr> <tr><td>Outside Casing Diameter</td><td><u>2.2-inch</u></td></tr> <tr><td>Inside Casing Diameter</td><td><u>2-inch</u></td></tr> <tr><td>Casing Joint Type</td><td><u>threaded</u></td></tr> <tr><td>Casing/Screen joint type</td><td><u>threaded</u></td></tr> <tr><td>Screen material</td><td><u>PVC</u></td></tr> <tr><td>Screen opening size</td><td><u>0.010-inch</u></td></tr> <tr><td>Screen length</td><td><u>10 ft.</u></td></tr> <tr><td>Depth of Well</td><td><u>44 ft.</u></td></tr> </table>	Ground surface	<u>999.81 ft.</u>	Top of Protective Casing	<u>1003.46 ft.</u>	Top of Well Casing	<u>1003.16 ft.</u>	Benchmark Elevation	<u>997.69 ft.</u>	Benchmark Description	<u>TOC of MW-7AR</u>	Name of Driller	<u>Rick</u>	Drilling Method	<u>HS auger</u>	Drilling Fluid	<u>none</u>	Bore hole Diameter	<u>7 & 3/4-inch</u>	Soil Sampling Method	<u>continuous</u>	Depth of Boring	<u>44 ft.</u>	Casing Material	<u>PVC</u>	Length of Casing	<u>37 ft.</u>	Outside Casing Diameter	<u>2.2-inch</u>	Inside Casing Diameter	<u>2-inch</u>	Casing Joint Type	<u>threaded</u>	Casing/Screen joint type	<u>threaded</u>	Screen material	<u>PVC</u>	Screen opening size	<u>0.010-inch</u>	Screen length	<u>10 ft.</u>	Depth of Well	<u>44 ft.</u>	<p>Well Installation, continued:</p> <p>Filter pack:</p> <table style="margin-left: 20px;"> <tr><td>Material</td><td><u>Muscatine gravel</u></td></tr> <tr><td>Grain Size</td><td><u>#00</u></td></tr> <tr><td>Volume</td><td><u>200 lbs.</u></td></tr> </table> <p>Seal (minimum 3 ft. length above filter pack):</p> <table style="margin-left: 20px;"> <tr><td>Material</td><td><u>bentonite grout</u></td></tr> <tr><td>Placement Method</td><td><u>poured</u></td></tr> <tr><td>Volume</td><td>_____</td></tr> </table> <p>Backfill (if different from seal):</p> <table style="margin-left: 20px;"> <tr><td>Material</td><td><u>none</u></td></tr> <tr><td>Placement Method</td><td>_____</td></tr> <tr><td>Volume</td><td>_____</td></tr> </table> <p>Surface seal design:</p> <p>Material of Protective Casing: <u>4-inch steel protector w/ locking lid</u></p> <p>Material of grout between protective casing and well casing <u>concrete</u></p> <p>Protective cap material <u>steel</u></p> <p>Vented? (Y/N) <u>N</u> Locking? (Y/N) <u>Y</u></p> <p>Well cap material <u>expanding rubber cap</u></p> <p>Vented? (Y/N) <u>N</u></p> <p>D. Groundwater Measurement</p> <p>Water level (+/-0.01 ft. below top of inner well casing) <u>10.60</u></p> <p>Stabilization time <u>3 weeks</u></p> <p>Well development method <u>Waterra dedicated pump</u></p> <hr/> <p>Upgradient or downgradient well? (see piezometric map from Hydrogeological study) <u>upgradient-shallow</u></p> <p>Average Depth of Frostline <u>4-feet</u></p>	Material	<u>Muscatine gravel</u>	Grain Size	<u>#00</u>	Volume	<u>200 lbs.</u>	Material	<u>bentonite grout</u>	Placement Method	<u>poured</u>	Volume	_____	Material	<u>none</u>	Placement Method	_____	Volume	_____
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BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail							
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description		
		Depth								
	TOC	986.86								
	Ground	983.9								
	Concrete	3	CS	0 - 30 ft	HS		0 - 3 ft	Brown Sandy Lean Clay trace of Gravel		
	Bentonite Seal	23.5					3 - 19 ft	Dark Gary Sandy Lean Clay trace of Gravel		
							19.0 - 19.1 ft	Sand/Gravel Seam (wet)		
							19.1 - 35 ft	Dark Gray Sandy Lean Clay trace of Gravel		
	Sand Pack	24.8								
	Well Screen	34.8	ST	30 - 32 ft		1.5 ft				
	Well Bottom	35	CS	32 - 35 ft						
	Bottom of Boring	35								
	AR-Air Rotary		HS-Hollow Stem Auger		Date:	8/14/97			Driller:	Shirley Environmental
	AS-Auger Sample		PA-Power Auger (solid stem)		Time:	9:40			Logged By:	Krumel
	CS-Continuous Sampler		SS-Split Spoon		Water Level:	33			Date/Time Start:	8/14/97 9:30
	HA-Hand Auger		ST-Shelby Tube		Elevation:	953.86			Date/Time End:	8/14/97 11:30
<p>Barker Environmental Services, Inc. 1800 Cummins Road - Suite 201 Des Moines, Iowa 50315 Phone: (515) 253-9214 Fax: (515) 253-9122</p>			Borehole Diameter:		8.25"		Project:		BES Project No. E97011	
			Well Casing Diameter:		2"		Location:		Perry, Iowa	
			Well Screen Size:		0.010"		Client:		North Dallas SLF	
							Owner:		North Dallas SLF	
							Boring/Well No:		MW-8	

BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail		Boring Log Detail							
	Material	Elevation	Sample Method	Sample Interval	Drilling Method	Recovery (inches)	Strata Depth (ft)	Description	
	TOC	Depth							
	TOC	987.14			AS		0-5'	Light Brown Clay, Sand and Grit	
			1.9			AS		5'-10'	Light Brown Clay and Dry
						AS		10'-15'	Light Brown Clay and Moist
	Ground		985.22			AS		15'-20'	Brown and Gray Clay
			0.0						
	Bentonite Seal		984.22						
			1.0						
	Sand Pack		978.80						
			6.4						
	Well Screen		969.20						
			15.0						
	Well Bottom		964.20						
			20.00						
Bottom of Boring		963.80							
		20.40							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon MR-Mud Rotary WB-Wash Boring		Date: 10/10/2007 Time: 3:45 PM Water Level: 12.00 Elevation: 975.14					Driller: Kevin Sperflage Logged By: Mike Dixon Date/Time Start: 12:10 PM Date/Time End: 3:30 PM		
		Borehole Diameter: 7.25 inch Well Casing Diameter: 2 inch Well Screen Size: 0.010 inch LUST/SLF Permit No.: 08-SDP-03-84P Project No.: NDALS 07005					Project: North Dallas Sanitary Landfill Location: Boone, IA Client: North Dallas Landfill, Inc. Owner: North Dallas Landfill, Inc. Boring/Well No: MW-8R		

SWL measured from TOC

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>North Dallas Sanitary Landfill</u>	Permit #	<u>08-SDP-03-84P</u>
Well or Piezometer #	<u>MW-8R</u>	Date Started	<u>10/10/2007</u>
Project No.	<u>NDALS 07005</u>	Date Completed	<u>10/10/2007</u>

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 821.0319</u> <u>E 1405.146</u>
Distance and Direction from boundry to well	<u>600' N and 601' E</u> <u>of SW property corner</u>

Elevation(+/-0.01 ft. MSL):

Ground surface	<u>985.22</u>
Top of Protective Casing	<u>987.45</u>
Top of Well Casing	<u>987.14</u>
Benchmark Elevation	<u>NA</u>
Benchmark Description	<u>NA</u>

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>3.84 ft³</u>

Seal (minimum of 3 ft. length above filter pack)

Material	<u>Bentonite chips ¹</u>
Placement Method	<u>backfilled</u>
Volume	<u>1.39 ft³</u>

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants (BLEC)
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller Kevin Sperfslage
Drilling Method Hollow Stem
Drilling Fluid None
Bore hole Diameter 7.25 inches
Soil Sampling Method NA
Depth of Boring * 20.4

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

Surface seal design:

Material of Protective Casing:
Metal

Material of grout between protective casing and well casing
Concrete

Protective cap material
Metal

Vented? (Y/N) N Locking? (Y/N) Y

Well cap material
PVC

Vented? (Y/N) N

C. Monitoring Well Installation

Casing Material PVC
Length of Casing 21.9
Outside Casing Diameter 2.375 inch
Inside Casing Diameter 2.0 inch
Casing Joint Type threaded
Casing/Screen joint type threaded
Screen material PVC
Screen opening size 0.010 inch
Screen length 5'
Depth of Well ** 22.94

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner well casing) 975.14

Stabilization time < 24 hours

Well development method
NA

Upgradient or downgradient well?
Downgradient

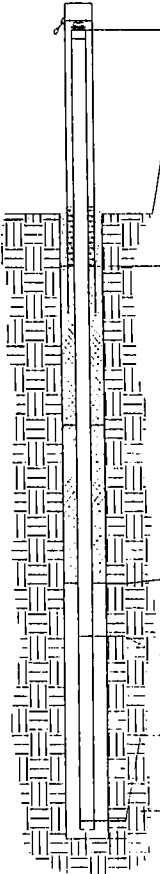
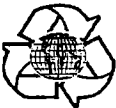
Average Depth of Frostline
3-feet

* Depth of boring measured from ground surface.

** Depth of well measured from Top of Casing (TOC).

¹ Chips instead of grout used.

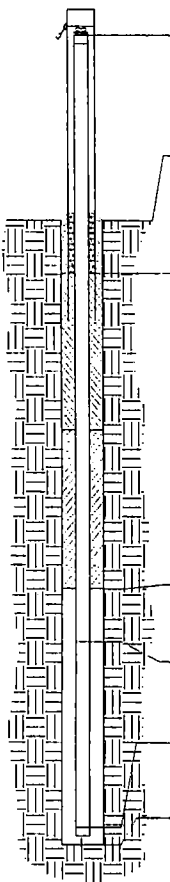
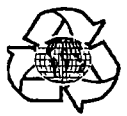
BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail								
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description			
		Depth									
	TOC	982.77									
	Ground	980.0									
	Concrete	3	CS	0 - 10 ft	HS		0 - 4 ft	Brown to Gray Clay trace of Gravel			
	Bentonite Seal	4.5					4 - 15 ft	Brown to Gray Sandy Lean Clay trace of Gravel			
	Sand Pack	4.8									
	Well Screen	14.8	ST	10 - 12 ft		2 ft					
	Well Bottom	15	CS	12 - 15 ft							
	Bottom of Boring	15									
	AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) CS-Continuous Sampler SS-Split Spoon HA-Hand Auger ST-Shelby Tube			Date:	8/14/97				Driller: Shirley Environmental		
				Time:	14:45				Logged By: Krumel		
				Water Level:	dry				Date/Time Start: 8/14/97 13:15		
				Elevation:					Date/Time End: 8/14/97 14:40		
	 Barber Environmental Services, Inc. 1404 Commerce Road - Suite 201 Des Moines, Iowa 50315 Phone: (515) 271-9514 Fax: (515) 272-0152			Borehole Diameter:		8.25"		Project: BES Project No. E97011			
				Well Casing Diameter:		2"		Location: Perry, Iowa		Client: North Dallas SLF	
				Well Screen Size:		0.010"		Owner: North Dallas SLF		Boring/Well No: MW-9A	

BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail					
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description
		Depth						
	TOC	950.07						
	Ground	947.2						
	Concrete	3	CS	0 - 30 ft	HS		0 - 6 ft	Brown Sandy Lean Clay trace of Gravel
	Bentonite Seal	22					6 - 6.5 ft	Gray Fine Sand
							6.5 - 21 ft	Brown Sandy Lean Clay trace of Gravel
							21 - 27 ft	Brown to Gray Sandy Lean Clay trace of Gravel
	Sand Pack	22.9					27 - 31.5 ft	Dark Gray Sandy Lean Clay trace of Gravel
	Well Screen	32.9	ST	30 - 32 ft		2 ft	31.5 - 33 ft	Black Weathered Shale
	Well Bottom	33	CS	32 - 33 ft				
	Bottom of Boring	33						
AR-Air Rotary HS-Hollow Stem Auger		Date:	8/14/97				Driller: Shirley Environmental	
AS-Auger Sample PA-Power Auger (solid stem)		Time:	16:20				Logged By: Krumel	
CS-Continuous Sampler SS-Split Spoon		Water Level:	dry				Date/Time Start: 8/14/97 15:00	
HA-Hand Auger ST-Shelby Tube		Elevation:					Date/Time End: 8/14/97 16:20	
<p>Barber Environmental Services, Inc. 1300 Cummins Road - Suite 204 Des Moines, Iowa 50316 Phone: (515) 261-3414 Fax: (515) 268-0162</p>		Borehole Diameter:		8.25"		Project: BES Project No. E97011		
		Well Casing Diameter:		2"		Location: Perry, Iowa		
		Well Screen Size:		0.010"		Client: North Dallas SLF		
						Owner: North Dallas SLF		
						Boring/Well No: MW-9B		

BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail								
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description			
		TOC	1007.73								
		Ground	1004.9								
		Concrete	1	CS	0 - 25 ft	HS		0 - 4 ft	Brown Clay trace of Gravel		
		Bentonite Seal	19					4 - 18 ft	Brown Sandy Lean Clay trace of Gravel		
		Sand Pack	20.3					18 - 32 ft	Gray Sandy Lean Clay trace of Gravel		
		Well Screen	30.3	ST	25 - 27 ft		2 ft				
		Well Bottom	32	CS	27 - 32 ft						
		Bottom of Boring	32								
	AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) CS-Continuous Sampler SS-Split Spoon HA-Hand Auger ST-Shelby Tube			Date:	8/26/97				Driller:	Shirley Environmental	
			Time:	15:20				Logged By:	Krumel		
			Water Level:	dry				Date/Time Start:	8/26/97 13:45		
			Elevation:					Date/Time End:	8/26/97 14:35		
 Barker Environmental Services, Inc. 1900 Cummins Road - Suite 201 Des Moines, Iowa 50315 Phone: (515) 258-8814 Fax: (515) 258-0150			Borehole Diameter:		8.25"		Project:			BES Project No. E97011	
			Well Casing Diameter:		2"		Location:		Perry, Iowa		
			Well Screen Size:		0.010"		Client:		North Dallas SLF		
							Owner:		North Dallas SLF		
							Boring/Well No:		MW-11		

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

Boring / Well Number: MW-12		Facility Name: Metro Park West Landfill		Facility Street Address: Perry, Iowa		
Boring Depth (ft) X Diameter (in): 21'x12.25"				Drilling Method: HS		
Well Contractor Name: Joe Green Registration Number: #2721				Logged By: Kris Sommer		
Ground Surface Elevation (ASL): 989.76			Top of Casing Elevation (ASL): 993.21			
Date: 8/25/10 Start Time: 10:00 AM		Date: 8/25/10 End Time: 11:25		UST Number	LUST Number	
Depth Feet	Well Construction Details	Blow Count if applicable	Sample		PID/FID Reading	Rock Formations, Soil Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
			No.	Type*		
-2.5	<p>TOPC- 993.47 TOC- 993.21</p>					
0	989.76					
	988.76		0-0.5			Grass Cover
	988.76		0.5-2			Brown/Light Brown Clay Silt Sand. Damp.
-2.5	986.76		2-6.5			Dark Brown Clay Silty Sand, Damp
	985.16		6.5-8			Brown Grey Mix Clay Silt Trace Sand and Pebbles, Damp to Moist
-5	982.26		8-12.5			Brown Clay Silt with Trace Sand and Pebbles. Moist.
	981.26		12.5-19			Brown Grey Mix Clay Trace Silt and Sand with Trace Pebbles. Moist.
-7.5	979.76		19-21			Grey Clay Trace Silt, Sand and Pebbles. Moist.
	979.76					
-10						
-12.5						
-15						
-17.5						
-20	969.76					
	968.76					
-22.5						<i>Bottom of Boring at 21 feet</i>
-25						

* SS (split spoon) HS (hollow stem auger) HA (hand auger)

Observations	Date:	8/25/10	8/26/10			
Water Levels (ASL)	Level:	985.16	970.75			
Static Water Level Symbol	Time:	12:21 PM	10:15 AM			

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit # <u>08-SDP-03-84P</u>
Well or Piezometer #	<u>MW-12</u>	Date Started <u>8/25/2010</u>
Project No.	<u>METRO 10111</u>	Date Completed <u>8/25/2010</u>

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 680828.466</u>
	<u>E 1459508.686</u>
Distance and Direction from boundry to well	_____

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>9.84 ft³</u>

Seal (minimum of 3 ft. length above filter pack)

Elevation(+/-0.01 ft. MSL):	Material
Ground surface	<u>Bentonite grout</u>
Top of Protective Casing	Placement Method
Top of Well Casing	<u>treme grouted</u>
Benchmark Elevation	Volume
Benchmark Description	<u>0.79 ft³</u>

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants (BLEC)
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller Joe Green
 Drilling Method Hollow Stem
 Drilling Fluid None
 Bore hole Diameter 12.25 inches
 Soil Sampling Method Continuous Sampler
 Depth of Boring * 21.0'

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

Surface seal design:

Material of Protective Casing:
Metal

Material of grout between protective casing and well casing
Concrete

Protective cap material
Metal

Vented? (Y/N) Y Locking? (Y/N) Y

Well cap material
J Plug

Vented? (Y/N) N

C. Monitoring Well Installation

Casing Material PVC
 Length of Casing 13.5'
 Outside Casing Diameter 4.5 inch
 Inside Casing Diameter 4.0 inch
 Casing Joint Type threaded
 Casing/Screen joint type threaded
 Screen material PVC
 Screen opening size 0.010 inch
 Screen length 10.0'
 Depth of Well ** 23.45'

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner well casing) 22.46

Stabilization time > 24 hours

Well development method
Surge Block

Upgradient or downgradient well?
NA

Average Depth of Frostline
3-feet

* Depth of boring measured from ground surface.
 ** Depth of well measured from Top of Casing (TOC).

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

Boring / Well Number: MW-13		Facility Name: Metro Park West Landfill		Facility: Perry, Iowa		
Boring Depth (ft) X Diameter (in): 21'x12.25"				Drilling Method: HS		
Well Contractor Name: Joe Green				Registered By: Kris Sommer		
Registration Number: #2721						
Ground Surface Elevation (ASL): 987.29			Top of Casing Elevation (ASL): 990.22			
Date: 8/25/10		Date: 8/25/10		UST Number	LUST Number	
Start Time: 2:00		End Time: 3:21				
Depth Feet	Well Construction Details	Blow Count if applicable	Sample		PID/FID Reading	Rock Formations, Soil Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
			No.	Type*		
-2.5	OPC- 990.36 TOC- 990.22					
0	987.29		0-4			Brown Clay Silt Sand with Trace Pebbles. Dry to slightly Damp.
2.5	984.29		4-6			Brown Light Brown Clay Silt with Trace Sand and Pebbles. Damp.
	983.13		6-9			Grey Silt Sand. Saturated.
5			9-10			Brown Grey Mix Clay Silt Sand with Trace Pebbles. Moist.
7.5	979.79		10-14			Grey Clay Silt Sand. Moist.
	978.79		14-15			Grey Sand with Trace Pebbles Silt and Clay. Saturated.
10	977.29		15-21			Grey Clay, Sand with Trace Pebbles. Moist.
12.5						
15						
17.5						
20	967.29					
	966.29					
22.5	Bottom of Boring					Bottom of Boring at 21 feet
25						

* SS (split spoon) HS (hollow stem auger) HA (hand auger)

Observations	Date:	8/25/10	8/26/10			
Water Levels (ASL)	Level:	983.13	968.51			
Static Water Level Symbol	Time:	3:40	10:00			

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name Metro Park West Landfill Permit # 08-SDP-03-84P
 Well or Piezometer # MW-13 Date Started 8/25/2010 Date Completed 8/25/2010
 Project No. METRO 10111

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location N 680496.308
 of Well E 1459503.206

Distance and Direction _____
 from boundry to well _____

Elevation(+/-0.01 ft. MSL):

Ground surface 987.29
 Top of Protective Casing 990.36
 Top of Well Casing 990.22
 Benchmark Elevation NA
 Benchmark Description NA

Well Installation, continued:

Filter pack:

Material Silica Sand
 Grain Size _____
 Volume 9.84 ft³

Seal (minimum of 3 ft. length above filter pack)

Material Bentonite grout
 Placement Method treme grouted
 Volume 0.79 ft³

Backfill (if different from seal):

Material NA
 Placement Method NA
 Volume NA

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants (BLEC)
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller Joe Green
 Drilling Method Hollow Stem
 Drilling Fluid None
 Bore hole Diameter 12.25 inches
 Soil Sampling Method Continuous Sampler
 Depth of Boring * 21.0'

Surface seal design:

Material of Protective Casing:
Metal
 Material of grout between protective casing
 and well casing
Concrete
 Protective cap material.
Metal
 Vented? (Y/N) Y Locking? (Y/N) Y
 Well cap material
J Plug
 Vented? (Y/N) N

C. Monitoring Well Installation

Casing Material PVC
 Length of Casing 12.9'
 Outside Casing Diameter 4.5 inch
 Inside Casing Diameter 4.0 inch
 Casing Joint Type threaded
 Casing/Screen joint type threaded
 Screen material PVC
 Screen opening size 0.010 inch
 Screen length 10.0'
 Depth of Well ** 22.92'

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner
 well casing) 21.71
 Stabilization time > 24 hours
 Well development method
Surge Block

Upgradient or downgradient well?
NA
 Average Depth of Frostline
3-feet

* Depth of boring measured from ground surface.

** Depth of well measured from Top of Casing (TOC).

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

Boring / Well Number: MW-14	Facility Name: Metro Park West Landfill	Facility Street Address: Perry, IA
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Boring Depth (ft) X Diameter (in): 26.0 x 8.25	Drilling Method: HS
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Well Contractor Name: Mike Dixon Registration Number: 8438	Logged By: Mike Dixon
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Ground Surface Elevation (ASL): 967.68	Top of Casing Elevation (ASL): 970.30
---	--

Date: 10/18/2011	Date: 10/18/2011	UST Number: NA	LUST Number: NA
Start Time: 11:30 am	End Time: 1:00 pm		

Depth Feet	Well Construction Details	Blow Count if applicable	Sample		PID/FID Reading	Rock Formations, Soil Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
			No.	Type*		
0	POPC - 970.79 TOC - 970.30 Protective casing in concrete seal		0-1			Bare ground.
3.5	Bentonite seal		1-5			Brown, silty clay with traces of rock.
7			5-10			Dark brown, silty clay, very moist at 8-10'.
10.5	Sand pack Well screen in sand pack		10-14			Soft and moist, dark brown, silty clay (moist and soft).
14			14-15 15-20			Gray, silty clay with brown and black colored mottling, traces of rock (moist and soft).
21			20-26			Gray, silty clay with brown and black colored mottling, traces of rock (moist and soft). Moisture at 18'.
24.5						Gray and brown, silty, sandy clay with rust brown colored mottling.
28						Bottom of Boring at 26 feet
31.5						
35						
38.5						

* SS (split spoon) HS (hollow stem auger) HA (hand auger)

Observations	Date:	10/31/11			
Water Levels (ASL)	Level:	955.41			
Static Water Level Symbol	Time:	12:46 pm			

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit # 08-SDP-03-84P
Well or Piezometer #	<u>MW-14</u>	Date Started <u>10/18/2011</u> Date Completed <u>10/18/2011</u>
Project No.	<u>METRO 11108</u>	

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 679,760.76</u>	<u>E 1,459,625.55</u>
Distance and Direction from boundry to well	_____	

Elevation(+/-0.01 ft. MSL):

Ground surface	<u>967.68</u>
Top of Protective Casing	<u>970.79</u>
Top of Well Casing	<u>970.30</u>
Benchmark Elevation	<u>NA</u>
Benchmark Description	<u>NA</u>

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>4.56 ft³</u>

Seal (minimum of 3 ft. length above filter pack)

Material	<u>Bentonite grout</u>
Placement Method	<u>treme grouted</u>
Volume	<u>1.43 ft³</u>

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants (BLEC)
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller	<u>Mike Dixon</u>
Drilling Method	<u>Hollow Stem</u>
Drilling Fluid	<u>None</u>
Bore hole Diameter	<u>8.25 inches</u>
Soil Sampling Method	<u>Continuous Sampler</u>
Depth of Boring *	<u>26.0'</u>

Surface seal design:

Material of Protective Casing:	<u>Metal</u>
Material of grout between protective casing and well casing	
Protective cap material	<u>Concrete</u>
Protective cap material	<u>Metal</u>
Vented? (Y/N) <u>Y</u>	Locking? (Y/N) <u>Y</u>
Well cap material	<u>J Plug</u>
Vented? (Y/N) <u>Y</u>	

C. Monitoring Well Installation

Casing Material	<u>PVC</u>
Length of Casing	<u>13.00'</u>
Outside Casing Diameter	<u>4.5 inch</u>
Inside Casing Diameter	<u>4.0 inch</u>
Casing Joint Type	<u>threaded</u>
Casing/Screen joint type	<u>threaded</u>
Screen material	<u>PVC</u>
Screen opening size	<u>0.010 inch</u>
Screen length	<u>14.93'</u>
Depth of Well **	<u>27.93'</u>

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner well casing)	<u>14.89</u>
Stabilization time	<u>13 days</u>
Well development method	<u>Purge</u>

Upgradient or downgradient well?

Downgradient
Average Depth of Frostline
3-feet

* Depth of boring measured from ground surface.
** Depth of well measured from Top of Casing (TOC).

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

Boring / Well Number: MW-15		Facility Name: Metro Park West Landfill	Facility: Perry, IA Street Address:			
Boring Depth (ft) X Diameter (in): 21.0 x 8.25			Drilling Method: HS			
Well Contractor Name: Mike Dixon Registration Number: 8438			Logged By: Mike Dixon			
Ground Surface Elevation (ASL): 979.99		Top of Casing Elevation (ASL): 982.61				
Date: 10/18/2011 Start Time: 8:45 am	Date: 10/18/2011 End Time: 10:45 am	UST Number: NA	LUST Number: NA			
Depth Feet	Well Construction Details	Blow Count if applicable	Sample		PID/FID Reading	Rock Formations, Soil Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
			No.	Type*		
0	OPC - 983.13 TOC - 982.61 Protective casing in concrete seal		0.0-0.5			Bare ground.
3.5	Bentonite seal		0.5-3			Brown, silty clay with traces of rock.
7			3-5			Gray, silty clay with traces of rock.
10.5	Sand pack Well screen in sand pack		5-8			Gray, silty clay with traces of rock.
14			8-10			Brown, silty clay with gray mottling and traces of sand. Slightly moist at 8-10'.
17.5			10-15			Gray, silty clay with traces of sand and rock (hard).
21			15-21			Gray, silty clay with traces of sand and rock (soft and moist).
24.5						<i>Bottom of Boring at 21 feet</i>
28						
31.5						
35						
38.5						

* SS (split spoon) HS (hollow stem auger) HA (hand auger)

Observations	Date:	11/8/11			
Water Levels (ASL)	Level:	961.29			
Static Water Level Symbol	Time:	NA			

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit # <u>08-SDP-03-84P</u>
Well or Piezometer #	<u>MW-15</u>	Date Started <u>10/18/2011</u> Date Completed <u>10/18/2011</u>
Project No.	<u>METRO 11108</u>	

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 680,106.24</u>	<u>E 1,460,169.04</u>
Distance and Direction from boundry to well	_____	

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>3.26 ft³</u>

Seal (minimum of 3 ft. length above filter pack)

Elevation(+/-0.01 ft. MSL):	Material
Ground surface	<u>Bentonite grout</u>
Top of Protective Casing	Placement Method
Top of Well Casing	<u>treme grouted</u>
Benchmark Elevation	Volume
Benchmark Description	<u>1.43 ft³</u>

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants (BLEC)
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller: Mike Dixon
 Drilling Method: Hollow Stem
 Drilling Fluid: None
 Bore hole Diameter: 8.25 inches
 Soil Sampling Method: Continuous Sampler
 Depth of Boring *: 21.0'

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

Surface seal design:

Material of Protective Casing:
Metal

Material of grout between protective casing and well casing
Concrete

Protective cap material
Metal

Vented? (Y/N) Y Locking? (Y/N) Y

Well cap material
J Plug

Vented? (Y/N) Y

C. Monitoring Well Installation

Casing Material: PVC
 Length of Casing: 13.50'
 Outside Casing Diameter: 4.5 inch
 Inside Casing Diameter: 4.0 inch
 Casing Joint Type: threaded
 Casing/Screen joint type: threaded
 Screen material: PVC
 Screen opening size: 0.010 inch
 Screen length: 9.20'
 Depth of Well **: 22.70'

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner well casing) 18.70

Stabilization time 21 days

Well development method
Purge

Upgradient or downgradient well?
Downgradient

Average Depth of Frostline
3-feet

* Depth of boring measured from ground surface.

** Depth of well measured from Top of Casing (TOC).

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.05	DP	1 ft	HS	Full	0-2	Brown sandy clay, trace gravel	
			975.08						
	Ground	0.0						2-3	Brown/gray sandy clay mix
			973.0					3-4	Gray sandy clay, trace brown clay
	Bentonite Seal	-2.0						4-10	Gray silty clay
			971.0					10-15	Gray silty clay, trace gravel
								15-28	Gray sandy clay
								28-30.5	Gray sandy clay, trace gravel
	Sand Pack	-12.3							
	Well Screen	960.8							
			-15.3						
	Well Bottom	957.8							
			-30.3						
	Bottom of Boring	942.8							
			-30.5						
		942.5							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon DP-Direct Push HA-Hand Auger WB-Wash Boring		Date: 4/21/2015 Time: 11:40 AM Water Level: 10.00 Elevation: 965.08						Driller: Saberprobe, LLC Logged By: Austin Banks Date/Time Start: - Date/Time End: -	
		Borehole Diameter: 8 inches Well Casing Diameter: 2 inch Well Screen Size: 0.010 inch LUST/SLF Permit No.: 08-SDP-03-84P Project No.: METRO 15104						Project: Metro Park West Landfill Location: Perry, Iowa Client: Metro Waste Authority Owner: Metro Waste Authority Boring/Well No: MW-16	

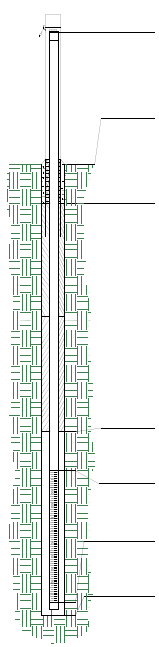

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

Boring / Well Number: MW-19		Facility Name: Metro Park West Landfill	Facility Street Address: Perry, IA			
Boring Depth (ft) X Diameter (in): 31.0 x 8.25		Drilling Method: HS				
Well Contractor Name: Mike Dixon Registration Number: 8438		Logged By: Mike Dixon				
Ground Surface Elevation (ASL): 963.28		Top of Casing Elevation (ASL): 966.30				
Date: 10/19/2011 Start Time: 8:30 am	Date: 10/19/2011 End Time: 11:00 am	UST Number: NA	LUST Number: NA			
Depth Feet	Well Construction Details	Blow Count if applicable	Sample		PID/FID Reading	Rock Formations, Soil Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
			No.	Type*		
-3.5	OPC - 966.84 TOC - 966.30					
0	963.28 Protective casing in concrete seal		0-5			Brown, silty clay with trace sand and rocks. Moist at 5'.
3.5	960.28 Bentonite seal		5-17			Brown, gray, and green silty clay with traces of sand and rock, dark gray/rust colored mottling (soft and moist).
7						
10.5						
14	949.78 948.28 Sand pack Well screen in sand pack		17-20			No Return.
17.5			20-22			Brown and gray silty clay (soft and moist).
21			22-25			Gray, silty clay with traces of rock and sand and caliche deposits (soft).
24.5	937.93		25-28			Gray, silty clay with traces of rock and sand and caliche deposits (moist and soft).
28	933.12 932.28		28-31			Brown, silty clay with traces of rock and sand (moist and soft).
31.5						<i>Bottom of Boring at 31 feet</i>
35						
38.5						

* SS (split spoon) HS (hollow stem auger) HA (hand auger)

Observations	Date:	10/31/11			
Water Levels (ASL)	Level:	937.93			
Static Water Level Symbol	Time:	12:55 pm			

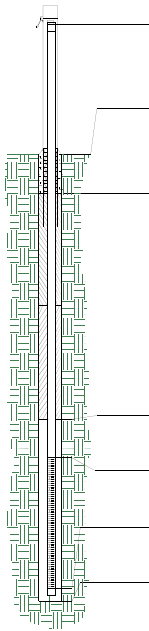

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
	TOC	2.56				HS		0	Grass and topsoil
	Ground	939.46						0-2	Gray sandy silty clay, very moist
		0.00						2-3	Blue/gray sandy silty clay, moist
		936.9						3-5	Light brown/gray mottling, sandy silty clay
		-3.00						5-10	Gray sandy silty clay, moist
	Bentonite Seal	933.9						10-12.5	Gray/dark gray sandy silty clay, very moist
		-3.00						12.5-15	Sand, well sorted, damp to wet
		933.9						15-20	Gray sand, wet
		-3.00						20-22	Gray sandy silty clay
	Sand Pack	-8.19						22-26	Gray sand
		-8.19							
		-8.19							
Well Screen	928.7								
Well Bottom	-9.69								
Well Bottom	927.2								
Bottom of Boring	-24.69								
Bottom of Boring	912.2								
Bottom of Boring	-26.00								
Bottom of Boring	910.9								
Bottom of Boring	910.9								
AR-Air Rotary AS-Auger Sample GS-Grab Sample HA-Hand Auger	HS-Hollow Stem Auger PA-Power Auger (solid stem) SS-Split Spoon WB-Wash Boring	Date: 10/25/2013 Time: 2:01 AM Water Level: 19.50 Elevation: 919.96						Driller: Mike Dixon Logged By: Mike Dixon Date/Time Start: 10/23/2013 5:15 PM Date/Time End: 10/24/2013 10:30 AM	
			Borehole Diameter: 8.25 inches Well Casing Diameter: 2 inch Well Screen Size: 0.010 inch LUST/SLF Permit No.: 80-SDP-03-84P Project No.: METRO 13104	Project: MPW Landfill Location: Perry, Iowa Client: Metro Waste Authority Owner: Metro Waste Authority Boring/Well No: MW-20					

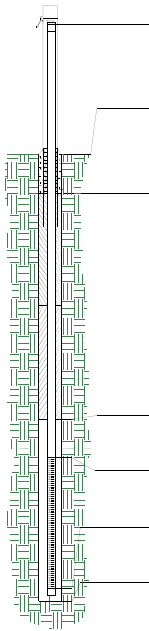

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.77			HS		0	Grass and topsoil	
	Ground		937.97					0-7	Brown sandy silty clay
			0.00					7-10	Gray sandy silty clay
			935.2					10-15	Gray sand, unsorted, dry
	Bentonite Seal		-3.00					15-20	Gray sand/rock, wet at 18'
			932.2					20-26	Gray sandy silty clay, trace gravel
	Sand Pack		-8.50						
	Well Screen		926.7						
			-10.00						
	Well Bottom		925.2						
			-25.00						
	Bottom of Boring		910.2						
		-26.00							
		909.2							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon HA-Hand Auger WB-Wash Boring			Date:	10/25/2013				Driller:	Mike Dixon
			Time:	1:30 PM				Logged By:	Mike Dixon
			Water Level:	18.00				Date/Time Start:	10/23/2013 11:41 AM
			Elevation:	919.97				Date/Time End:	10/23/2013 5:30 PM
			Borehole Diameter:	8.25 inches				Project:	MPW Landfill
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa
			Well Screen Size:	0.010 inch				Client:	Metro Waste Authority
			LUST/SLF Permit No.:	80-SDP-03-84P				Owner:	Metro Waste Authority
			Project No.:	METRO 13104				Boring/Well No:	MW-21

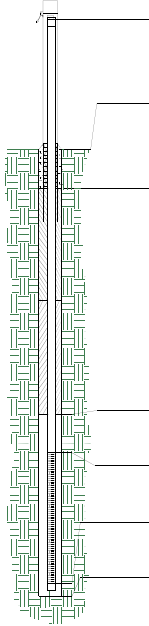

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.66			HS		0	Crop field	
	Ground		998.26					0-2	Dark brown sandy silty clay
								2-5	Light brown sandy silty clay, soft, moist
			0.00					5-16	Light brown sandy silty clay, brown and red/brown mottling, very moist at 10'
	Bentonite Seal		995.6					16-21	Dark gray sandy silty clay, moist pockets in soil core
			-1.00						
	Sand Pack		994.6						
			-3.00						
	Well Screen		992.6						
		-5.00							
Well Bottom		990.6							
		-20.00							
Bottom of Boring		975.6							
		-21.00							
		974.6							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon HA-Hand Auger WB-Wash Boring			Date:	10/25/2013				Driller:	Mike Dixon
			Time:	3:40 PM				Logged By:	Mike Dixon
			Water Level:	Dry				Date/Time Start:	10/25/2013 10:30 AM
			Elevation:	NA				Date/Time End:	10/25/2013 12:30 PM
			Borehole Diameter:	8.25 inches			Project:	MPW Landfill	
			Well Casing Diameter:	2 inch			Location:	Perry, Iowa	
			Well Screen Size:	0.010 inch			Client:	Metro Waste Authority	
			LUST/SLF Permit No.:	80-SDP-03-84P			Owner:	Metro Waste Authority	
			Project No.:	METRO 13104			Boring/Well No:	MW-22	

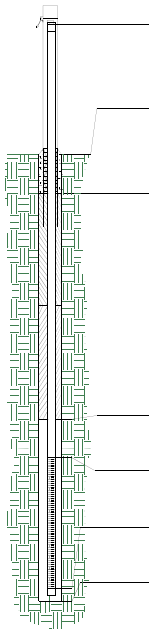

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.98			HS		0	Grass and topsoil	
	Ground		991.18					0-7	Dark brown sandy silty clay, trace gravel
			0.00					7-10	Brown/light brown sandy silty clay, trace gravel, light brown/dark brown/rust mottling, very moist at 9.5-10'
			988.2					10-14.5	Brown/light brown sandy silty clay, trace gravel, brown/rust brown mottling, weathered granite/quartz rock, sand lenses at 14'
	Bentonite Seal		-2.00						
	Sand Pack		986.2					14.5-17	Dark brown/gray sandy silty clay, moisture in pockets in soil core
								17-21	Dark gray sandy silty clay, rocky, hard and firm
	Well Screen		-5.00						
	Well Bottom		-20.00						
	Bottom of Boring		-21.00						
		967.2							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon HA-Hand Auger WB-Wash Boring			Date:	10/25/2013				Driller:	Mike Dixon
			Time:	3:05 PM				Logged By:	Mike Dixon
			Water Level:	20.00				Date/Time Start:	10/25/2013 8:30 AM
			Elevation:	971.18				Date/Time End:	10/25/2013 10:00 AM
			Borehole Diameter:	8.25 inches				Project:	MPW Landfill
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa
			Well Screen Size:	0.010 inch				Client:	Metro Waste Authority
			LUST/SLF Permit No.:	80-SDP-03-84P				Owner:	Metro Waste Authority
			Project No.:	METRO 13104				Boring/Well No:	MW-23

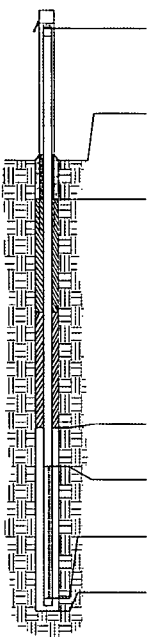

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
	TOC	2.84				HS		0	Grass and topsoil
	Ground	982.44						0-2	Dark brown sandy silty clay, moist
		0.00						2-5	Brown/light brown sandy silty clay, gravel at 3'
		979.6						5-10	Brown/light brown sandy silty clay, rust brown mottling, sand lenses, trace gravel, very moist
		-1.00						10-14.5	Brown sandy silty clay, gray and dark rust mottling, trace gravel
	Bentonite Seal	-1.00						14.5-21	Gray sandy silty clay, rocky, hard, moisture in pockets of soil core
	978.6								
	978.6								
	978.6								
	978.6								
	Sand Pack	-3.50							
	Well Screen	976.1							
	-5.00								
Well Bottom	974.6								
	-20.00								
Bottom of Boring	959.6								
	-21.00								
	958.6								
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon HA-Hand Auger WB-Wash Boring			Date:	10/25/2013				Driller:	Mike Dixon
			Time:	2:37 PM				Logged By:	Mike Dixon
			Water Level:	Dry				Date/Time Start:	10/24/2013 4:45 PM
			Elevation:	NA				Date/Time End:	10/24/2013 6:45 PM
			Borehole Diameter:	8.25 inches			Project:	MPW Landfill	
			Well Casing Diameter:	2 inch			Location:	Perry, Iowa	
			Well Screen Size:	0.010 inch			Client:	Metro Waste Authority	
			LUST/SLF Permit No.:	80-SDP-03-84P			Owner:	Metro Waste Authority	
			Project No.:	METRO 13104			Boring/Well No:	MW-24	

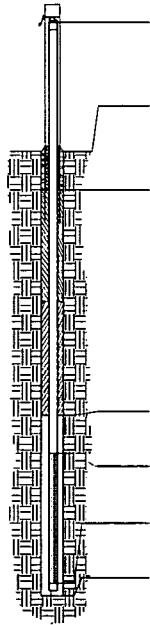

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.68			HS		0	Grass and topsoil	
	Ground		982.28					0-3	Dark brown sandy silty clay, moist
								3-5	Brown sandy silty clay with trace gravel
			0.00					5-20	Light brown sandy silty clay, brown , rust brown mottling, sand lenses, moist at 13', gray mottling 15-20'
	Bentonite Seal		979.6					20-26	Gray sandy silty clay, hard, moist pockets
			-3.00						
	Sand Pack		976.6						
	Well Screen		-8.50						
Well Bottom		971.1							
		-10.00							
		969.6							
		-25.00							
		954.6							
		-26.00							
		953.6							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon HA-Hand Auger WB-Wash Boring			Date:	10/25/2013				Driller:	Mike Dixon
			Time:	3:23 PM				Logged By:	Mike Dixon
			Water Level:	17.31				Date/Time Start:	10/24/2013 1:50 PM
			Elevation:	964.97				Date/Time End:	10/24/2013 4:00 PM
			Borehole Diameter:	8.25 inches			Project:	MPW Landfill	
			Well Casing Diameter:	2 inch			Location:	Perry, Iowa	
			Well Screen Size:	0.010 inch			Client:	Metro Waste Authority	
			LUST/SLF Permit No.:	80-SDP-03-84P			Owner:	Metro Waste Authority	
			Project No.:	METRO 13104			Boring/Well No:	MW-25	

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.80			HS		0	Grass	
			940.6					0-1	Topsoil
								1-4	Sand/clayey sand
	Ground		0.00					4-5	Gray sandy silty clay, moist
			937.8					5-10	Dark brown sandy silty clay, moist
								10-13	Dark gray sandy silty clay, moist
	Bentonite Seal		-3.00					13-15	Gray sand, dry
			934.8					15-20	Gray sand, moist, wet at 20'
								20-27	Brown/gray clayey sand (coarse sand)
								27-31	Light brown sandy silty clay
	Sand Pack		-13.50						
			924.3						
	Well Screen		-15.35						
		922.5							
Well Bottom		-30.35							
		907.5							
Bottom of Boring		-31.00							
		906.8							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon HA-Hand Auger WB-Wash Boring			Date:	2/14/2014				Driller:	Mike Dixon
			Time:	11:30 AM				Logged By:	Mike Dixon
			Water Level:	23.20				Date/Time Start:	2/14/2014 9:30 AM
			Elevation:	917.40				Date/Time End:	2/14/2014 12:30 PM
			Borehole Diameter:	8.25 inches				Project:	MPW Landfill
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa
			Well Screen Size:	0.010 inch				Client:	Metro Waste Authority
			LUST/SLF Permit No.:	80-SDP-03-84P				Owner:	Metro Waste Authority
			Project No.:	METRO 13104				Boring/Well No:	MW-26

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.23	DP	1 ft	HS	Full	0-1	Black organic matter	
		943.07							
	Ground	0.0						1-8	Brown sandy clay
		940.8						8-9	Gray sandy clay, trace brown mottling
	Bentonite Seal	-2.0						9-15	Gray sandy clay
		938.8						15-20	Gray compressed sand
	Sand Pack	-7.0							
		933.8							
	Well Screen	-10.0							
		930.8							
	Well Bottom	-20.0							
		920.8							
	Bottom of Boring	-20.0							
	920.8								
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon DP-Direct Push HA-Hand Auger WB-Wash Boring			Date:	4/21/2015				Driller:	Saberprobe, LLC
			Time:	3:50 PM				Logged By:	Austin Banks
			Water Level:	13.63				Date/Time Start:	-
			Elevation:	929.44				Date/Time End:	-
			Borehole Diameter:	8 inches				Project:	Metro Park West Landfill
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa
			Well Screen Size:	0.010 inch				Client:	Metro Waste Authority
			LUST/SLF Permit No.:	08-SDP-03-84P				Owner:	Metro Waste Authority
			Project No.:	METRO 15104				Boring/Well No:	MW-27

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit #	<u>08-SDP-03-84P</u>
Well or Piezometer #	<u>MW-27</u>	Date Started	<u>4/21/2015</u>
Project No.	<u>METRO 15104</u>	Date Completed	<u>4/21/2015</u>

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 679551.3</u> <u>E 1459267</u>
Distance and Direction from boundary to well	_____

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>4.42</u> ft ³

Elevation(+/-0.01 ft. MSL):

Ground surface	<u>940.8</u>
Top of Protective Casing	<u>943.4</u>
Top of Well Casing	<u>943.07</u>
Benchmark Elevation	<u>NA</u>
Benchmark Description	<u>NA</u>

Seal (minimum of 3 ft. length above filter pack)

Material	<u>Bentonite grout</u>
Placement Method	<u>tremie tube</u>
Volume	<u>1.70</u> ft ³

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller Saberprobe, LLC
Drilling Method Hollow Stem
Drilling Fluid None
Bore hole Diameter 8 inches
Soil Sampling Method Continuous Sampler
Depth of Boring * 20.0

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

Surface seal design:

Material of Protective Casing:
Steel

Material of grout between protective casing and well casing
Bentonite

Protective cap material
Steel

Vented? (Y/N) Y Locking? (Y/N) Y

Well cap material
Plastic

Vented? (Y/N) Y

C. Monitoring Well Installation

Casing Material PVC
Length of Casing 12.2
Outside Casing Diameter 2.375 inch
Inside Casing Diameter 2.0 inch
Casing Joint Type threaded
Casing/Screen joint type threaded
Screen material PVC
Screen opening size 0.010 inch
Screen length 10
Depth of Well ** 22.23

D. Groundwater Measurement

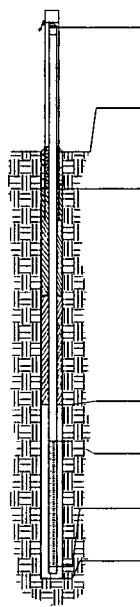

Fluid level (+/-0.01 ft. below top of inner well casing) 13.63
Stabilization time < 24 hours
Well development method
Hand bailing

Upgradient or downgradient well?
Downgradient
Average Depth of Frostline
3 feet

* Depth of boring measured from ground surface.

** Depth of well measured from Top of Casing (TOC).

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		TOC	3.15			HS		0-4	Brown and black lean clay with organic matter
			946.35					4-18	Brown and black soft fine sandy silt (alluvium)
		Ground	0.0					18-20	Gray and dark gray fine sand, wet (alluvium)
			943.2					20-22	Sandy clay with gravel (alluvium)
		Bentonite Seal	-3.0					22-23	Gray weathered shale
			940.2					23	Gray shale, hard
		Sand Pack	-10.5						
		Well Screen	932.7						
			-12.0						
		Well Bottom	931.2						
		-22.0							
	Bottom of Boring	921.2							
		-23.0							
		920.2							
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon DP-Direct Push HA-Hand Auger WB-Wash Boring			Date:	10/18/2017				Driller:	Jerome Hobson
			Time:	3:15 PM				Logged By:	Chad Dentinger
			Water Level:	13.00				Date/Time Start:	10/18/2017 10:30 AM
			Elevation:	933.35				Date/Time End:	10/18/2017 3:00 PM
			Borehole Diameter:	7.25 inches				Project:	Metro Park West Landfill
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa
			Well Screen Size:	0.010 inch				Client:	Metro Waste Authority
			LUST/SLF Permit No.:	08-SDP-03-84P				Owner:	Metro Waste Authority
			Project No.:	METRO 18101				Boring/Well No:	MW-28

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit # 08-SDP-03-84P
Well or Piezometer #	<u>MW-28</u>	Date Started <u>10/18/2017</u> Date Completed <u>10/18/2017</u>
Project No.	<u>METRO 18101</u>	

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 679551.3</u> <u>E 1459267</u>
Distance and Direction from boundary to well	_____

Well Installation, continued:

Filter pack:

Pre-packed screen:
0.125 mm (pre-pack)
0.65 mm (annular space)
3.20 ft³ (annular space)

Seal (minimum of 3 ft. length above filter pack)

Elevation(+/-0.01 ft. MSL):	Material	<u>Bentonite chips+</u>
Ground surface	Placement Method	<u>poured</u>
Top of Protective Casing	Volume	<u>1.92</u> ft ³
Top of Well Casing		
Benchmark Elevation		
Benchmark Description		

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller Jerome Hobson
Drilling Method Hollow Stem
Drilling Fluid None
Bore hole Diameter 7.25 inches
Soil Sampling Method Continuous Sampler
Depth of Boring * 23.0

Backfill (if different from seal):

Material NA
Placement Method NA
Volume NA

Surface seal design:

Material of Protective Casing:
Steel
Material of grout between protective casing and well casing
Bentonite
Protective cap material
Steel
Vented? (Y/N) Y Locking? (Y/N) Y
Well cap material
Plastic
Vented? (Y/N) Y

C. Monitoring Well Installation

Casing Material PVC
Length of Casing 15.2
Outside Casing Diameter 2.375 inch
Inside Casing Diameter 2.0 inch
Casing Joint Type threaded
Casing/Screen joint type threaded
Screen material PVC
Screen opening size 0.010 inch
Screen length 10
Depth of Well ** 25.15

D. Groundwater Measurement

Fluid level (+/-0.01 ft. below top of inner well casing) 13.00
Stabilization time < 24 hours
Well development method
Hand bailing

Upgradient or downgradient well?
Upgradient
Average Depth of Frostline
3 feet

^ Elevation approximate due to heavy tree cover.
* Depth of boring measured from ground surface.
** Depth of well measured from Top of Casing (TOC).
+ Access limitations precluded the use of bentonite grout for the seal.

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit # 08-SDP-03-84P
Well or Piezometer #	<u>LFGW-W1</u>	Date Started <u>8/25/2010</u> Date Completed <u>8/25/2010</u>
Project No.	<u>METRO 10111</u>	

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 680822.017</u>
	<u>E 1459085.398</u>

Distance and Direction from boundry to well _____

Elevation(+/-0.01 ft. MSL):

Ground surface	<u>1000.33</u>
Top of Protective Casing	<u>1004.36</u>
Top of Well Casing	<u>1004.08</u>
Benchmark Elevation	<u>NA</u>
Benchmark Description	<u>NA</u>

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>15.96 ft³</u>

Seal (minimum of 3 ft. length above filter pack)

Material	<u>Bentonite grout</u>
Placement Method	<u>treme grouted</u>
Volume	<u>1.57 ft³</u>

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants (BLEC)
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller	<u>Joe Green</u>
Drilling Method	<u>Hollow Stem</u>
Drilling Fluid	<u>None</u>
Bore hole Diameter	<u>12.25 inches</u>
Soil Sampling Method	<u>Continuous Sampler</u>
Depth of Boring *	<u>18.0</u>

Surface seal design:

Material of Protective Casing:	<u>Metal</u>
Material of grout between protective casing and well casing	<u>Concrete</u>
Protective cap material	<u>Metal</u>
Vented? (Y/N)	<u>Y</u> Locking? (Y/N)
Well cap material	<u>J Plug</u>
Vented? (Y/N)	<u>N</u>

C. Monitoring Well Installation

Casing Material	<u>PVC</u>
Length of Casing	<u>8.75'</u>
Outside Casing Diameter	<u>4.5 inch</u>
Inside Casing Diameter	<u>4.0 inch</u>
Casing Joint Type	<u>threaded</u>
Casing/Screen joint type	<u>threaded</u>
Screen material	<u>PVC</u>
Screen opening size	<u>0.020 inch</u>
Screen length	<u>5.0'</u>
Depth of Well **	<u>13.75'</u>

D. Groundwater Measurement

Water level (+/-0.01 ft. below top of inner well casing)	<u>13.72</u>
Stabilization time	<u>> 12 hours</u>
Well development method	<u>Surge block</u>

Upgradient or downgradient well?
Downgradient
 Average Depth of Frostline
3-feet

* Depth of boring measured from ground surface.

** Depth of well measured from Top of Casing (TOC).

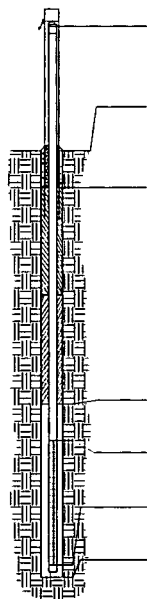

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

Boring / Well Number: LFGW-W1		Facility Name: Metro Park West Landfill		Facility: Perry, Iowa		
				Street Address:		
Boring Depth (ft) X Diameter (in): 18'x12.25"				Drilling Method: HS		
Well Contractor Name: Joe Green				Logged By:		
Registration Number: #2721				Kris Sommer		
Ground Surface Elevation (ASL): 1000.33			Top of Casing Elevation (ASL): 1004.08			
Date: 8/25/10		Date: 8/25/10		UST Number	LUST Number	
Start Time: 5:00		End Time: 6:00				
Depth Feet	Well Construction Details	Blow Count if applicable	Sample		PID/FID Reading	Rock Formations, Soil Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
			No.	Type*		
-2.5						
0	1000.33					
0	999.33		0-0.5			Grass/Grass Thatch Cover to Topsoil.
0	998.33		0.5-5			Dark Brown Clay Silt. Damp.
2.5	997.33					
5	995.33		5-10.5			Grey Clay Silt with Trace Sand and Pebbles. Damp.
7.5						
10	990.36		10.5-15			Brown Grey Mix, Clay Silt Trace Sand. Damp.
10	990.33					
10	989.33					
12.5						
15			15-18			Brown Grey Mix. Clay Silt Sand. Moist.
17.5	982.33					
	Bottom of Boring					Bottom of Boring at 18 feet
20						
22.5						
25						

* SS (split spoon) HS (hollow stem auger) HA (hand auger)

Observations	Date:	8/26/10			
Water Levels (ASL)	Level:	990.36			
Static Water Level Symbol	Time:	9:45 A.M.			

BORING LOG/MONITORING PROBE CONSTRUCTION DETAIL

Monitoring Probe Detail			Boring Log Detail							
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description		
		TOC	3.13			HS		0-5	Brown silty clay, trace gravel	
			993.73							
		Ground	0.0					5-21	Brown sandy lean clay (till)	
			990.6					21-26	Gray sandy lean clay (till)	
		Bentonite Seal	-1.0					26-27	Gray silty clay (till)	
			989.6					27-32.5	Gray sandy lean clay, stiff (till)	
		Sand Pack	-2.0							
			988.6							
		Well Screen	-2.0							
			988.6							
		Well Bottom	-32.0							
			958.6							
		Bottom of Boring	-32.5							
		958.1								
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon DP-Direct Push HA-Hand Auger WB-Wash Boring			Date:	9/7/2017				Driller:	Jerome Hobson	
			Time:	2:30 PM				Logged By:	Chad Dentlinger	
			Water Level:	Dry				Date/Time Start:	9/6/2017 9:30 AM	
			Elevation:	NA				Date/Time End:	9/7/2017 2:15 PM	
			Borehole Diameter:	7.25				Project:	Metro Park West Landfill	
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa	
			Well Screen Size:	0.020 inch				Client:	Metro Waste Authority	
			LUST/SLF Permit No.:	08-SDP-03-84P				Owner:	Metro Waste Authority	
			Project No.:	METRO 18101				Boring/Well No:	LFGW-W2	

MONITORING WELL/PIEZOMETER CONSTRUCTION FORM

Disposal Site Name	<u>Metro Park West Landfill</u>	Permit # 08-SDP-03-84P
Well or Piezometer #	<u>LFGW-W2</u>	Date Started <u>9/6/2017</u> Date Completed <u>9/7/2017</u>
Project No.	<u>METRO 18101</u>	

A. Surveyed Locations and Elevations

Locations (+/-0.5 ft.):

Surveyed location of Well	<u>N 680057.3</u> <u>E 1458834.0</u>
Distance and Direction from boundary to well	_____

Well Installation, continued:

Filter pack:

Material	<u>Silica Sand</u>
Grain Size	
Volume	<u>7.80</u> ft ³

Seal (minimum of 3 ft. length above filter pack)

Elevation(+/-0.01 ft. MSL):		Material	<u>Bentonite chips</u>
Ground surface	<u>990.6</u>	Placement Method	<u>poured</u>
Top of Protective Casing	<u>994.0</u>	Volume	<u>0.26</u> ft ³
Top of Well Casing	<u>993.73</u>		
Benchmark Elevation	<u>NA</u>		
Benchmark Description	<u>NA</u>		

Backfill (if different from seal):

Material	<u>NA</u>
Placement Method	<u>NA</u>
Volume	<u>NA</u>

B. Soil Boring Information

Name and Address of Construction Company
Barker Lemar Engineering Consultants
1801 Industrial Circle
West Des Moines, IA 50265

Name of Driller	<u>Jerome Hobson</u>
Drilling Method	<u>Hollow Stem</u>
Drilling Fluid	<u>None</u>
Bore hole Diameter	<u>7.25 inches</u>
Soil Sampling Method	<u>Continuous Sampler</u>
Depth of Boring *	<u>32.5</u>

Surface seal design:

Material of Protective Casing:	<u>Steel</u>
Material of grout between protective casing and well casing	
Protective cap material	<u>Bentonite</u>
Vented? (Y/N) <u>Y</u>	Locking? (Y/N) <u>Y</u>
Well cap material	<u>Plastic</u>
Vented? (Y/N) <u>N</u>	

C. Monitoring Well Installation

Casing Material	<u>PVC</u>
Length of Casing	<u>5.1</u>
Outside Casing Diameter	<u>2.375 inch</u>
Inside Casing Diameter	<u>2.0 inch</u>
Casing Joint Type	<u>threaded</u>
Casing/Screen joint type	<u>threaded</u>
Screen material	<u>PVC</u>
Screen opening size	<u>0.020 inch</u>
Screen length	<u>30</u>
Depth of Well **	<u>35.13</u>

D. Groundwater Measurement


Fluid level (+/-0.01 ft. below top of inner well casing)	<u>Dry</u>
Stabilization time	<u>< 24 hours</u>
Well development method	<u>Not applicable</u>

Upgradient or downgradient well?
Not applicable
Average Depth of Frostline
3 feet

* Depth of boring measured from ground surface.

** Depth of well measured from Top of Casing (TOC).


Soil Boring Log And Monitoring Well Construction Diagram for: SB-1/MW-30

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.867506	Y Coordinates: 494.160504
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 21' x 6.25"	
Logged by: Dan Bacahowski	Ground Surface Elevation (ASL): 998.09'	
Start Date: 12/7/2021	Finish Date: 12/7/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0				14		OH	(0'-2') Top Soil - Organic (PP:2.5 tsf)
1	Concrete				40.0		
2					40.0		
3	Riser			15	50.0	CL	(3'-5') Olive Gray, Sandy Silty Clay
4					50.0	CL	(4'-7') Gray Silty Clay
5	v				50.0		
6	Bentonite				-		
7					-		
8					95.0	CL	(8'-9') Light Brown, Sandy Silty Clay
9	Screen				95.0	SC CL	(9'-10') Sand Seam
10					-	CL	10'-13') Dark Gray, Sandy Silty Clay
11					-		
12	Sand				-		
13					75.0	SC CL	(13'-13.5') Light Brown, Sandy Clay
14					75.0	CL	(13.5'-15') Dark Gray, Sandy Silty Clay
15					75.0		
16					-		
17					-		
18					90.0	CL	(18'-20') Dark Gray, Sandy Silty Clay
19					90.0		
20	Backfilled with sand upon completion				90.0		
21							
22							
23							
24							
25							

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v - Static Water Level s - sample collected	
Observation Date:	12/8/2021	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	8:00 a.m.	Well Casing Diameter:	2"	SLF Permit No.:	08-SDP-03-84P
Static Water Level (ASL):	5.81'	Well Screen Size:	0.010"	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-2

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.84020	Y Coordinates: -94.11323
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 33.5' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 993.47'	
Start Date: 12/8/2021	Finish Date: 12/8/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation	
		No.	Type					
0	Backfilled with cuttings upon completion →					OH	(0"-6") Top Soil - Organic (PP:2.5 tsf)	
1					60.0	CL	(6"-2') Light Brown, Sandy Silty Clay (PP:1.5 tsf)	
2					-			
3				27	100.0	CL	(3'-5') Light Brown, Sandy Silty Clay (PP:2.75 tsf)	
4					100.0			
5					-			
6					-			
7					-			
8				24	100.0	CL	(8'-10') Light Brown/Olive, Sandy Silty Clay (PP:2.5 tsf)	
9					100.0			
10					-			
11					-			
12					-			
13				39	100.0	CL	(13'-15') Dark Gray, Sandy Silty Clay (PP:2.0 tsf)	
14					100.0			
15					-			
16					-			
17					-			
18				53	100.0	CL	(18'-20') Dark Gray, Sandy Silty Clay (PP:>4.5 tsf)	
19					100.0			
20					-			
21					-			
22					-			
23					100.0	CL	(23'-25') Dark Gray, Sandy Silty Clay (PP:>4.5 tsf)	
24					100.0			
25					-			
26					-			
27					-			
28				(28'-30')	SIEVE	80.0	CL	(28'-29') Dark Gray, Sandy Silty Clay (PP:3.5 tsf)
29						80.0	SC	(29'-30') Light Brown, Well-Graded, Sandy Clay
30						-		
31						-		
32						-		
33						-	SC	(33'-33.5') Light Brown, Well-Graded, Sandy Clay
34		End of boring						
35								

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	12/9/2021	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	8:00 a.m.	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	8.50'	Well Screen Size:	-	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-3

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.867222	Y Coordinates: -94.156330
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 35' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 994.65'	
Start Date: 12/8/2021	Finish Date: 12/8/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0	Backfilled with cuttings upon completion →					OH	(0"-2') Top Soil - Organic
1					30.0		
2					-		
3					60.0	CL	(3'-5') Light Brown, Sandy Silty Clay (PP:6.5 tsf)
4					60.0		
5					-		
6					-		
7					-		
8					90.0	CL	(8'-10') Light Brown, Sandy Silty Clay (PP:2.75 tsf)
9					90.0		
10					-		
11					-		
12					-		
13					100.0	CL	(13'-15') Light Brown, Sandy Silty Clay (PP:1.75 tsf)
14					100.0		
15					-		
16					-		
17					-		
18			(18'-19.5')	PERM	90.0	CL	(18'-19') Light Brown, Sandy Silty Clay (PP:>4.5 tsf)
19					90.0	CL	(19'-20') Dark Gray, Sandy Silty Clay (PP:>4.5 tsf)
20					-		
21					-		
22					-		
23					90.0	CL	(23'-25') Dark Gray, Sandy Silty Clay (PP:>4.5 tsf)
24					90.0		
25					-		
26					-		
27					-		
28					80.0	CL	(28'-30') Dark Gray, Sandy Silty Clay (PP:4.25 tsf)
29					80.0		
30					-		
31					-		
32					-		
33					100.0	CL	(33'-35') Dark Gray, Sandy Silty Clay (PP:4.0 tsf)
34					100.0		
35	End of boring						

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-4

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.866063	Y Coordinates: -94.158615
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 35' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 1,001.45'	
Start Date: 12/7/2021	Finish Date: 12/7/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0	Backfilled with cuttings upon completion →					OH	(0"-2') Top Soil - Organic (PP:2.5 tsf)
1					20.0		
2					-		
3				18	20.0	CL	(3'-5') Light Brown, Sandy Silty Clay (PP:1.5 tsf)
4					20.0		
5					-		
6					-		
7					-		
8				25	100.0	CL	(8'-10') Light Brown, Sandy Silty Clay (PP:2.0 tsf)
9					100.0		
10					-		
11					-		
12					-		
13				30	100.0	CL	(13'-15') Light Brown, Sandy Silty Clay (PP:1.5 tsf)
14					100.0		
15					-		
16					-		
17					-		
18				47	30.0	CL	(18'-19') Dark Gray, Sandy Silty Clay (PP:2.5 tsf)
19					30.0	SC	(19'-20') Sand Seam (PP:1.0 tsf)
20					-		
21					-		
22					-		
23				27	100.0	CL	(23'-25') Dark Gray, Sandy Silty Clay (PP:3.75 tsf)
24					100.0		
25					-		
26					-		
27					-		
28				46	90.0	CL	(28'-30') Dark Gray, Sandy Silty Clay (PP:2.5 tsf)
29					90.0		
30					-		
31					-		
32					-		
33			(33'-35')	SIEVE	100.0	CL	(33'-35') Dark Gray, Sandy Silty Clay (PP:4.0 tsf)
34				HYDRO	100.0		
35	End of boring		ATTER				

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-5

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.865462	Y Coordinates: -94.156160
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 35' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 1,001.45'	
Start Date: 12/6/2021	Finish Date: 12/6/2021	

Depth (feet)	Well Construction Details		Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation		
			No.	Type						
0	Backfilled with cuttings upon completion →				14		OH	(0"-6") Top Soil - Organic		
1						50.0	CL	(6"-2') Light Brown, Sandy Silty Clay (PP:3.0 tsf)		
2						-				
3						80.0	CL	(3'-5') Light Brown, Sandy Silty Clay (PP:3.0 tsf)		
4						80.0				
5						-				
6						-				
7						-				
8					(8'-10')	PERM	39	-	CL	(8'-10') Light Brown, Sandy Silty Clay (PP:3.5 tsf)
9								-		
10								-		
11								-		
12								-		
13							33	100.0	CL	(13'-15') Dark Brown, Sandy Silty Clay (PP:3.25 tsf)
14								100.0		
15								-		
16								-		
17								-		
18					(18'-20')	SIEVE	34	20.0	CL	(18'-20') Dark Gray, Sandy Silty Clay, Sand Seam w/ Moisture (PP:3.25 tsf)
19						HYDRO		20.0		
20						ATTER		-		
21								-		
22								-		
23								100.0	CL	(23'-25') Dark Gray, Sandy Silty Clay (PP:1.75 tsf)
24								100.0		
25								-		
26								-		
27								-		
28								100.0	CL	(28'-30') Dark Gray, Sandy Silty Clay (PP:4.5 tsf)
29								100.0		
30								-		
31								-		
32								-		
33								100.0	CL	(33'-35') Dark Gray, Sandy Silty Clay (PP:4.5 tsf)
34								100.0		
35	End of boring									

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-6

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.865383	Y Coordinates: -94.159730
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 32.5' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 987.6'	
Start Date: 12/7/2021	Finish Date: 12/7/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation	
		No.	Type					
0	Backfilled with cuttings upon completion →					CL	(0"-2') Light Brown, Sandy Silty Clay	
1					-			
2						-		
3						100.0	CL	(3'-5') Light Brown/Olive, Sandy Silty Clay (PP:4.0 tsf)
4						100.0		
5						-		
6						-		
7						-		
8						80.0	CL	(8'-10') Dark Brown, Sandy Silty Clay (PP:2.5 tsf)
9						80.0		
10						-		
11						-		Moist
12						-		
13						100.0	CL	(13'-15') Dark Gray, Sandy Silty Clay (PP:3.25 tsf)
14						100.0		
15						-		
16						-		
17						-		
18						-	CL	(18'-20') Dark Gray, Sandy Silty Clay
19						-		
20						-		
21						-		
22						-		
23						-	CL	(23'-25') Dark Gray, Sandy Silty Clay, Shale Encountered
24						-		
25						-		
26						-		
27						-		
28						-		
29						80.0		(29.5'-31') Weathered Shale (PP:>4.5 tsf)
30						80.0		
31						-		
32						-		(32.5') Limestone
33		End of Boring						
34								
35								

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-7

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.865012	Y Coordinates: -94.157978
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 35' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 989.447'	
Start Date: 12/6/2021	Finish Date: 12/6/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation	
		No.	Type					
0	Backfilled with cuttings upon completion →					OH	(0'-2') Top Soil - Organic (PP:1.75 tsf)	
1					10.0			
2					-			
3					15.0	CL	(3'-5') Organic Silt/Fill (PP:2.0 tsf)	
4					15.0			
5					-			
6					-			
7					-			
8					15	30.0	SC CL	(8'-10') Clayey Sand
9						30.0		
10						-		
11						-		
12						-		
13					64	40.0	CL/SC	(13'-15') Clay, Transition Sand
14						40.0		
15						-		
16						-		
17						-		
18					29	80.0	CL/SC	(18'-20') Light Brown Sand, Dark Gray Sandy Silty Clay (PP:4.5)
19						80.0		
20						-		
21						-		
22						-		
23						80.0	CL	(23'-25') Gray, Sandy Silty Clay w/ Sand Seams (PP:3.5 tsf)
24						80.0		
25						-		
26						-		
27						-		
28					19	100.0	CL	(28'-30') Dark Gray, Sandy Silty Clay (PP:2.75 tsf)
29						100.0		
30						-		
31						-		
32						-		
33						100.0	CL	(33'-35') Dark Gray/Olive, Sandy Silty Clay (PP:4.0 tsf)
34						100.0		
35	End of boring							

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518


Soil Boring Log And Monitoring Well Construction Diagram for: SB-9/MW-31

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.863791	Y Coordinates: -94.160466
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 25' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 980.2819'	
Start Date: 12/7/2021	Finish Date: 12/7/2021	


Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0						OH	(0'-2') Top Soil - Organic
1	Concrete →				60.0	CL	Light Brown, Sandy Silty Clay (PP:3.0 tsf)
2					60.0		
3	Riser →			14	50.0	CL	(3'-5') Light Brown w/ Fill Sandy Silty Clay (PP:3.0 tsf)
4					50.0		
5					-		
6	Bentonite →				-		
7					-		
8				15	75.0	CL	(8'-10') Light Brown, Sandy Silty Clay (PP: 2.25 tsf)
9					75.0		
10	v				-		
11					-		
12					-		
13				40	100.0	CL	(13'-14') Light Brown, Sandy Silty Clay (PP:4.0 tsf)
14					100.0	CL	(14'-15') (Dark Gray, Sandy Silty Clay (PP:2.5 tsf)
15					-		
16	Sand →				-		
17	Screen →				-		
18				27	-	CL	(18'-20') Sandy Material/Moist, Likely Sand Seam
19					-		
20					-		
21					-		
22					-		
23				63	50.0	CL	(23'-25') Dark Gray Moist Sandy Silty Clay (PP:0.5 tsf)
24					50.0		
25	End of boring				-		

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	12/8/2021	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	8:00 a.m.	Well Casing Diameter:	2"	SLF Permit No.:	08-SDP-03-84P
Static Water Level (ASL):	10.4'	Well Screen Size:	0.010"	Project No.:	10310518

Soil Boring Log And Monitoring Well Construction Diagram for: SB-10/MW-32

Facility Name: Metro Park West Landfill - Perry, Iowa		X Coordinates: 41.864460		W Coordinates: -94.156085			
Well Contractor Name: Kris Sommer		Drilling Method: Rotary Auger					
Well Contractor Registration No: 5222		Boring Depth (ft) x Diameter (in): 20' x 6.25"					
Logged by: Dan Bacehowski		Ground Surface Elevation (ASL): 966.11'					
Start Date: 12/8/2021		Finish Date: 12/8/2021		Top of Casing Elevation (ASL): 968.58			
Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0						OH	(0'-1.5') Top Soil - Organic
1	Concrete				60.0	CL	(1.5'-2') Olive/Brown, Sandy Silty Clay (PP:1.75 tsf)
2							
3	Riser				80.0	CL	(3'-5') Light Tan/Brown (PP:1.0 tsf)
4					80.0		
5							
6	Bentonite						
7							
8		(8'-10')	SIEVE	25	30.0	CL	(8'-10') Light Brown, Sandy Silty Clay (PP:1.25 tsf)
9	Screen		HYDRO		30.0		
10			ATTER				
11							
12	Sand						
13				27	100.0	CL	(13'-15') Light Gray, Sandy Silty Clay (PP:4.0 tsf)
14					100.0		
15							
16							
17		(17'-19')	SIEVE				
18	Backfilled with sand upon completion			36	-	CL	(18'-19') Dark Gray, Sandy Silty Clay (PP:4.0 tsf)
19						SC	(19'-20') Sand Saturated, Well-Graded
20							
21	End of boring						
22							
23							
24							
25							
* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)			Symbols to Use: v - Static Water Level s - sample collected		
Observation Date:		12/9/2021		Borehole Diameter:		6.25"	
Time:		8:00 a.m.		Well Casing Diameter:		2"	
Static Water Level (ASL):		6.38'		Well Screen Size:		0.010"	
				Location:		MPW Landfill	
				SLF Permit No.:		08-SDP-03-84P	
				Project No.:		10310518	


Soil Boring Log And Monitoring Well Construction Diagram for: SB-11

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.866283	Y Coordinates: -94.165064
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 25' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 1,003.50	
Start Date: 12/8/2021	Finish Date: 12/8/2021	

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0	Backfilled with cuttings upon completion →			9		OH	(0"-2') Top Soil - Organic
1				13	75		
2				18	-		
3				3,4,6	90.0	CL	(3.5'-5') Olive Gray/Gray, Sandy Silty Clay (PP:2.0 tsf)
4					90.0		
5					-		
6				6,9,14	60.0	CL	(6'-7.5') Olive Gray/Light Brown (PP:>4.5)
7					-		
8				2,4,5	50.0	CL	(8.5'-10') Light Gray/Olive, Sandy Silty Clay (PP:1.75 tsf)
9					50.0		
10					-		
11					-		
12					-		
13				3,5,6	0.0	CL	(13.5'-15') Waste Material in Drill Cuttings, Wet w/ Leachate Odor
14					-		
15					-		
16					-		
17					-		
18				2,3,6	-	CL	(18.5'-20') Additional Waste Material on Drill Cuttings, Dark Gray w/ Waste Material (PP:2.5 tsf)
19					-		
20					-		
21					-		
22					-		
23				2,2,3	-	-	(23.5'-25') Waste Material w/ Liquids
24					-		
25				-			
26	End of boring						
27							
28							
29							
30							
31							
32							
33							
34							
35							

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518

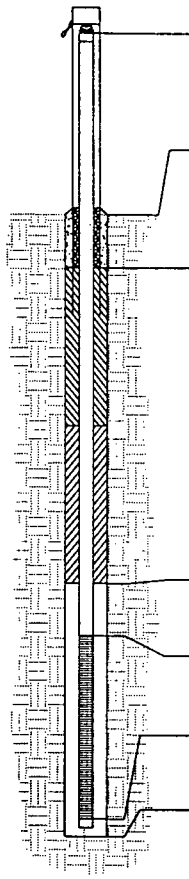
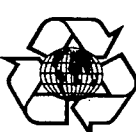
Soil Boring Log And Monitoring Well Construction Diagram for: SB-12

Facility Name: Metro Park West Landfill - Perry, Iowa	X Coordinates: 41.863045	Y Coordinates: -94.158513
Well Contractor Name: Kris Sommer	Drilling Method**: Rotary Auger	
Well Contractor Registration No: 5222	Boring Depth (ft) x Diameter (in): 35' x 6.25"	
Logged by: Dan Bacehowski	Ground Surface Elevation (ASL): 984.3219	
Start Date: 12/6/2021	Finish Date: 12/6/2021	

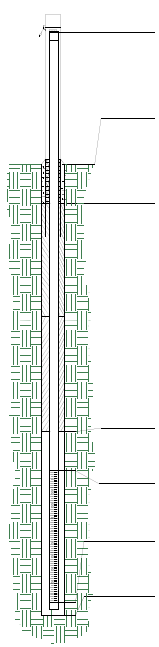

Depth (feet)	Well Construction Details	Sample		Blow Count	Recovery (%)	USCS	Sample Descriptions: soil, color, classification, observation
		No.	Type				
0	Backfilled with cuttings upon completion →			5		OH	(0"-2') Top Soil - Organic (PP:3.0 tsf)
1					50.0		
2				7	5.0	CL	(2'-4') Light Olive Brown Sandy Silty Clay (PP:1.5 tsf)
3					5.0		
4					15.0	CL	(4'-6') Light Olive Brown/Gray Sandy Silty Clay (PP:1.75 tsf)
5					15.0		
6				6	100.0	CL	(6'-8') Light Brown/Olive Sandy Silty Clay (PP:2.5 tsf)
7					100.0		
8					-	CL	(8'-10') Light Olive Brown (PP:4.0 tsf)
9					-		
10					100.0	CL	(10'-12') Light Gray/Brown Sandy Silty Clay (PP:3.5 tsf)
11					100.0		
12					100.0		(12'-14') Light Brown/Olive Sandy Silty Clay (PP:3.5 tsf)
13					100.0		
14					100.0	CL	(14'-16') Gray/Olive Sandy Silty Clay (PP:3.75 tsf)
15					100.0		
16					100.0	CL	(16'-18') Gray Sandy Silty Clay (PP:3.0 tsf)
17					100.0		
18					-	CL	(18'-20') Dark Gray Sandy Silty Clay (PP:2.5 tsf)
19					-		
20					-		
21					-		
22					-		
23					-		
24					-		
25					-		
26					-		
27					-		
28					100.0	CL	(28'-30') Dark Gray, Sandy Silty Clay (PP:2.75 tsf)
29					100.0		
30					100.0		
31					100.0		
32					100.0		
33					100.0	CL	(33'-35') Dark Gray, Sandy Silty Clay (PP:3.75 tsf)
32					100.0		
35				100.0			

* Sample Types: Split Spoon (SS) Continuous Core (CC)		** Drilling Method Options: Rotary Auger, Push Probe, Hand Auger, Air drilling, Hollow Stem Auger, Other (Describe)		Symbols to Use: v – Static Water Level s – sample collected	
Observation Date:	-	Borehole Diameter:	6.25"	Location:	MPW Landfill
Time:	-	Well Casing Diameter:	-	SLF Permit No.:	80-SDP-03-84P
Static Water Level (ASL):	-	Well Screen Size:	-	Project No.:	10310518

BORING LOG/MONITORING WELL CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (feet)	Depth (feet)	Description	
		Depth							
	TOC	940.00							
	Ground	940							
	Concrete	1		ST	4 - 6 ft	HS	16"	24"	Dark Gray Sandy Lean Clay
				SS	6 - 8 ft	HS	8"		Gray Silty Clay
	Bentonite Seal	40.6		SS	9 - 11 ft	HS	8"		Gray Med. Sand @ 8 ft. Gray Med. Coarse Sand, Trace Gravel to 26 ft.
				SS	29 - 31 ft	HS	18"		Gray Sandy Lean Clay
				ST	34 - 36 ft	HS	20"	24"	Gray Sandy Lean Clay, Trace Gravel
				SS	39 - 41 ft	HS	18"		Gray Sandy Lean Clay
	Sand Pack	45.6		SS	44 - 46 ft	HS	20"		Gray Sandy Lean Clay
	Well Screen	50.6		SS	49 - 51 ft	HS	20"		Gray Shale @ 49.5 ft.
	Well Bottom	51							
	Bottom of Boring	51							Bottom of Boring @ 51.0 ft.
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) CS-Continuous Sampler SS-Split Spoon HA-Hand Auger ST-Shelby Tube			Date:	3/23/99	3/30/99			Driller:	Barker-Lemar
			Time:	10:00	10:15			Logged By:	K. Sperflage
			Water Level:	6.0	21.72			Date/Time Start:	3/23/99
			Elevation:		918.28			Date/Time End:	3/23/99
 Barker, Lemar & Associates 1300 Cummins Road - Suite 201 Des Moines, Iowa 50315 Phone: 515-256-8814 Fax: 515-256-0152			Borehole Diameter:		8.25"		Project:		Project No. 99018
			Well Casing Diameter:		2"		Location:		Perry, Iowa
			Well Screen Size:		0.010"		Client:		North Dallas SLF
							Owner:		North Dallas SLF
							Boring/Well No:		MW-2BR

BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation Depth	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
	TOC	2.56				HS		0	Grass and topsoil
	Ground	939.46						0-2	Gray sandy silty clay, very moist
		0.00						2-3	Blue/gray sandy silty clay, moist
		936.9						3-5	Light brown/gray mottling, sandy silty clay
		-3.00						5-10	Gray sandy silty clay, moist
	Bentonite Seal	933.9						10-12.5	Gray/dark gray sandy silty clay, very moist
								12.5-15	Sand, well sorted, damp to wet
								15-20	Gray sand, wet
								20-22	Gray sandy silty clay
	Sand Pack							22-26	Gray sand
		-8.19							
		928.7							
	Well Screen	-9.69							
Well Bottom	927.2								
Bottom of Boring	-24.69								
	912.2								
	-26.00								
	910.9								
AR-Air Rotary AS-Auger Sample GS-Grab Sample HA-Hand Auger	HS-Hollow Stem Auger PA-Power Auger (solid stem) SS-Split Spoon WB-Wash Boring	Date: 10/25/2013 Time: 2:01 AM Water Level: 19.50 Elevation: 919.96					Driller: Mike Dixon Logged By: Mike Dixon Date/Time Start: 10/23/2013 5:15 PM Date/Time End: 10/24/2013 10:30 AM		
			Borehole Diameter: 8.25 inches Well Casing Diameter: 2 inch Well Screen Size: 0.010 inch LUST/SLF Permit No.: 80-SDP-03-84P Project No.: METRO 13104	Project: MPW Landfill Location: Perry, Iowa Client: Metro Waste Authority Owner: Metro Waste Authority Boring/Well No: MW-20					

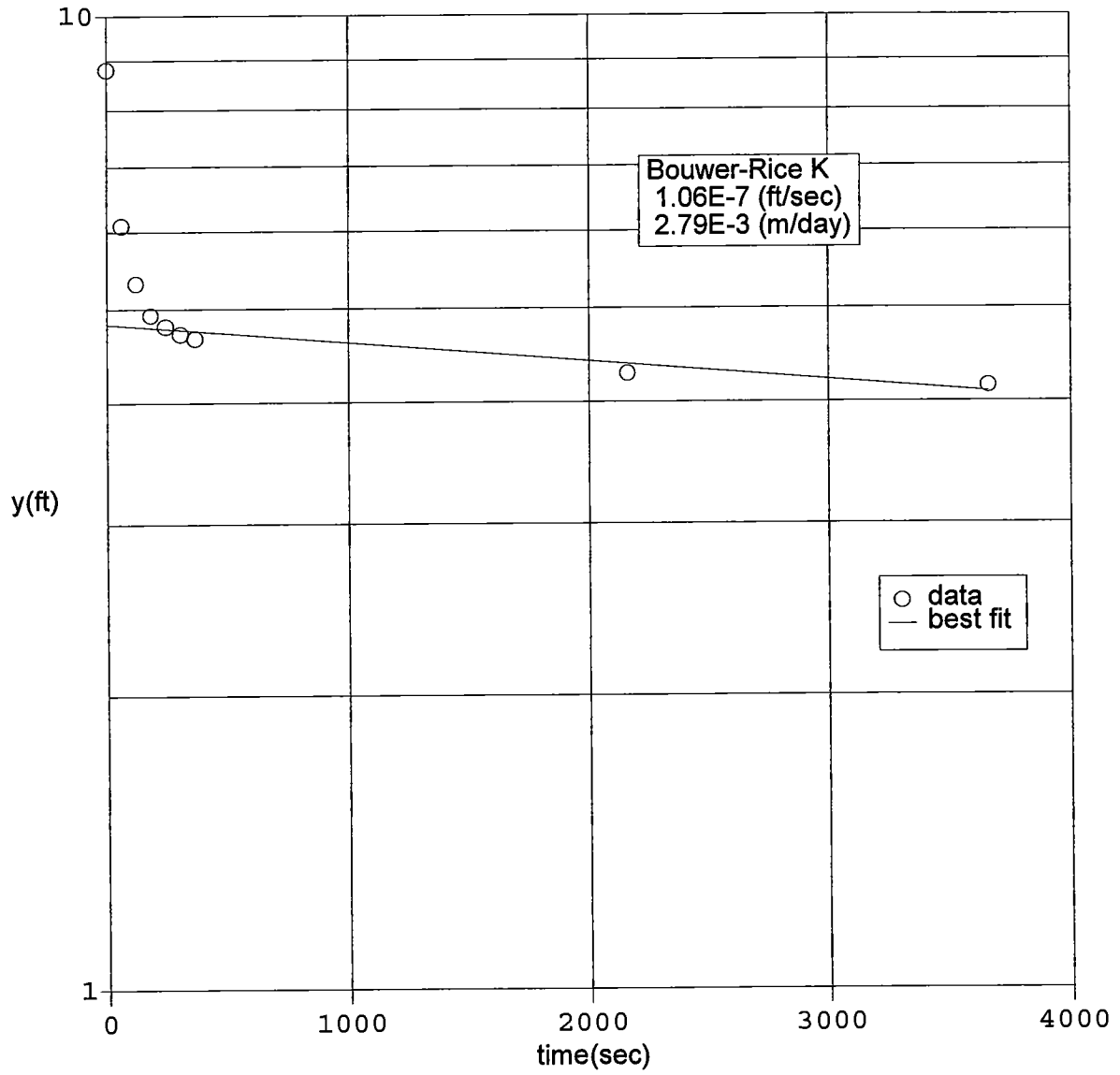
BORING LOG/PIEZOMETER CONSTRUCTION DETAIL

Monitoring Well Detail			Boring Log Detail						
	Material	Elevation	Sample Method	Sample Interval	Drill Method	Recovery (inches)	Strata Depth (ft)	Description	
		Depth							
	TOC	2.23	DP	1 ft	HS	Full	0-1	Black organic matter	
		943.07							
	Ground	0.0						1-8	Brown sandy clay
		940.8						8-9	Gray sandy clay, trace brown mottling
	Bentonite Seal	-2.0						9-15	Gray sandy clay
		938.8						15-20	Gray compressed sand
	Sand Pack	-7.0							
		933.8							
	Well Screen	-10.0							
		930.8							
	Well Bottom	-20.0							
		920.8							
Bottom of Boring	-20.0								
	920.8								
AR-Air Rotary HS-Hollow Stem Auger AS-Auger Sample PA-Power Auger (solid stem) GS-Grab Sample SS-Split Spoon DP-Direct Push HA-Hand Auger WB-Wash Boring			Date:	4/21/2015				Driller:	Saberprobe, LLC
			Time:	3:50 PM				Logged By:	Austin Banks
			Water Level:	13.63				Date/Time Start:	-
			Elevation:	929.44				Date/Time End:	-
			Borehole Diameter:	8 inches				Project:	Metro Park West Landfill
			Well Casing Diameter:	2 inch				Location:	Perry, Iowa
			Well Screen Size:	0.010 inch				Client:	Metro Waste Authority
			LUST/SLF Permit No.:	08-SDP-03-84P				Owner:	Metro Waste Authority
			Project No.:	METRO 15104				Boring/Well No.:	MW-27

APPENDIX D
SLUG TEST ANALYSIS WORKSHEETS

CLAY

North Dallas Sanitary Landfill - 9/9/97 - MW-4R1



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: E97011
Well Number: MW-4R1

Hydraulic Conductivity

Bouwer-Rice: 1.06E-7 (ft/sec), 2.79E-3 (m/day)

Well Geometry (ft)

H: 41.38
Le: 11.5
Lw: 12.08
rc: .083
rw: .344

drainable filter pack porosity: 0.15
effective radius: 1.54E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 33.455
A: 2.517
B: 0.367
C: 2.109
ln(Re/rw): 2.309

Least Squares Fit

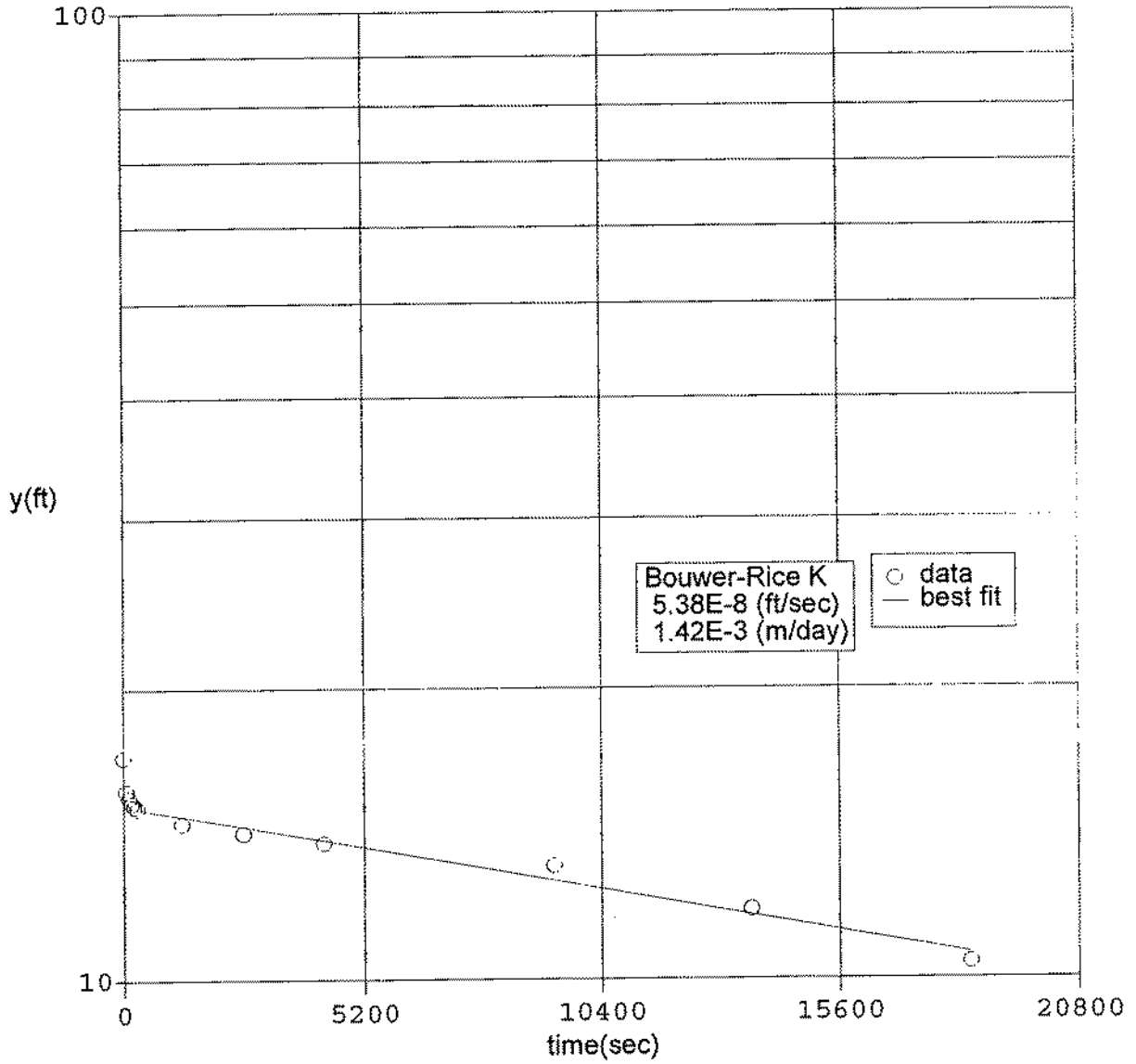
slope: -4.48E-5
intercept: 1.57E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
0.0	8.810	0.0	4.822
60.0	6.090	0.0	4.809
120.0	5.310	0.0	4.796
180.0	4.930	1.0	4.783
240.0	4.800	1.0	4.770
300.0	4.710	1.0	4.757
360.0	4.660	1.0	4.745
2160.0	4.280	1.0	4.377
3660.0	4.150	1.0	4.093

CLAY

North Dallas Sanitary Landfill - 9/9/97 - MW-4R2



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: E97011
Well Number: MW-4R2

Hydraulic Conductivity

Bouwer-Rice: 5.38E-8 (ft/sec), 1.42E-3 (m/day)

Well Geometry (ft)

H: 37.21
Le: 11.0
Lw: 22.7
rc: .083
rw: .344

drainable filter pack porosity: 0.15
effective radius: 1.54E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 32.0
A: 2.476
B: 0.36
C: 2.063
ln(Re/rw): 2.618

Least Squares Fit

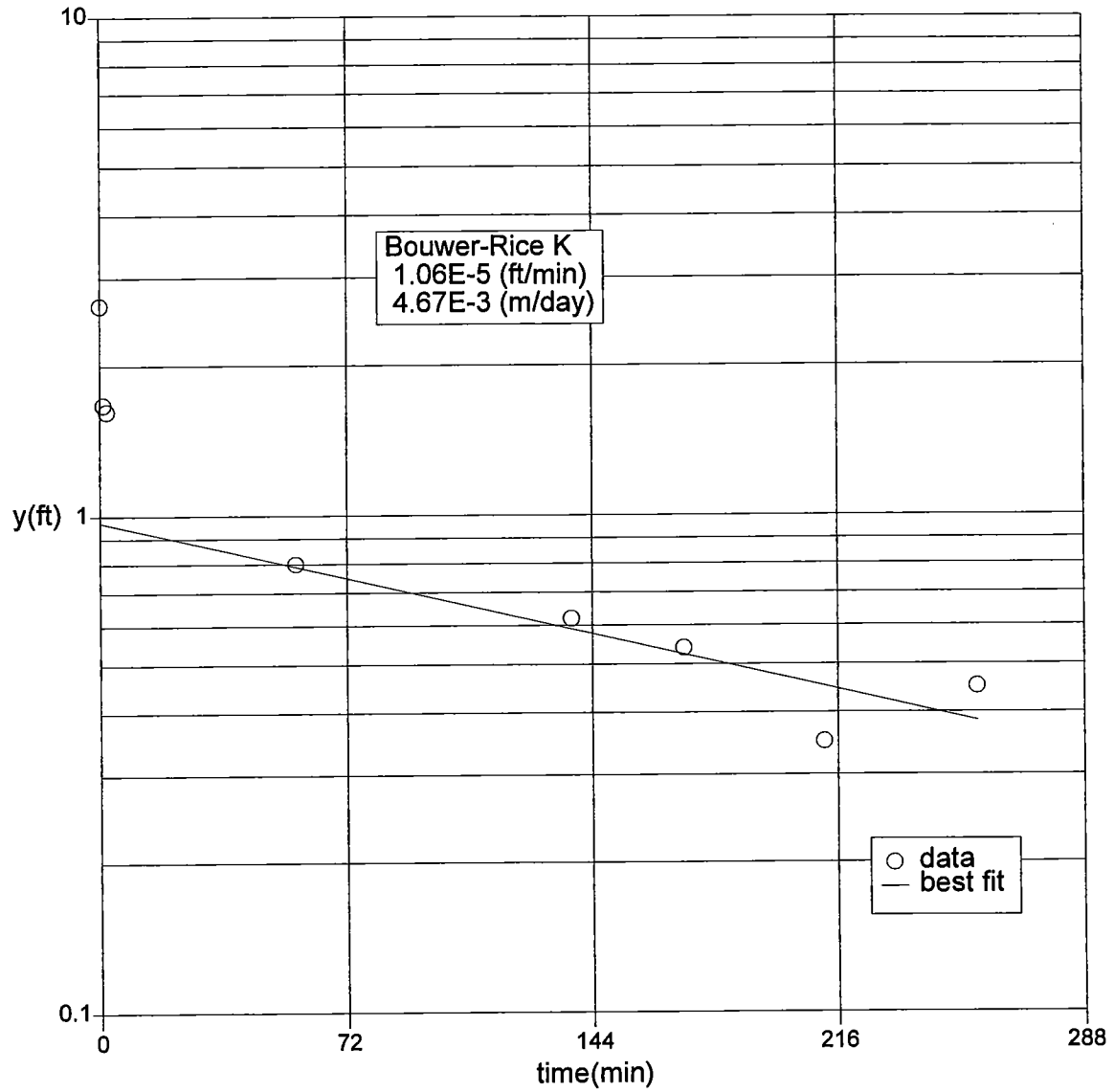
slope: -1.92E-5
intercept: 2.72E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
0.0	16.980	0.0	15.122
60.0	15.680	0.0	15.105
120.0	15.430	0.0	15.087
180.0	15.230	0.0	15.070
240.0	15.130	0.0	15.053
300.0	15.040	0.0	15.035
1260.0	14.490	0.0	14.761
2580.0	14.150	1.0	14.392
4320.0	13.820	1.0	13.920
9360.0	13.080	1.0	12.638
13680.0	11.780	1.0	11.634
18450.0	10.380	1.0	10.617

CLAY

North Dallas Sanitary Landfill - 1/2/98 - MW-6A



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: 97011
Well Number: MW-6A

Hydraulic Conductivity

Bower-Rice: 1.06E-5 (ft/min), 4.67E-3 (m/day)

Well Geometry (ft)

H: 12.22
Le: 7.62
Lw: 7.62
rc: .083
rw: .323

drainable filter pack porosity: 0.15
effective radius: 1.47E-1 (ft)

Bower Rice Coefficients

Le/rw: 23.599
A: 2.241
B: 0.318
C: 1.682
ln(Re/rw): 2.089

Least Squares Fit

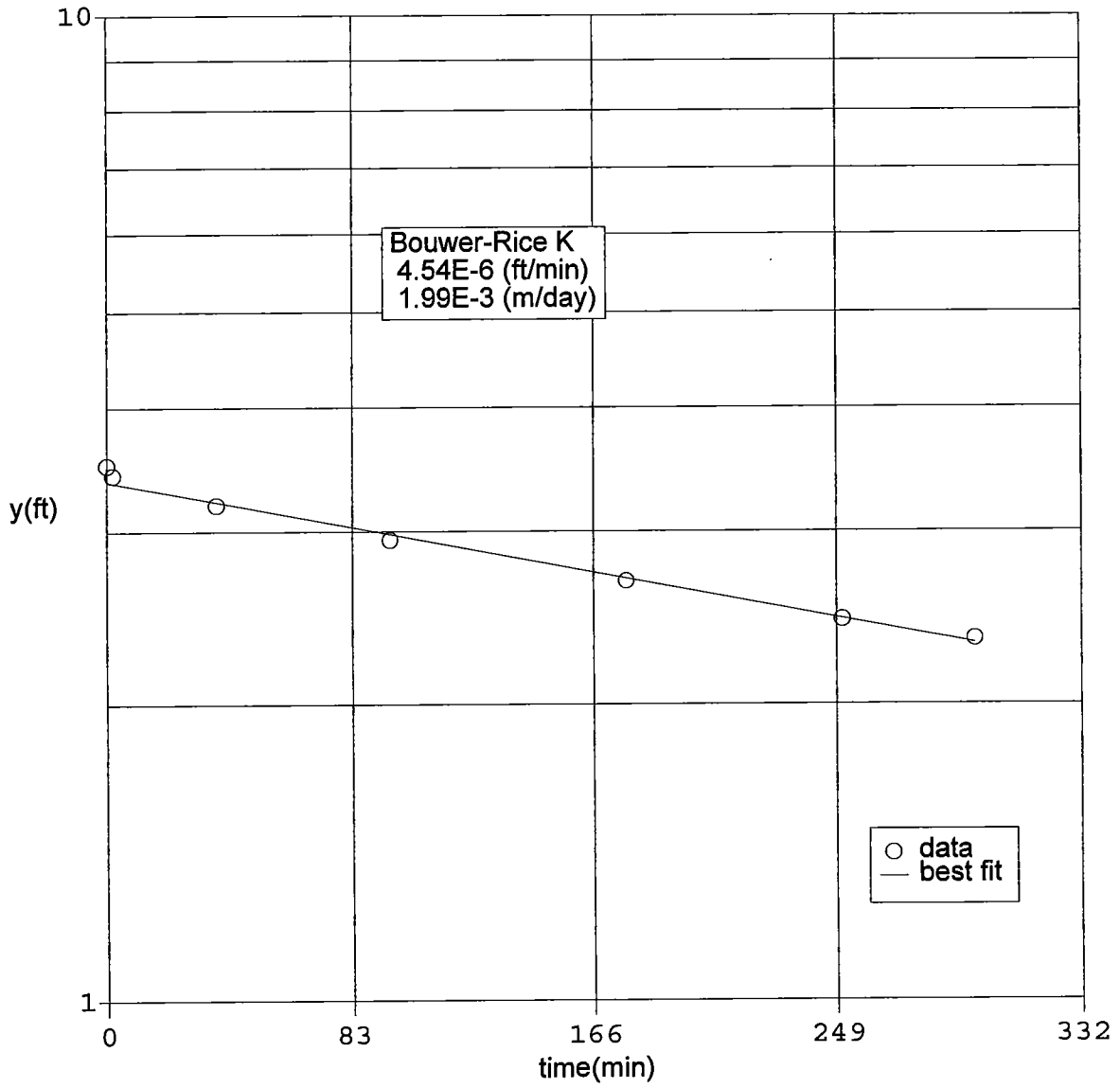
slope: -3.60E-3
intercept: -3.14E-2

Recovery Data and Fit

time(min)	y(ft)	weight	fit(ft)
0.0	2.640	0.0	0.969
1.0	1.670	0.0	0.966
2.0	1.620	0.0	0.962
57.0	0.800	1.0	0.789
138.0	0.620	1.0	0.589
171.0	0.540	1.0	0.523
212.0	0.350	1.0	0.451
257.0	0.450	1.0	0.384

CLAY

North Dallas Sanitary Landfill - 1/2/98 - MW-6B



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: 97011
Well Number: MW-6B

Hydraulic Conductivity

Bouwer-Rice: 4.54E-6 (ft/min), 1.99E-3 (m/day)

Well Geometry (ft)

H: 32.92
Le: 10.0
Lw: 32.92
rc: .083
rw: .323

drainable filter pack porosity: 0.15
effective radius: 1.47E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 30.969
A: 2.447
B: 0.355
C: 2.03
ln(Re/rw): 3.296

Least Squares Fit

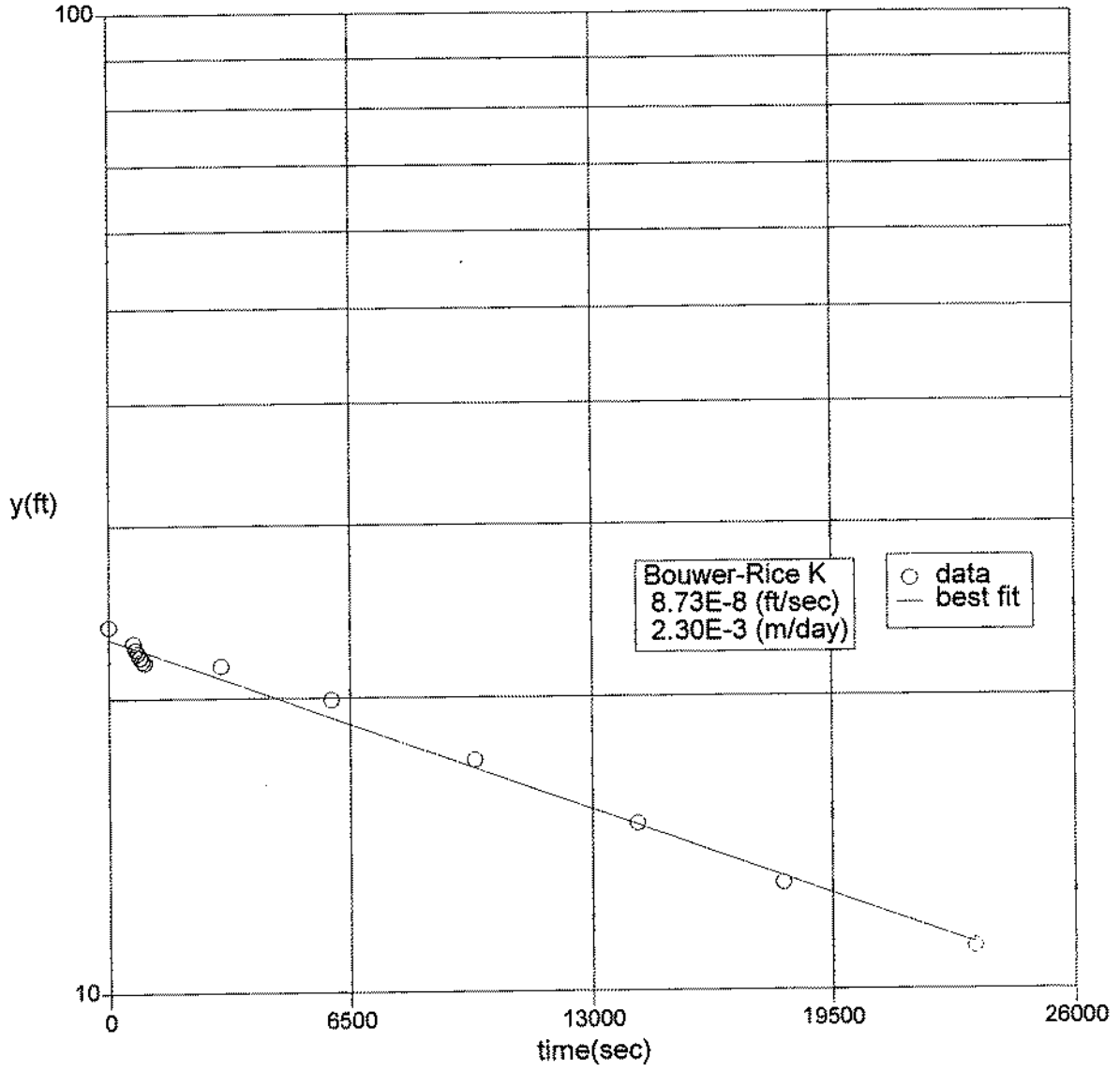
slope: -1.28E-3
intercept: 1.21E+0

Recovery Data and Fit

time (min)	y (ft)	weight	fit (ft)
0.0	3.500	0.0	3.368
2.0	3.420	1.0	3.360
37.0	3.190	1.0	3.213
96.0	2.940	1.0	2.979
177.0	2.670	1.0	2.686
251.0	2.440	1.0	2.444
296.0	2.330	1.0	2.307

CLAY

North Dallas Sanitary Landfill - 9/9/97 - MW-8



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: E97011
Well Number: MW-8

Hydraulic Conductivity

Bouwer-Rice: 8.73E-8 (ft/sec), 2.30E-3 (m/day)

Well Geometry (ft)

H: 48.31
Le: 11.5
Lw: 30.41
rc: .083
rw: .344

drainable filter pack porosity: 0.15
effective radius: 1.54E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 33.455
A: 2.517
B: 0.367
C: 2.109
ln(Re/rw): 2.747

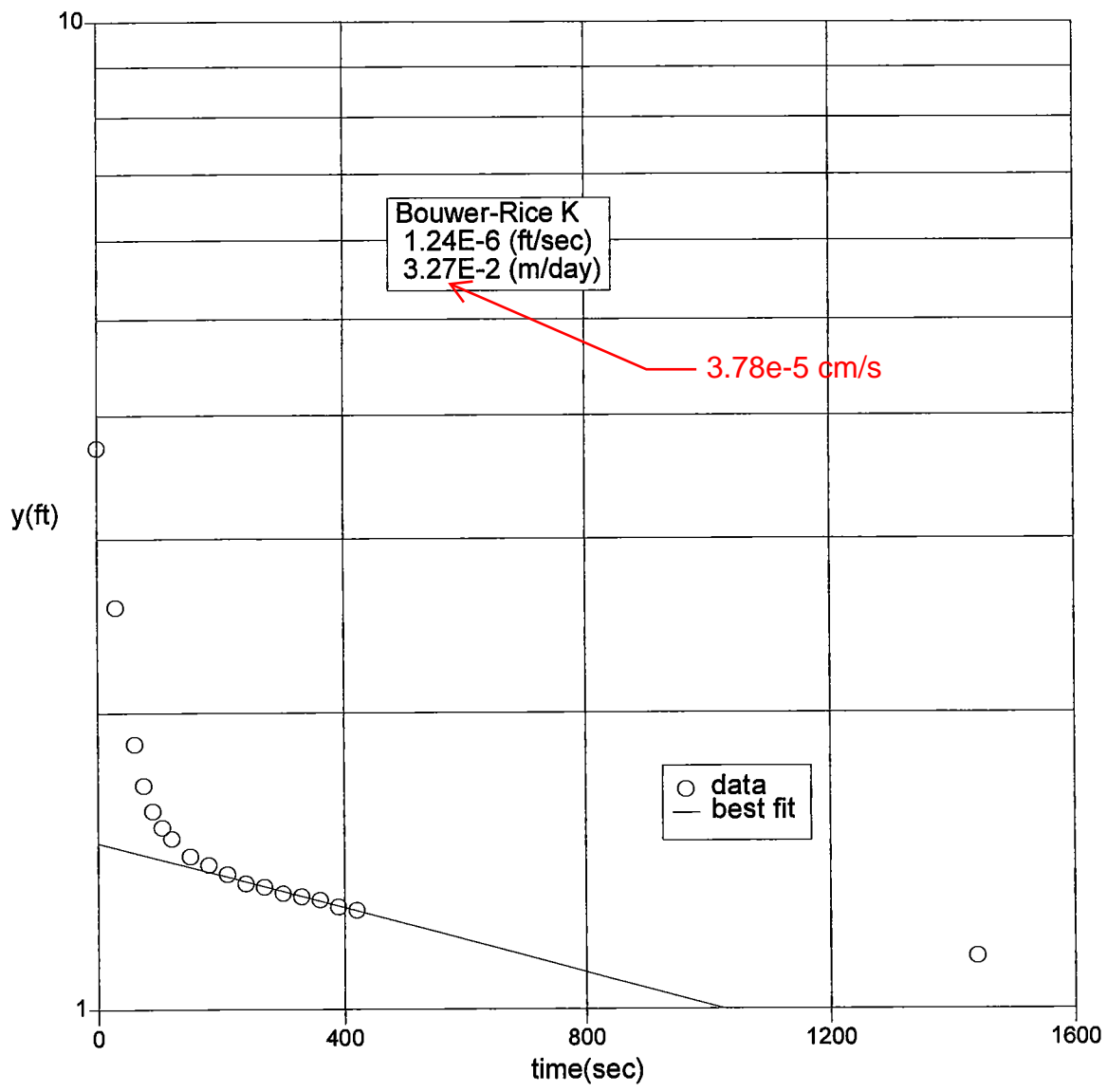
Least Squares Fit

slope: -3.10E-5
intercept: 3.13E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
0.0	23.650	0.0	22.980
660.0	22.750	1.0	22.514
720.0	22.420	1.0	22.472
780.0	22.230	1.0	22.431
840.0	22.010	1.0	22.389
900.0	21.830	1.0	22.347
960.0	21.740	1.0	22.306
3000.0	21.550	1.0	20.939
6000.0	19.900	1.0	19.080
9840.0	17.250	1.0	16.938
14220.0	14.830	1.0	14.788
18180.0	12.870	1.0	13.080
23310.0	11.060	1.0	11.157

North Dallas Sanitary Landfill - 9/9/97 - MW-9A



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: E97011
Well Number: MW-9A

Hydraulic Conductivity

Bouwer-Rice: 1.24E-6 (ft/sec), 3.27E-2 (m/day)

Well Geometry (ft)

H: 41.38
Le: 6.38
Lw: 6.38
rc: .083
rw: .344

drainable filter pack porosity: 0.15
effective radius: 1.54E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 18.56
A: 2.1
B: 0.291
C: 1.432
ln(Re/rw): 1.779

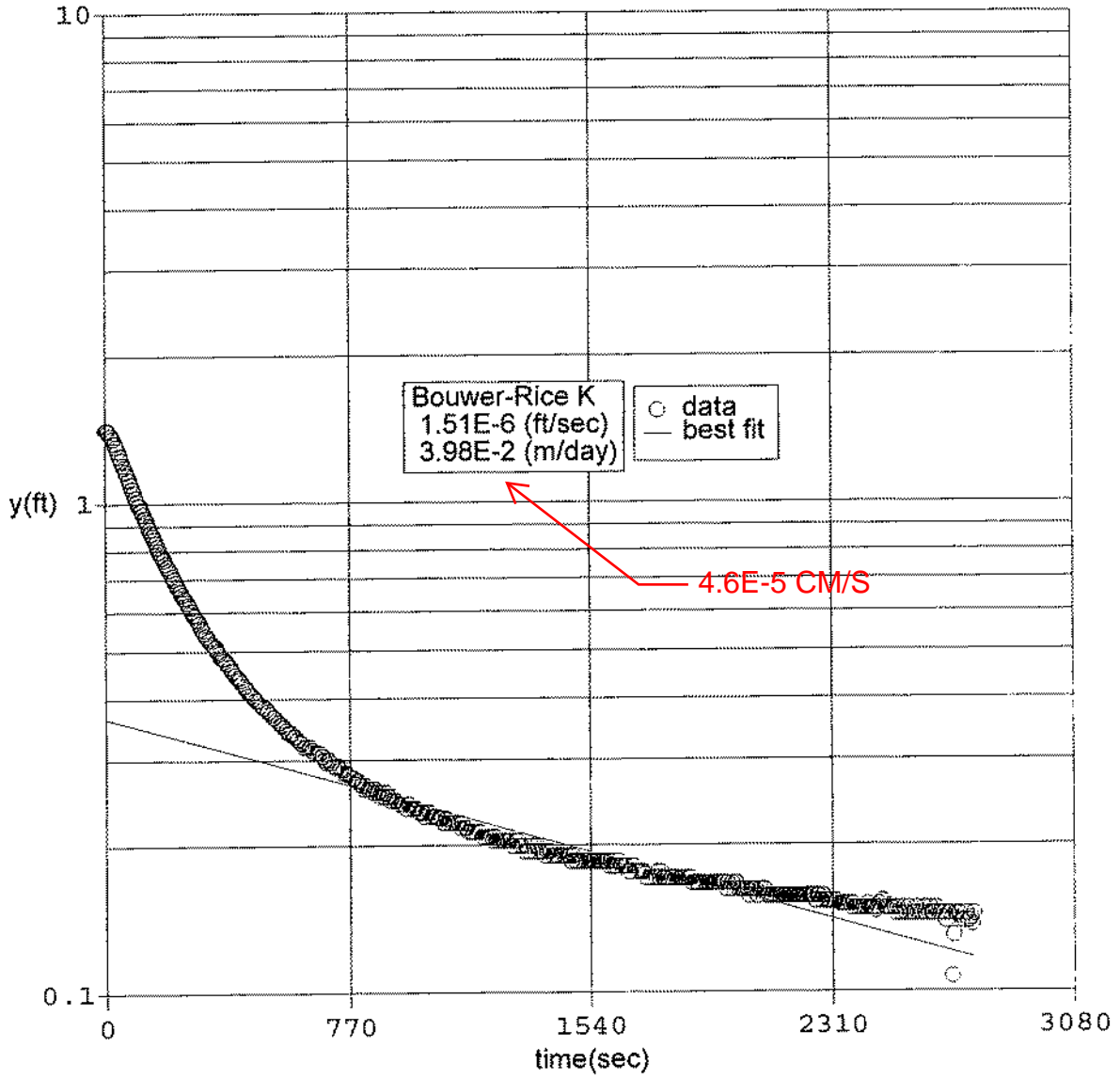
Least Squares Fit

slope: -3.78E-4
intercept: 3.88E-1

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
0.0	3.710	0.0	1.474
30.0	2.560	0.0	1.457
60.0	1.860	0.0	1.441
75.0	1.690	0.0	1.433
90.0	1.590	0.0	1.425
105.0	1.530	0.0	1.416
120.0	1.490	0.0	1.408
150.0	1.430	0.0	1.393
180.0	1.400	0.0	1.377
210.0	1.370	1.0	1.361
240.0	1.340	1.0	1.346
270.0	1.330	1.0	1.331
300.0	1.310	1.0	1.316
330.0	1.300	1.0	1.301
360.0	1.290	1.0	1.286
390.0	1.270	1.0	1.272
420.0	1.260	1.0	1.257
1440.0	1.130	0.0	0.855

North Dallas Sanitary Landfill - 9/9/97 - MW-9B



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: E97011
Well Number: MW-9B

Hydraulic Conductivity

Bouwer-Rice: 1.51E-6 (ft/sec), 3.98E-2 (m/day)

Well Geometry (ft)

H: 20.45
Le: 9.5
Lw: 20.45
rc: .083
rw: .344

drainable filter pack porosity: 0.15
effective radius: 1.54E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 27.636
A: 2.354
B: 0.338
C: 1.883
ln(Re/rw): 2.964

Least Squares Fit

slope: -4.11E-4
intercept: -1.01E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
0.0	1.410	0.0	0.365
5.0	1.410	0.0	0.364
10.0	1.401	0.0	0.363
15.0	1.378	0.0	0.363
20.0	1.375	0.0	0.362
25.0	1.357	0.0	0.361
30.0	1.325	0.0	0.360
35.0	1.306	0.0	0.360
40.0	1.281	0.0	0.359
45.0	1.249	0.0	0.358
50.0	1.225	0.0	0.358
55.0	1.198	0.0	0.357
60.0	1.184	0.0	0.356
65.0	1.161	0.0	0.355
70.0	1.140	0.0	0.355
75.0	1.117	0.0	0.354
80.0	1.094	0.0	0.353
85.0	1.071	0.0	0.352
90.0	1.052	0.0	0.352
95.0	1.027	0.0	0.351
100.0	1.009	0.0	0.350

105.0	0.990	0.0	0.350
110.0	0.990	0.0	0.349
115.0	0.969	0.0	0.348
120.0	0.951	0.0	0.347
125.0	0.933	0.0	0.347
130.0	0.919	0.0	0.346
135.0	0.900	0.0	0.345
140.0	0.886	0.0	0.345
145.0	0.870	0.0	0.344
150.0	0.856	0.0	0.343
155.0	0.843	0.0	0.342
160.0	0.829	0.0	0.342
165.0	0.815	0.0	0.341
170.0	0.799	0.0	0.340
175.0	0.785	0.0	0.340
180.0	0.776	0.0	0.339
185.0	0.766	0.0	0.338
190.0	0.753	0.0	0.338
195.0	0.743	0.0	0.337
200.0	0.732	0.0	0.336
205.0	0.723	0.0	0.335
210.0	0.709	0.0	0.335
215.0	0.700	0.0	0.334
220.0	0.690	0.0	0.333
225.0	0.676	0.0	0.333
230.0	0.672	0.0	0.332
235.0	0.660	0.0	0.331
240.0	0.651	0.0	0.331
245.0	0.642	0.0	0.330
250.0	0.637	0.0	0.329
255.0	0.628	0.0	0.329
260.0	0.619	0.0	0.328
265.0	0.614	0.0	0.327
270.0	0.603	0.0	0.327
275.0	0.593	0.0	0.326
280.0	0.589	0.0	0.325
285.0	0.580	0.0	0.325
290.0	0.575	0.0	0.324
295.0	0.570	0.0	0.323
300.0	0.557	0.0	0.323
305.0	0.552	0.0	0.322
310.0	0.545	0.0	0.321
315.0	0.536	0.0	0.321
320.0	0.531	0.0	0.320
325.0	0.527	0.0	0.319
330.0	0.517	0.0	0.319
335.0	0.517	0.0	0.318
340.0	0.513	0.0	0.317
345.0	0.508	0.0	0.317
350.0	0.499	0.0	0.316
355.0	0.494	0.0	0.315
360.0	0.487	0.0	0.315
365.0	0.483	0.0	0.314
370.0	0.483	0.0	0.313
375.0	0.478	0.0	0.313
380.0	0.473	0.0	0.312
385.0	0.464	0.0	0.312

390.0	0.464	0.0	0.311
395.0	0.455	0.0	0.310
400.0	0.455	0.0	0.310
405.0	0.446	0.0	0.309
410.0	0.441	0.0	0.308
415.0	0.441	0.0	0.308
420.0	0.437	0.0	0.307
425.0	0.432	0.0	0.306
430.0	0.425	0.0	0.306
435.0	0.425	0.0	0.305
440.0	0.420	0.0	0.305
445.0	0.416	0.0	0.304
450.0	0.411	0.0	0.303
455.0	0.407	0.0	0.303
460.0	0.407	0.0	0.302
465.0	0.402	0.0	0.301
470.0	0.397	0.0	0.301
475.0	0.397	0.0	0.300
480.0	0.397	0.0	0.300
485.0	0.388	0.0	0.299
490.0	0.388	0.0	0.298
495.0	0.384	0.0	0.298
500.0	0.384	0.0	0.297
505.0	0.381	0.0	0.296
510.0	0.377	0.0	0.296
515.0	0.372	0.0	0.295
520.0	0.372	0.0	0.295
525.0	0.367	0.0	0.294
530.0	0.367	0.0	0.293
535.0	0.363	0.0	0.293
540.0	0.358	0.0	0.292
545.0	0.358	0.0	0.292
550.0	0.354	0.0	0.291
555.0	0.354	0.0	0.290
560.0	0.349	0.0	0.290
565.0	0.344	0.0	0.289
570.0	0.344	0.0	0.289
575.0	0.340	1.0	0.288
580.0	0.340	1.0	0.287
585.0	0.340	1.0	0.287
590.0	0.335	1.0	0.286
595.0	0.335	1.0	0.286
600.0	0.330	1.0	0.285
605.0	0.330	1.0	0.285
610.0	0.326	1.0	0.284
615.0	0.324	1.0	0.283
620.0	0.319	1.0	0.283
625.0	0.319	1.0	0.282
630.0	0.319	1.0	0.282
635.0	0.319	1.0	0.281
640.0	0.319	1.0	0.280
645.0	0.319	1.0	0.280
650.0	0.314	1.0	0.279
655.0	0.310	1.0	0.279
660.0	0.310	1.0	0.278
665.0	0.310	1.0	0.278
670.0	0.310	1.0	0.277

675.0	0.310	1.0	0.276
680.0	0.305	1.0	0.276
685.0	0.305	1.0	0.275
690.0	0.300	1.0	0.275
695.0	0.296	1.0	0.274
700.0	0.300	1.0	0.274
705.0	0.300	1.0	0.273
710.0	0.296	1.0	0.273
715.0	0.291	1.0	0.272
720.0	0.291	1.0	0.271
725.0	0.291	1.0	0.271
730.0	0.291	1.0	0.270
735.0	0.291	1.0	0.270
740.0	0.287	1.0	0.269
745.0	0.282	1.0	0.269
750.0	0.287	1.0	0.268
755.0	0.282	1.0	0.268
760.0	0.280	1.0	0.267
765.0	0.280	1.0	0.266
770.0	0.280	1.0	0.266
775.0	0.275	1.0	0.265
780.0	0.275	1.0	0.265
785.0	0.275	1.0	0.264
790.0	0.271	1.0	0.264
795.0	0.271	1.0	0.263
800.0	0.271	1.0	0.263
805.0	0.266	1.0	0.262
810.0	0.266	1.0	0.262
815.0	0.261	1.0	0.261
820.0	0.266	1.0	0.260
825.0	0.261	1.0	0.260
830.0	0.261	1.0	0.259
835.0	0.261	1.0	0.259
840.0	0.261	1.0	0.258
845.0	0.257	1.0	0.258
850.0	0.261	1.0	0.257
855.0	0.257	1.0	0.257
860.0	0.257	1.0	0.256
865.0	0.252	1.0	0.256
870.0	0.257	1.0	0.255
875.0	0.252	1.0	0.255
880.0	0.252	1.0	0.254
885.0	0.257	1.0	0.254
890.0	0.252	1.0	0.253
895.0	0.252	1.0	0.253
900.0	0.247	1.0	0.252
905.0	0.252	1.0	0.252
910.0	0.247	1.0	0.251
915.0	0.247	1.0	0.250
920.0	0.247	1.0	0.250
925.0	0.243	1.0	0.249
930.0	0.243	1.0	0.249
935.0	0.243	1.0	0.248
940.0	0.243	1.0	0.248
945.0	0.243	1.0	0.247
950.0	0.238	1.0	0.247
955.0	0.243	1.0	0.246

960.0	0.243	1.0	0.246
965.0	0.238	1.0	0.245
970.0	0.238	1.0	0.245
975.0	0.238	1.0	0.244
980.0	0.238	1.0	0.244
985.0	0.238	1.0	0.243
990.0	0.234	1.0	0.243
995.0	0.234	1.0	0.242
1000.0	0.234	1.0	0.242
1005.0	0.234	1.0	0.241
1010.0	0.229	1.0	0.241
1015.0	0.234	1.0	0.240
1020.0	0.234	1.0	0.240
1025.0	0.234	1.0	0.239
1030.0	0.229	1.0	0.239
1035.0	0.229	1.0	0.238
1040.0	0.229	1.0	0.238
1045.0	0.229	1.0	0.237
1050.0	0.229	1.0	0.237
1055.0	0.227	1.0	0.236
1060.0	0.227	1.0	0.236
1065.0	0.227	1.0	0.236
1070.0	0.222	1.0	0.235
1075.0	0.222	1.0	0.235
1080.0	0.227	1.0	0.234
1085.0	0.222	1.0	0.234
1090.0	0.222	1.0	0.233
1095.0	0.222	1.0	0.233
1100.0	0.222	1.0	0.232
1105.0	0.222	1.0	0.232
1110.0	0.222	1.0	0.231
1115.0	0.222	1.0	0.231
1120.0	0.222	1.0	0.230
1125.0	0.217	1.0	0.230
1130.0	0.222	1.0	0.229
1135.0	0.217	1.0	0.229
1140.0	0.217	1.0	0.228
1145.0	0.217	1.0	0.228
1150.0	0.213	1.0	0.227
1155.0	0.213	1.0	0.227
1160.0	0.213	1.0	0.226
1165.0	0.213	1.0	0.226
1170.0	0.213	1.0	0.226
1175.0	0.213	1.0	0.225
1180.0	0.213	1.0	0.225
1185.0	0.213	1.0	0.224
1190.0	0.213	1.0	0.224
1195.0	0.208	1.0	0.223
1200.0	0.208	1.0	0.223
1205.0	0.208	1.0	0.222
1210.0	0.208	1.0	0.222
1215.0	0.208	1.0	0.221
1220.0	0.208	1.0	0.221
1225.0	0.208	1.0	0.221
1230.0	0.204	1.0	0.220
1235.0	0.208	1.0	0.220
1240.0	0.204	1.0	0.219

1245.0	0.204	1.0	0.219
1250.0	0.204	1.0	0.218
1255.0	0.204	1.0	0.218
1260.0	0.204	1.0	0.217
1265.0	0.204	1.0	0.217
1270.0	0.204	1.0	0.216
1275.0	0.204	1.0	0.216
1280.0	0.204	1.0	0.216
1285.0	0.204	1.0	0.215
1290.0	0.199	1.0	0.215
1295.0	0.199	1.0	0.214
1300.0	0.204	1.0	0.214
1305.0	0.204	1.0	0.213
1310.0	0.204	1.0	0.213
1315.0	0.199	1.0	0.212
1320.0	0.199	1.0	0.212
1325.0	0.199	1.0	0.212
1330.0	0.194	1.0	0.211
1335.0	0.199	1.0	0.211
1340.0	0.194	1.0	0.210
1345.0	0.194	1.0	0.210
1350.0	0.199	1.0	0.209
1355.0	0.194	1.0	0.209
1360.0	0.199	1.0	0.209
1365.0	0.194	1.0	0.208
1370.0	0.199	1.0	0.208
1375.0	0.194	1.0	0.207
1380.0	0.194	1.0	0.207
1385.0	0.194	1.0	0.206
1390.0	0.194	1.0	0.206
1395.0	0.190	1.0	0.206
1400.0	0.194	1.0	0.205
1405.0	0.194	1.0	0.205
1410.0	0.194	1.0	0.204
1415.0	0.190	1.0	0.204
1420.0	0.190	1.0	0.204
1425.0	0.190	1.0	0.203
1430.0	0.190	1.0	0.203
1435.0	0.190	1.0	0.202
1440.0	0.190	1.0	0.202
1445.0	0.190	1.0	0.201
1450.0	0.190	1.0	0.201
1455.0	0.190	1.0	0.201
1460.0	0.190	1.0	0.200
1465.0	0.190	1.0	0.200
1470.0	0.190	1.0	0.199
1475.0	0.190	1.0	0.199
1480.0	0.185	1.0	0.199
1485.0	0.190	1.0	0.198
1490.0	0.185	1.0	0.198
1495.0	0.185	1.0	0.197
1500.0	0.185	1.0	0.197
1505.0	0.185	1.0	0.197
1510.0	0.185	1.0	0.196
1515.0	0.185	1.0	0.196
1520.0	0.185	1.0	0.195
1525.0	0.185	1.0	0.195

1530.0	0.185	1.0	0.195
1535.0	0.185	1.0	0.194
1540.0	0.185	1.0	0.194
1545.0	0.185	1.0	0.193
1550.0	0.185	1.0	0.193
1555.0	0.185	1.0	0.193
1560.0	0.185	1.0	0.192
1565.0	0.185	1.0	0.192
1570.0	0.185	1.0	0.191
1575.0	0.185	1.0	0.191
1580.0	0.185	1.0	0.191
1585.0	0.185	1.0	0.190
1590.0	0.185	1.0	0.190
1595.0	0.185	1.0	0.189
1600.0	0.181	1.0	0.189
1605.0	0.185	1.0	0.189
1610.0	0.181	1.0	0.188
1615.0	0.181	1.0	0.188
1620.0	0.181	1.0	0.187
1625.0	0.181	1.0	0.187
1630.0	0.185	1.0	0.187
1635.0	0.181	1.0	0.186
1640.0	0.181	1.0	0.186
1645.0	0.181	1.0	0.186
1650.0	0.181	1.0	0.185
1655.0	0.181	1.0	0.185
1660.0	0.176	1.0	0.184
1665.0	0.176	1.0	0.184
1670.0	0.181	1.0	0.184
1675.0	0.181	1.0	0.183
1680.0	0.181	1.0	0.183
1685.0	0.176	1.0	0.182
1690.0	0.176	1.0	0.182
1695.0	0.176	1.0	0.182
1700.0	0.176	1.0	0.181
1705.0	0.176	1.0	0.181
1710.0	0.176	1.0	0.181
1715.0	0.171	1.0	0.180
1720.0	0.171	1.0	0.180
1725.0	0.171	1.0	0.180
1730.0	0.171	1.0	0.179
1735.0	0.171	1.0	0.179
1740.0	0.171	1.0	0.178
1745.0	0.171	1.0	0.178
1750.0	0.171	1.0	0.178
1755.0	0.176	1.0	0.177
1760.0	0.171	1.0	0.177
1765.0	0.176	1.0	0.177
1770.0	0.171	1.0	0.176
1775.0	0.171	1.0	0.176
1780.0	0.171	1.0	0.175
1785.0	0.171	1.0	0.175
1790.0	0.171	1.0	0.175
1795.0	0.171	1.0	0.174
1800.0	0.171	1.0	0.174
1805.0	0.171	1.0	0.174
1810.0	0.171	1.0	0.173

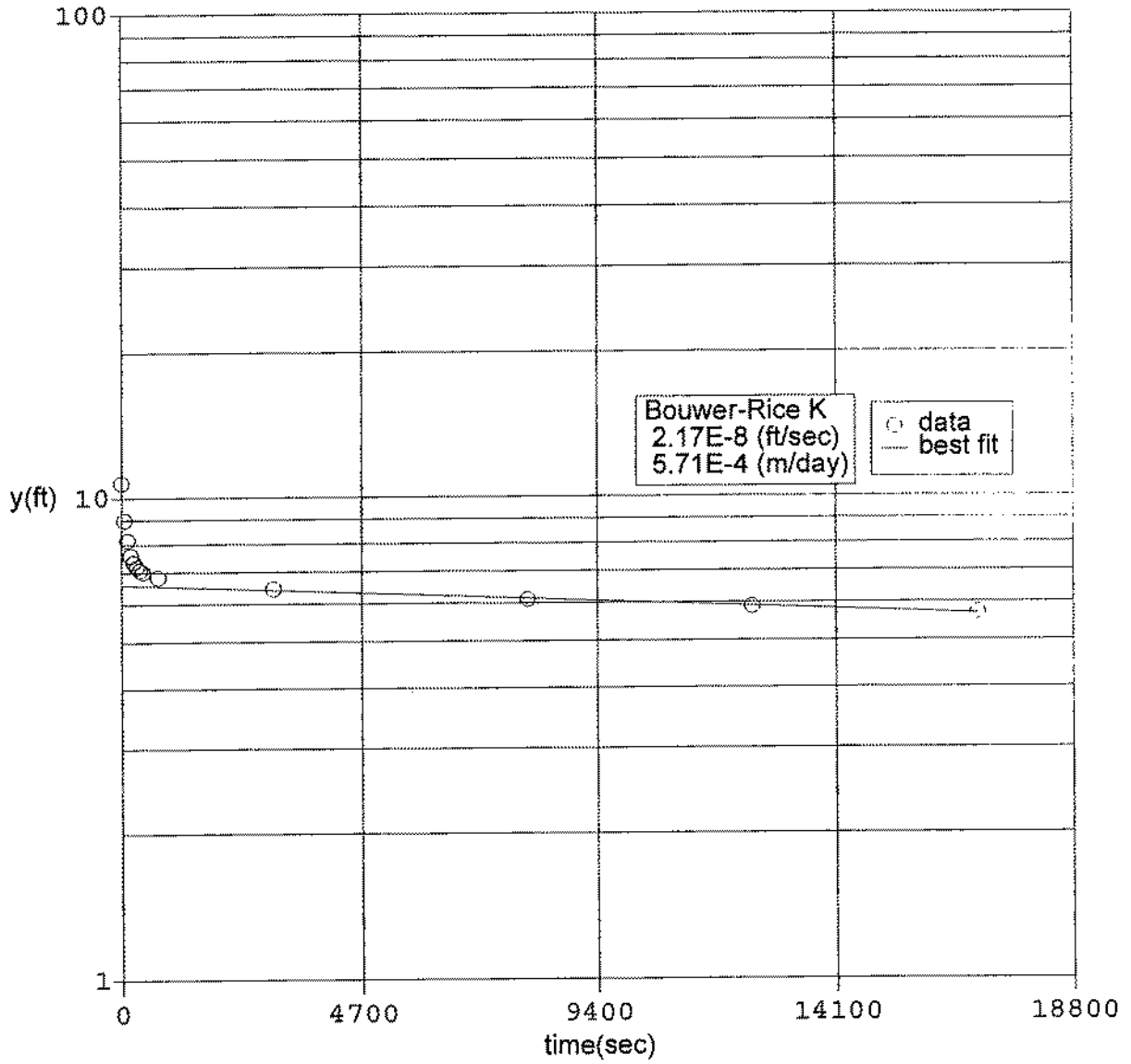
1815.0	0.171	1.0	0.173
1820.0	0.171	1.0	0.173
1825.0	0.171	1.0	0.172
1830.0	0.171	1.0	0.172
1835.0	0.171	1.0	0.172
1840.0	0.171	1.0	0.171
1845.0	0.171	1.0	0.171
1850.0	0.171	1.0	0.171
1855.0	0.171	1.0	0.170
1860.0	0.171	1.0	0.170
1865.0	0.167	1.0	0.169
1870.0	0.167	1.0	0.169
1875.0	0.167	1.0	0.169
1880.0	0.167	1.0	0.168
1885.0	0.167	1.0	0.168
1890.0	0.167	1.0	0.168
1895.0	0.167	1.0	0.167
1900.0	0.167	1.0	0.167
1905.0	0.167	1.0	0.167
1910.0	0.167	1.0	0.166
1915.0	0.167	1.0	0.166
1920.0	0.167	1.0	0.166
1925.0	0.167	1.0	0.165
1930.0	0.167	1.0	0.165
1935.0	0.167	1.0	0.165
1940.0	0.167	1.0	0.164
1945.0	0.167	1.0	0.164
1950.0	0.167	1.0	0.164
1955.0	0.167	1.0	0.163
1960.0	0.167	1.0	0.163
1965.0	0.167	1.0	0.163
1970.0	0.162	1.0	0.162
1975.0	0.167	1.0	0.162
1980.0	0.162	1.0	0.162
1985.0	0.162	1.0	0.161
1990.0	0.167	1.0	0.161
1995.0	0.162	1.0	0.161
2000.0	0.167	1.0	0.160
2005.0	0.167	1.0	0.160
2010.0	0.162	1.0	0.160
2015.0	0.162	1.0	0.159
2020.0	0.162	1.0	0.159
2025.0	0.162	1.0	0.159
2030.0	0.162	1.0	0.158
2035.0	0.162	1.0	0.158
2040.0	0.162	1.0	0.158
2045.0	0.157	1.0	0.157
2050.0	0.162	1.0	0.157
2055.0	0.162	1.0	0.157
2060.0	0.162	1.0	0.156
2065.0	0.162	1.0	0.156
2070.0	0.157	1.0	0.156
2075.0	0.162	1.0	0.155
2080.0	0.162	1.0	0.155
2085.0	0.162	1.0	0.155
2090.0	0.162	1.0	0.154
2095.0	0.162	1.0	0.154

2100.0	0.157	1.0	0.154
2105.0	0.157	1.0	0.154
2110.0	0.157	1.0	0.153
2115.0	0.157	1.0	0.153
2120.0	0.157	1.0	0.153
2125.0	0.157	1.0	0.152
2130.0	0.157	1.0	0.152
2135.0	0.157	1.0	0.152
2140.0	0.157	1.0	0.151
2145.0	0.157	1.0	0.151
2150.0	0.157	1.0	0.151
2155.0	0.157	1.0	0.150
2160.0	0.157	1.0	0.150
2165.0	0.157	1.0	0.150
2170.0	0.157	1.0	0.149
2175.0	0.157	1.0	0.149
2180.0	0.157	1.0	0.149
2185.0	0.157	1.0	0.149
2190.0	0.157	1.0	0.148
2195.0	0.157	1.0	0.148
2200.0	0.157	1.0	0.148
2205.0	0.157	1.0	0.147
2210.0	0.157	1.0	0.147
2215.0	0.157	1.0	0.147
2220.0	0.157	1.0	0.146
2225.0	0.157	1.0	0.146
2230.0	0.157	1.0	0.146
2235.0	0.157	1.0	0.146
2240.0	0.157	1.0	0.145
2245.0	0.157	1.0	0.145
2250.0	0.157	1.0	0.145
2255.0	0.153	1.0	0.144
2260.0	0.157	1.0	0.144
2265.0	0.157	1.0	0.144
2270.0	0.153	1.0	0.143
2275.0	0.153	1.0	0.143
2280.0	0.157	1.0	0.143
2285.0	0.153	1.0	0.143
2290.0	0.153	1.0	0.142
2295.0	0.153	1.0	0.142
2300.0	0.153	1.0	0.142
2305.0	0.153	1.0	0.141
2310.0	0.153	1.0	0.141
2315.0	0.153	1.0	0.141
2320.0	0.153	1.0	0.141
2325.0	0.153	1.0	0.140
2330.0	0.151	1.0	0.140
2335.0	0.151	0.0	0.140
2340.0	0.151	0.0	0.139
2345.0	0.151	0.0	0.139
2350.0	0.151	0.0	0.139
2355.0	0.151	0.0	0.139
2360.0	0.151	0.0	0.138
2365.0	0.151	0.0	0.138
2370.0	0.148	0.0	0.138
2375.0	0.151	0.0	0.137
2380.0	0.148	0.0	0.137

2385.0	0.148	0.0	0.137
2390.0	0.148	0.0	0.137
2395.0	0.148	0.0	0.136
2400.0	0.148	0.0	0.136
2405.0	0.148	0.0	0.136
2410.0	0.148	0.0	0.135
2415.0	0.148	0.0	0.135
2420.0	0.148	0.0	0.135
2425.0	0.151	0.0	0.135
2430.0	0.148	0.0	0.134
2435.0	0.148	0.0	0.134
2440.0	0.148	0.0	0.134
2445.0	0.148	0.0	0.134
2450.0	0.146	0.0	0.133
2455.0	0.148	0.0	0.133
2460.0	0.151	0.0	0.133
2465.0	0.153	0.0	0.132
2470.0	0.153	0.0	0.132
2475.0	0.153	0.0	0.132
2480.0	0.148	0.0	0.132
2485.0	0.148	0.0	0.131
2490.0	0.148	0.0	0.131
2495.0	0.148	0.0	0.131
2500.0	0.148	0.0	0.131
2505.0	0.148	0.0	0.130
2510.0	0.148	0.0	0.130
2515.0	0.144	0.0	0.130
2520.0	0.148	0.0	0.129
2525.0	0.144	0.0	0.129
2530.0	0.144	0.0	0.129
2535.0	0.144	0.0	0.129
2540.0	0.148	0.0	0.128
2545.0	0.144	0.0	0.128
2550.0	0.144	0.0	0.128
2555.0	0.148	0.0	0.128
2560.0	0.144	0.0	0.127
2565.0	0.144	0.0	0.127
2570.0	0.144	0.0	0.127
2575.0	0.144	0.0	0.127
2580.0	0.148	0.0	0.126
2585.0	0.144	0.0	0.126
2590.0	0.144	0.0	0.126
2595.0	0.144	0.0	0.126
2600.0	0.144	0.0	0.125
2605.0	0.148	0.0	0.125
2610.0	0.144	0.0	0.125
2615.0	0.148	0.0	0.124
2620.0	0.144	0.0	0.124
2625.0	0.148	0.0	0.124
2630.0	0.144	0.0	0.124
2635.0	0.144	0.0	0.123
2640.0	0.148	0.0	0.123
2645.0	0.148	0.0	0.123
2650.0	0.144	0.0	0.123
2655.0	0.144	0.0	0.122
2660.0	0.144	0.0	0.122
2665.0	0.144	0.0	0.122

2670.0	0.144	0.0	0.122
2675.0	0.139	0.0	0.121
2680.0	0.144	0.0	0.121
2685.0	0.144	0.0	0.121
2690.0	0.144	0.0	0.121
2695.0	0.107	0.0	0.120
2700.0	0.130	0.0	0.120
2705.0	0.144	0.0	0.120
2710.0	0.144	0.0	0.120
2715.0	0.144	0.0	0.119
2720.0	0.144	0.0	0.119
2725.0	0.139	0.0	0.119
2730.0	0.139	0.0	0.119
2735.0	0.139	0.0	0.118
2740.0	0.144	0.0	0.118
2745.0	0.139	0.0	0.118
2750.0	0.139	0.0	0.118
2755.0	0.141	0.0	0.118
2760.0	0.137	0.0	0.117
2765.0	0.144	0.0	0.117

North Dallas Sanitary Landfill - 9/9/97 - MW-11



Slug Test Results

Title: North Dallas Sanitary Landfill
Client: North Dallas Sanitary Landfill
Job Number: E97011
Well Number: MW-11

Hydraulic Conductivity

Bouwer-Rice: 2.17E-8 (ft/sec), 5.71E-4 (m/day)

Well Geometry (ft)

H: 16.26
Le: 13.0
Lw: 15.36
rc: .083
rw: .344

drainable filter pack porosity: 0.15
effective radius: 1.54E-1 (ft)

Bouwer Rice Coefficients

Le/rw: 37.818
A: 2.639
B: 0.389
C: 2.246
ln(Re/rw): 2.709

Least Squares Fit

slope: -8.83E-6
intercept: 1.89E+0

Recovery Data and Fit

time(sec)	y(ft)	weight	fit(ft)
0.0	10.730	0.0	6.588
60.0	8.980	0.0	6.584
120.0	8.150	0.0	6.581
180.0	7.580	0.0	6.577
240.0	7.340	0.0	6.574
300.0	7.170	0.0	6.570
360.0	7.060	0.0	6.567
420.0	6.990	0.0	6.563
720.0	6.820	0.0	6.546
2970.0	6.450	1.0	6.417
8010.0	6.100	1.0	6.138
12450.0	5.880	1.0	5.902
16920.0	5.700	1.0	5.673

APPENDIX E

**PERMEABILITY ANALYSIS AND PARTICLE SIZE DISTRIBUTION
CURVES**

ALLENDER BUTZKE ENGINEERS INC.

GEOTECHNICAL • ENVIRONMENTAL • CONSTRUCTION Q.C.

REC'D OCT 13 1997



Barker Environmental Services
Attn: Rochelle Shaw
1300 Cummings Rd., Suite 201
Des Moines, IA 50315

October 10, 1997

RE: Laboratory Soil Analysis
North Dallas County Landfill
PN 971529

Dear Ms. Shaw:

Enclosed are the results of flexible wall permeability and grain size tests performed on two samples submitted from the above project. The soils submitted consisted of undisturbed Shelby Tubes delivered in August 1997. Permeability characteristics of the undisturbed samples were evaluated by conducting flexible wall constant head permeability tests on 2 inches of each sample under a water pressure of 5 psi, i.e., approximately a water head of 11.5 feet. The results of the permeability test are provided on the following Table A. Results of the grain size are provided on the enclosed Figure Nos. 1 and 2.

TABLE A

Sample Designation	Moisture Content (percent)	Dry Density (pcf)	Coefficient of Permeability (cm/sec)
MW-9A (10 - 12 feet)	14.1	113.1	3.1×10^{-8}
MW-11 (25 - 27 feet)	14.2	119.5	1.5×10^{-8}

compare to
3.78e-5
horizontal

If there are any questions concerning these test results, please contact us at your convenience.

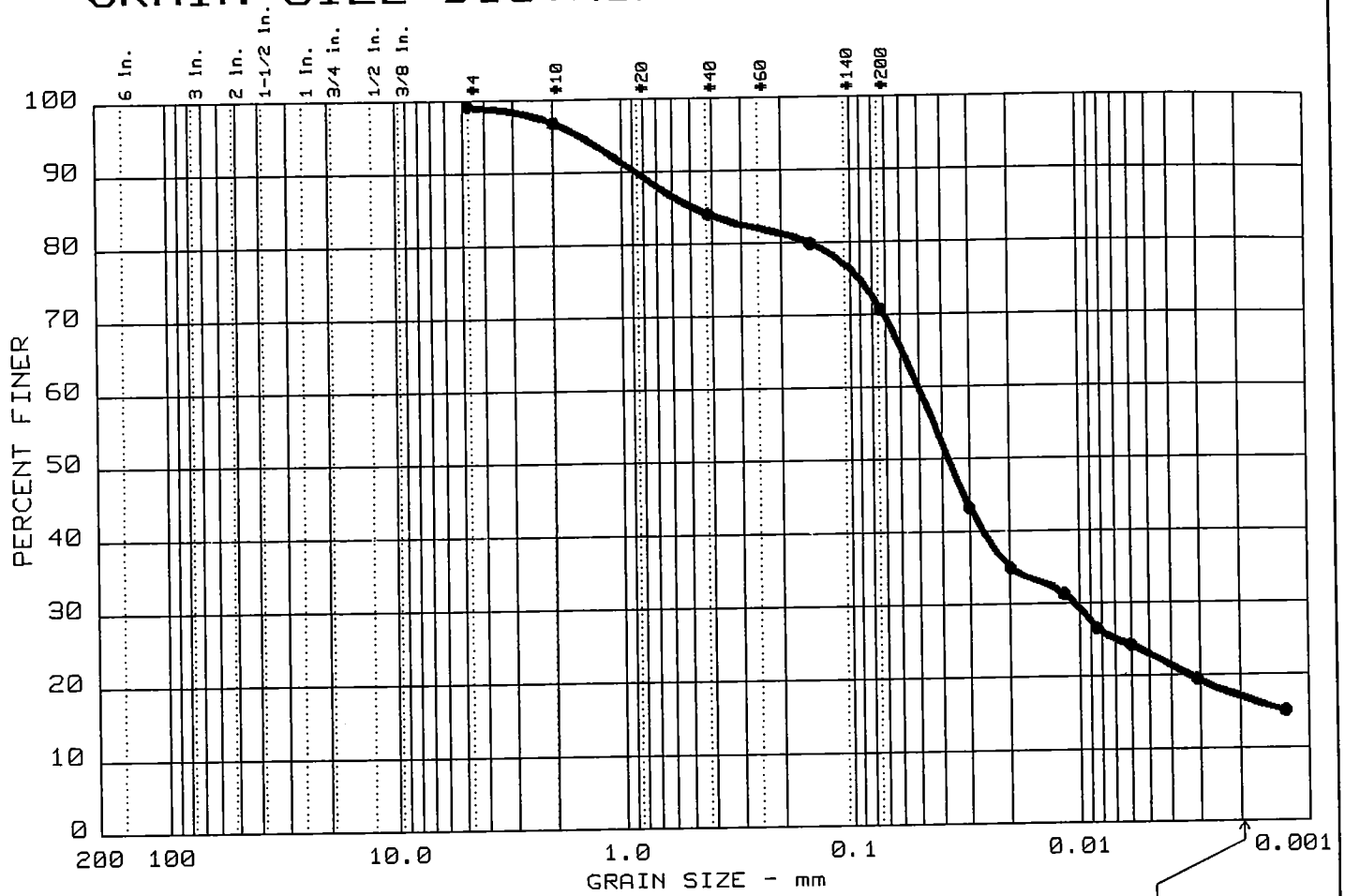
Respectfully submitted,
ALLENDER BUTZKE ENGINEERS INC.

David Logemann, P.E.
Project Engineer

POTENTIALLY
APPLIES. BORING
LOG REPORTS
SANDY
CLAY/TRACE
GRAVEL IN LAYER
15-20' RANGE

DKL/cg
3 PC Above

GRAIN SIZE DISTRIBUTION TEST REPORT



● % +3"	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.8	28.4	53.7	17.1

LL	PI	D ₈₅	D ₆₀	D ₅₀	D ₃₀	D ₁₅	D ₁₀	C _c	C _u
		0.48		0.04	0.010				

MATERIAL DESCRIPTION	USCS	AASHTO
● Gray sandy lean clay trace of gravel		

Project No.: 971529
 Project: North Dallas County Landfill
 ● Location: MW - 11 (25' - 27')

Date: 10/10/97

GRAIN SIZE DISTRIBUTION TEST REPORT
ALLENDER BUTZKE ENGINEERS INC.

Remarks:

Figure No. 2



GeoStudio Example File Reinforcement with Piles

To see the latest GeoStudio learning content, visit [Seequent Learning Centre](#) and search the catalogue for “GeoStudio”.

Introduction

Piles are a common stabilization method for geotechnical systems as they can withstand considerable shear. SLOPE/W stability analyses simulate pile reinforcement by including a resisting force in the limit equilibrium formulation representing the shear capacity of a pile row. This example compares the stability of a riverbank under natural conditions and when the riverbank is reinforced with piles.

Background

In SLOPE/W, pile reinforcement only provides shear resistance. The shear resisting force, S , per unit length along the pile row (in the out-of-page direction) is:

$$SR = \frac{SF}{s \cdot RF_s} \tag{Equation 1}$$

where SF is the shear force of the piles, s is the pile spacing, and RF_s is the shear reduction factor. The shear resistance is applied at the base of the slice that includes the pile, and may act parallel to the slip surface or perpendicular to the reinforcement.

Numerical Simulation

The simulated geometry was developed to represent a failed riverbank that may continue to move under elevated pore water pressure conditions – for example, due to spring snowmelt (Figure 1). Lacustrine sediments, underlain by a competent till, form the riverbank. Between the lacustrine sediments and till is a weak layer, which is the ultimate source for stability issues in this system. The Mohr-Coulomb material model defines the properties of the lacustrine sediments and weak layer, and the till was set as impenetrable bedrock (Figure 1).

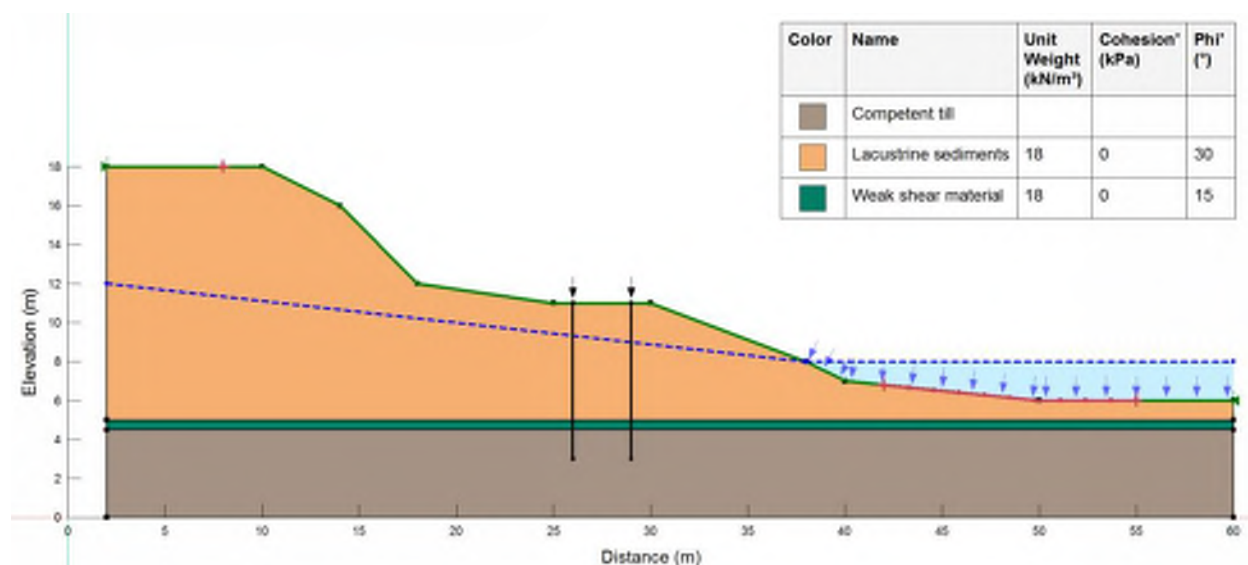


Figure 1. Riverbank configuration including the pile reinforcement, pore water pressure, and trial slip surface definition.

The first analysis in the project file considers the riverbank stability without reinforcement, while the second includes two rows of piles that are founded in the competent till (Figure 1). The piles

GeoStudio Example - Reinforcement with Piles

are 8 m long, 1 m apart (in the out-of-page direction), and are vertically oriented. A shear force of 100 kN and a shear reduction factor of 2 are assigned to each pile row, such that the shear resisting force per unit length along the river is:

$$SR = \frac{100}{(1)(2)} = 50 \text{ kN} \quad \text{Equation 2}$$

This resisting force acts parallel to the slip surface, as defined in the pile reinforcements settings.

The trial slip surfaces are defined using the Entry and Exit method in both analyses. All slip surfaces originate from the same point on the top of the bank and exit at the bottom, under the river. The Morgenstern-Price limit equilibrium method is used to determine the factor of safety of the trial slip surfaces. A piezometric line establishes the pore water pressure conditions throughout the domain (Figure 1).

Results and Discussion

Analysis 1 produced a large band of slip surfaces with a factor of safety between 1.0 and 1.1, with the critical factor of safety just above 1 (Figure 2). Thus, under natural conditions, the riverbank is unstable. With pile reinforcement, the two 50 kN shear resisting forces (one for each pile) are included in the limit equilibrium calculations, causing the factor of safety to increase by approximately 15% (Figure 3). Application of the pile resisting forces is evident in the free body diagrams for the slices containing the piles, Slices 13 and 15 (Figure 4). Thus, the piles provided enough resisting force to prevent movement of the riverbank under the given pore water pressure conditions.

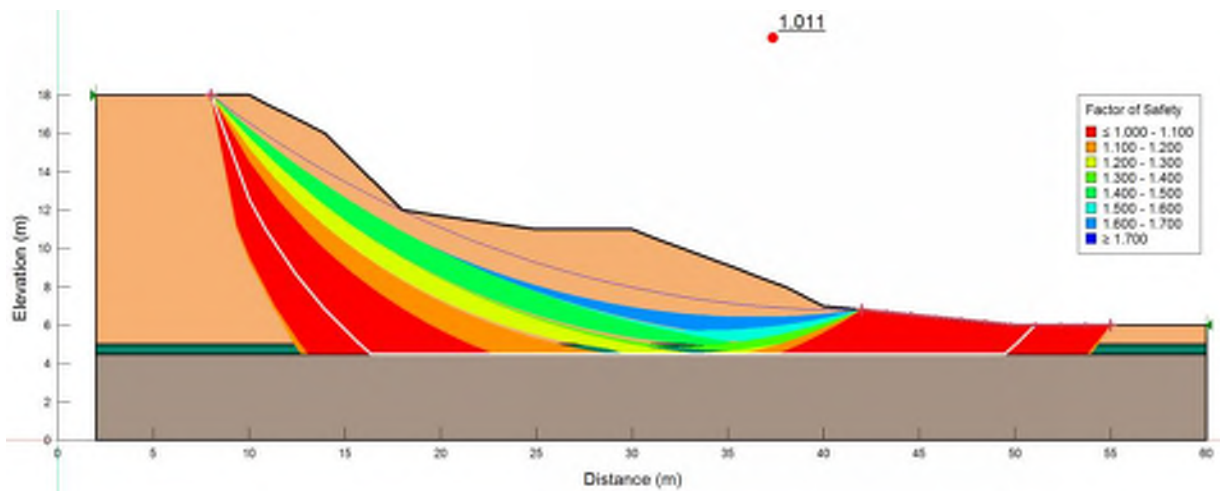


Figure 2. Stability results for the natural state (Analysis 1).

GeoStudio Example - Reinforcement with Piles

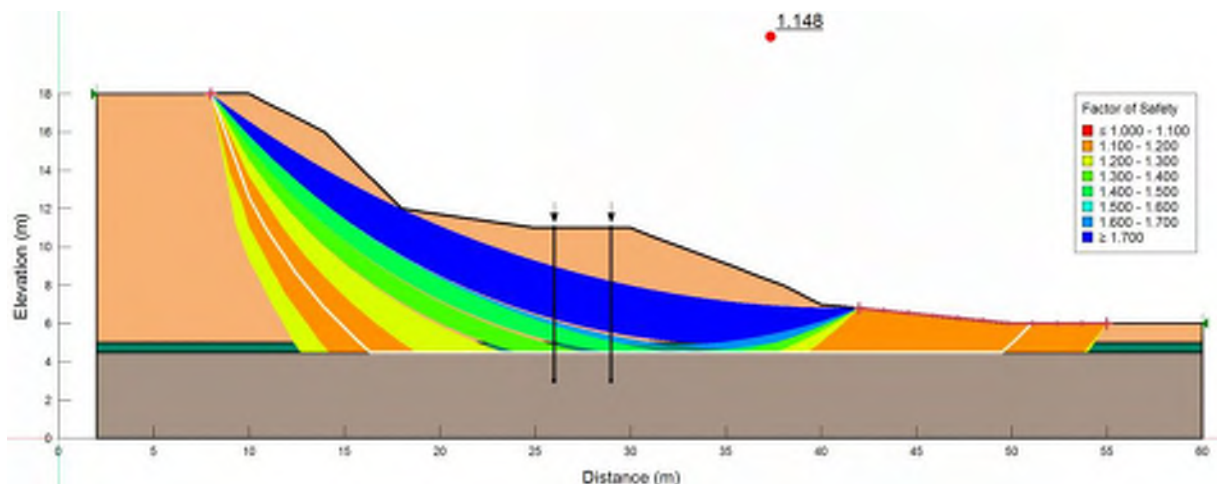


Figure 3. Stability results with pile reinforcement (Analysis 2).

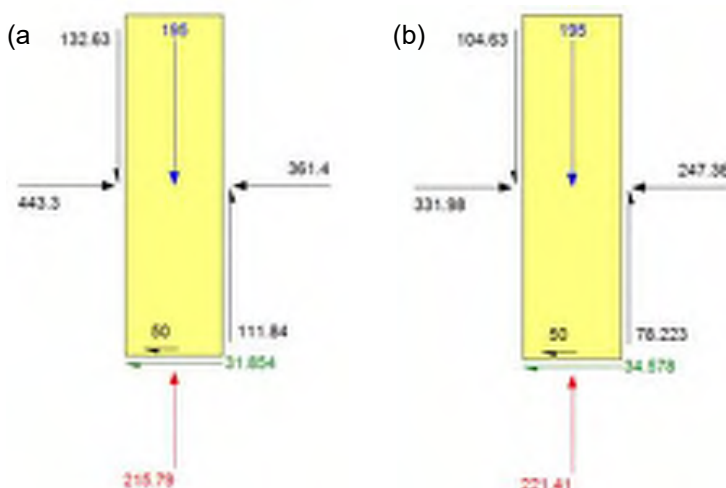


Figure 4. Free body diagrams for (a) Slice 13 and (b) Slice 15 in Analysis 2, with the pile resisting forces (50 kN) acting parallel to the slip surface.

One of the challenges with simulating reinforcement in a limit equilibrium analysis is determining the shear force available from the structural element – which is a true soil-structure interaction problem. For example, the stresses developed in the pile are dependent on the relative stiffness between the pile and the surrounding soil. Thus, SIGMA/W is ideal for assessing stability of systems with reinforcement, as it simulates the shear and moment distributions within the pile.

However, piles can be considered in a SLOPE/W analysis, like this one, with an understanding of the general design philosophy for piles and the implications of using a limitation equilibrium analysis. Pile design ultimately is aimed at halting movement of an unstable slope, as opposed to increasing the factor of safety. Even if the factor of safety of the sliding mass remains around unity, movement ceases as long as the piles remain intact. In this sense, the structural design of piles is more important than the margin of safety against movement.

Summary and Conclusions

Slope stabilization with pile reinforcement can be simulated in SLOPE/W as demonstrated above. In this case, the piles provided enough shear resistance to increase the factor of safety and prevent movement of the riverbank under the applied pore water pressures. SLOPE/W

GeoStudio Example - Reinforcement with Piles

analyses can be used to determine the shear force, provided by the piles, required to achieve the desired factor of safety.



Attachment B

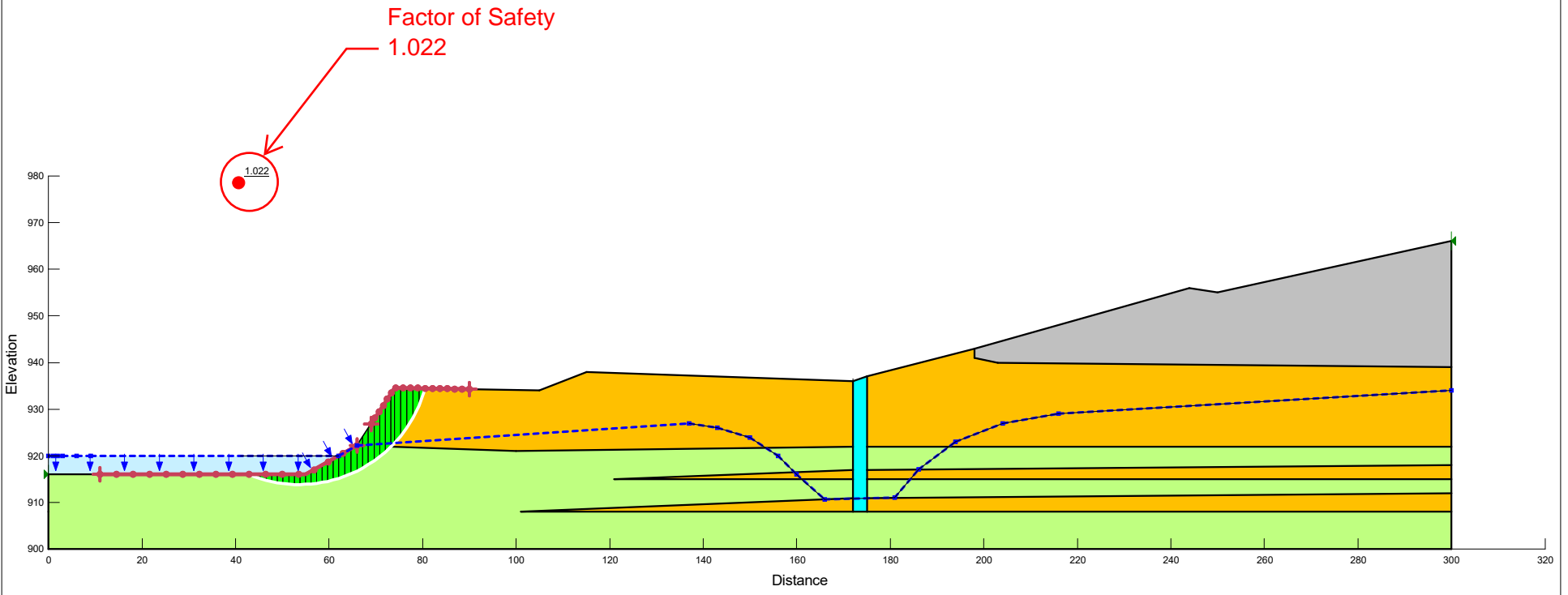
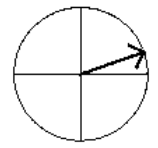
Slope Stability Run Results
and Settlement Calculations



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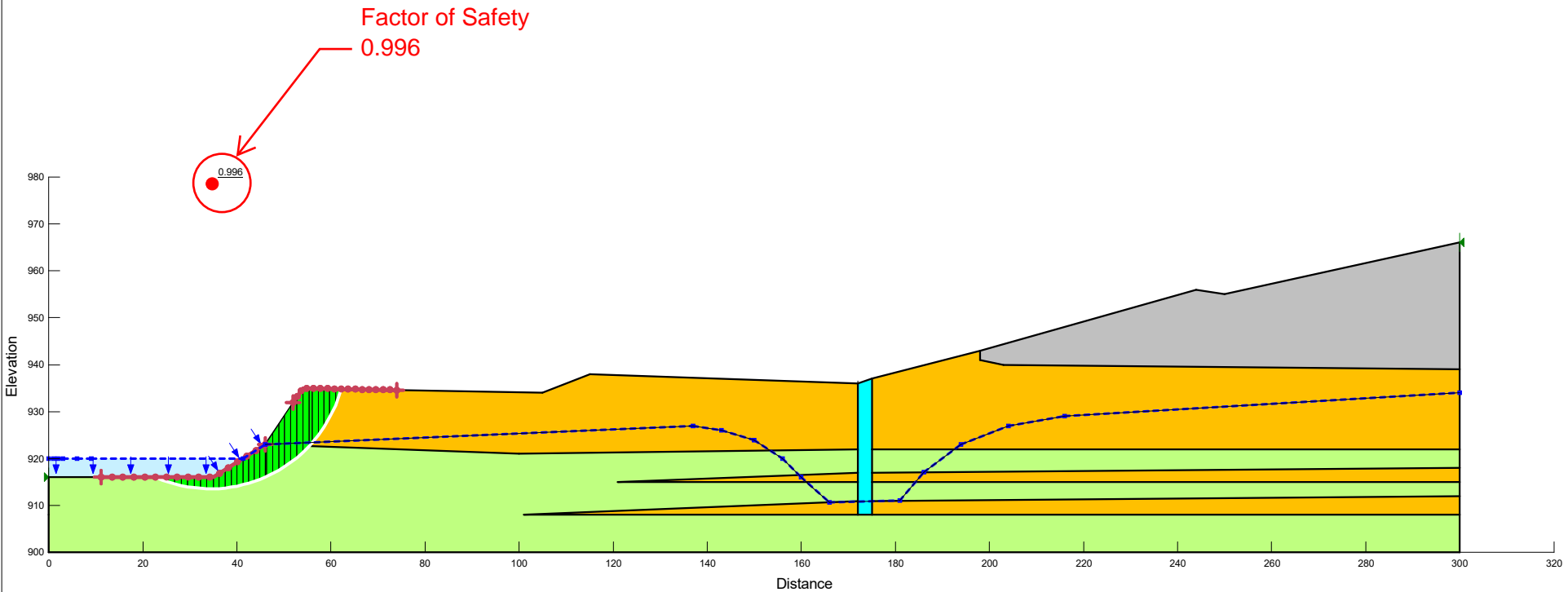
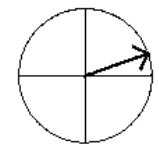
CIRCULAR FAILURE SCENARIOS

- Materials
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



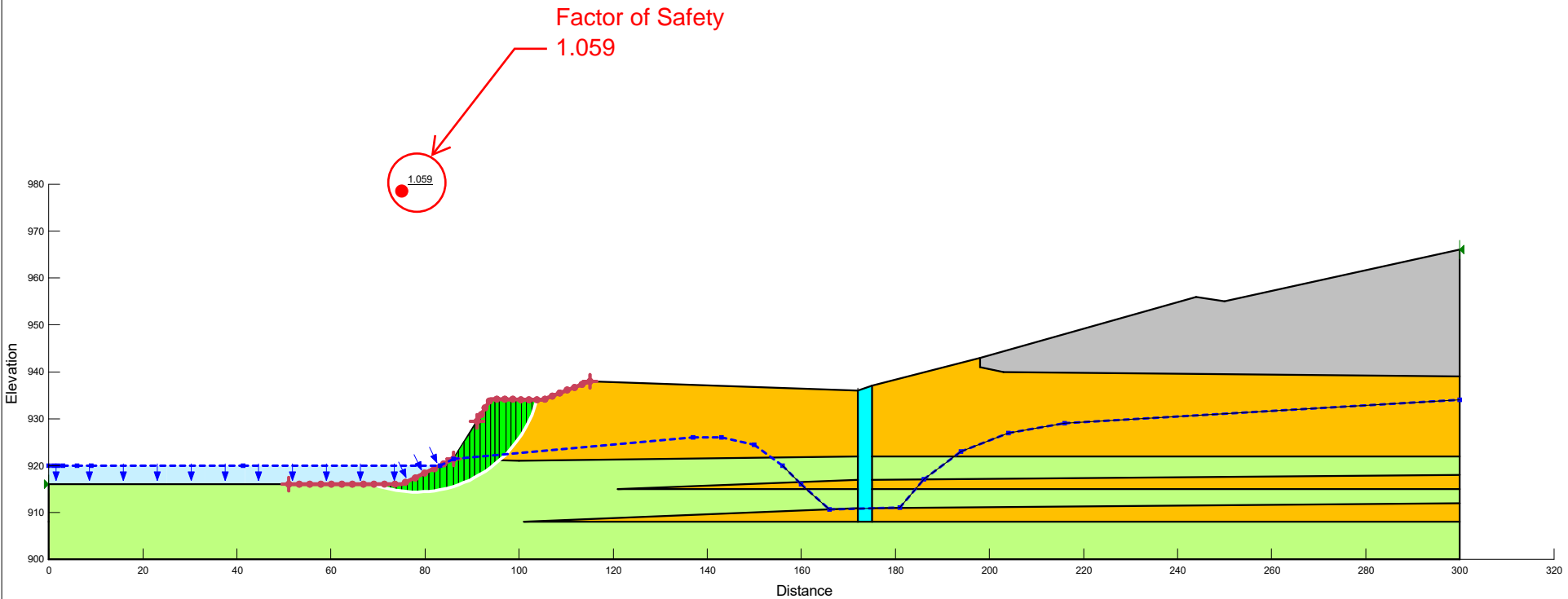
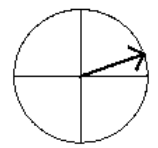
Run 1 - Base Model - Circular Wedge (Critical Slip Surface)

- Materials**
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste

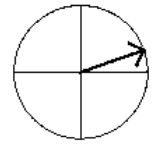


Run 2 - Riverbank 20 ft. NE - Circular Wedge (Critical Slip Surface)

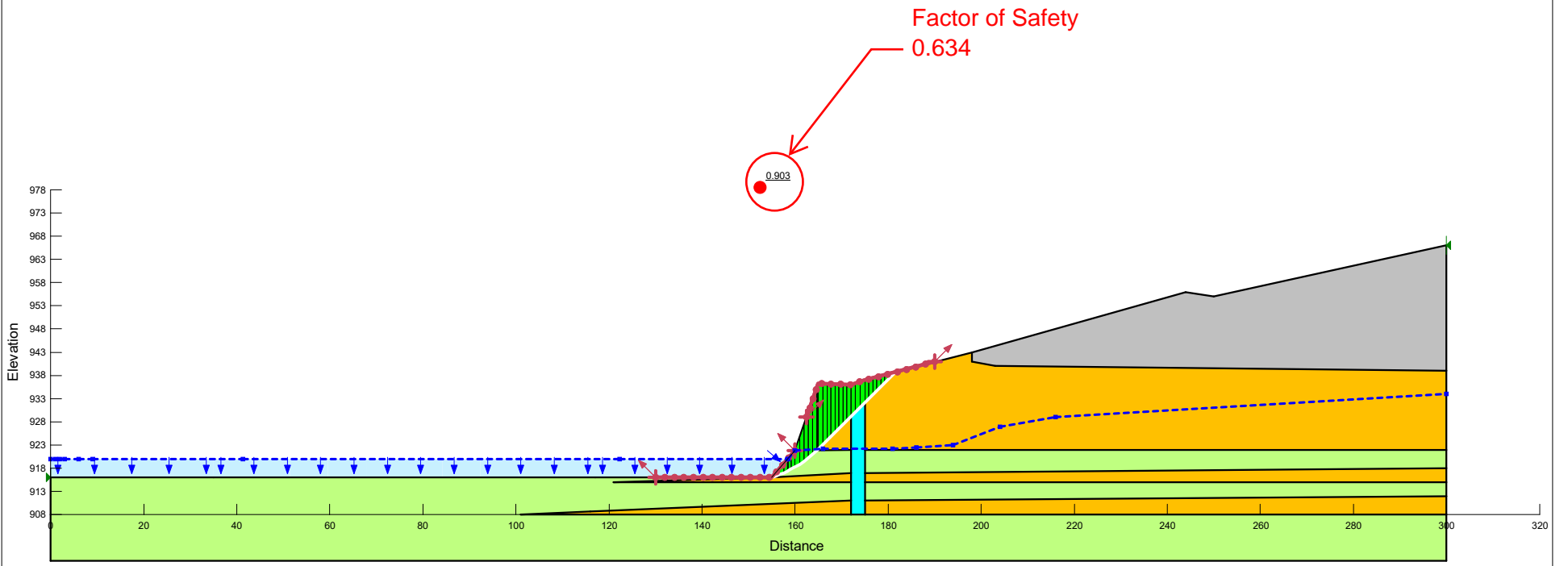
- Materials
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



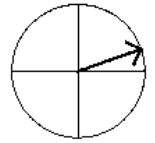
Run 3 - Riverbank 40 ft. NE - Circular Wedge (Critical Slip Surface)



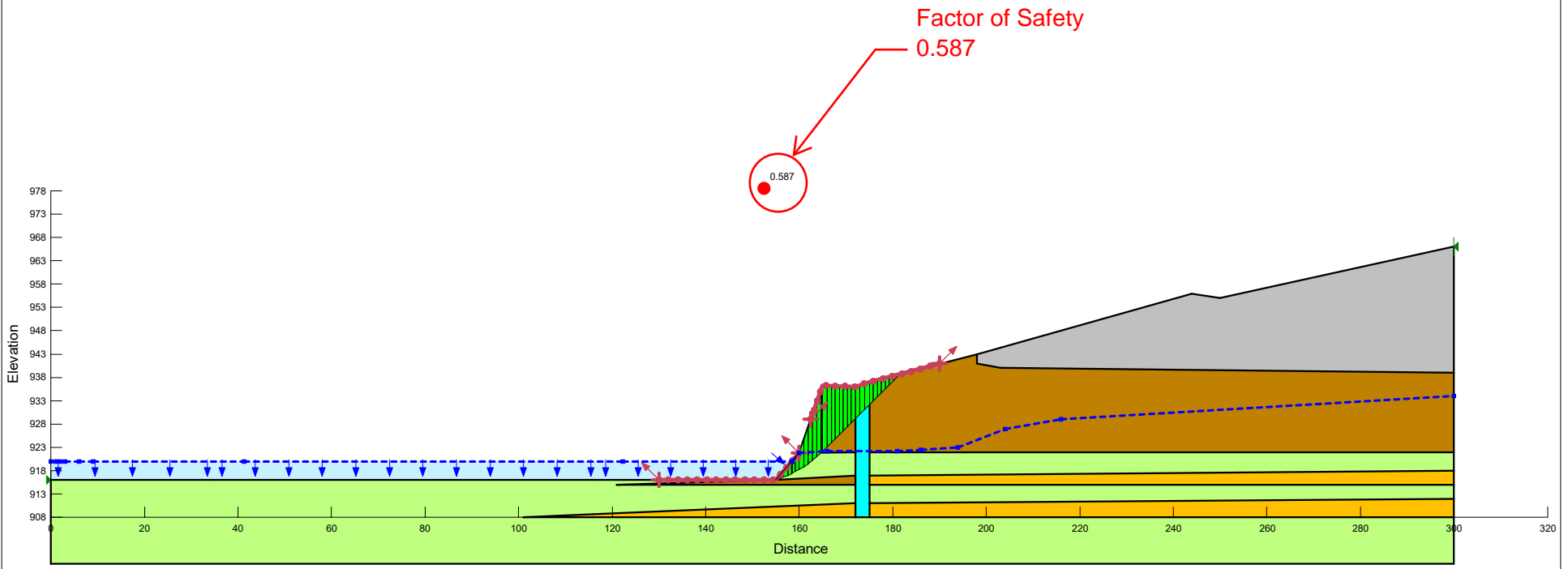
- Materials**
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



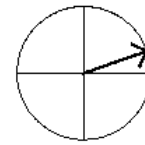
Run 4 - Toe Drain Collapse - Riverbank 120 ft. NE - Circular Wedge (Critical Slip Surface)



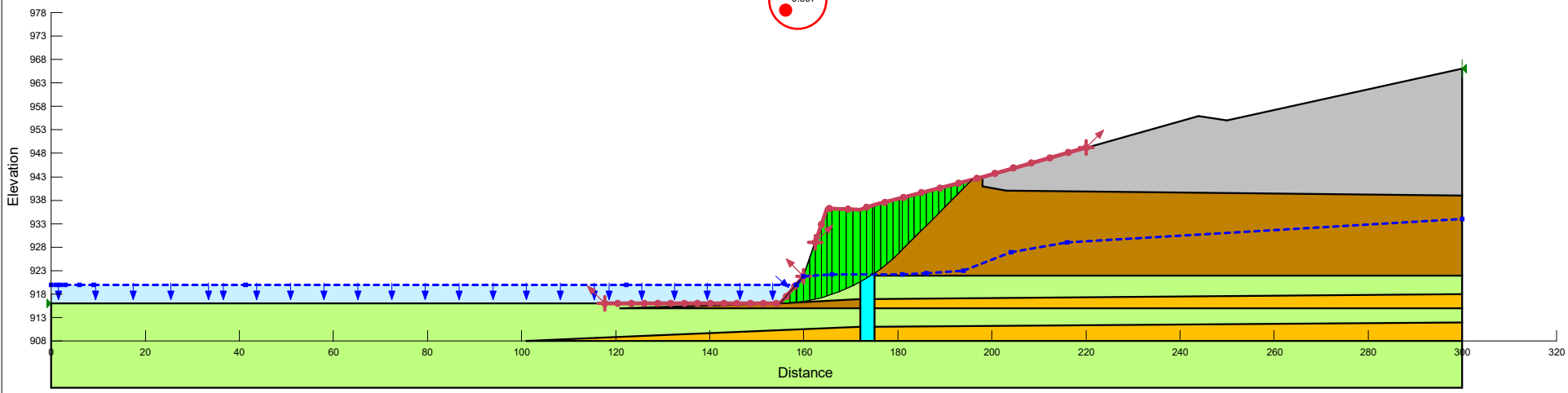
- Materials**
- Silty Clay
 - Silty Clay (Softened)
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



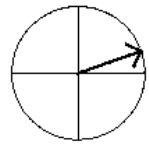
Run 5A - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Circular Wedge (Critical Slip Surface)



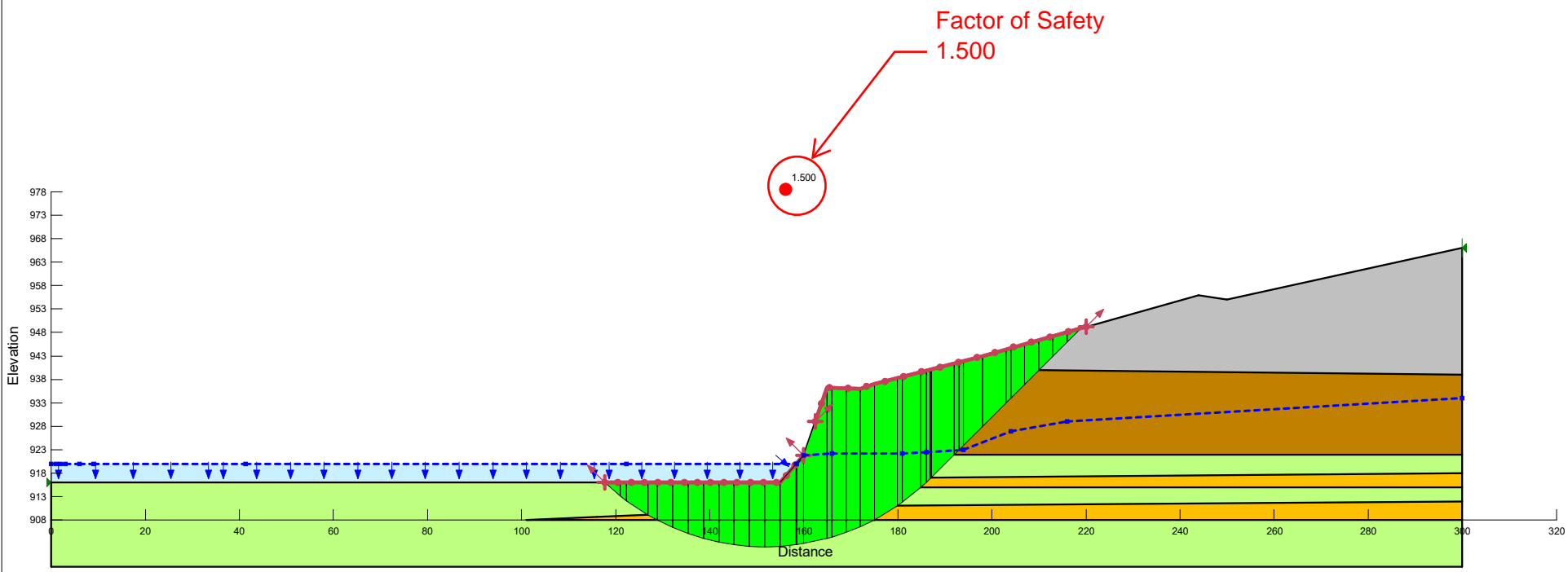
- Materials**
- Silty Clay
 - Silty Clay (Softened)
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



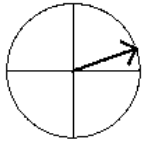
Run 5B - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Circular Wedge - FS ~ 1



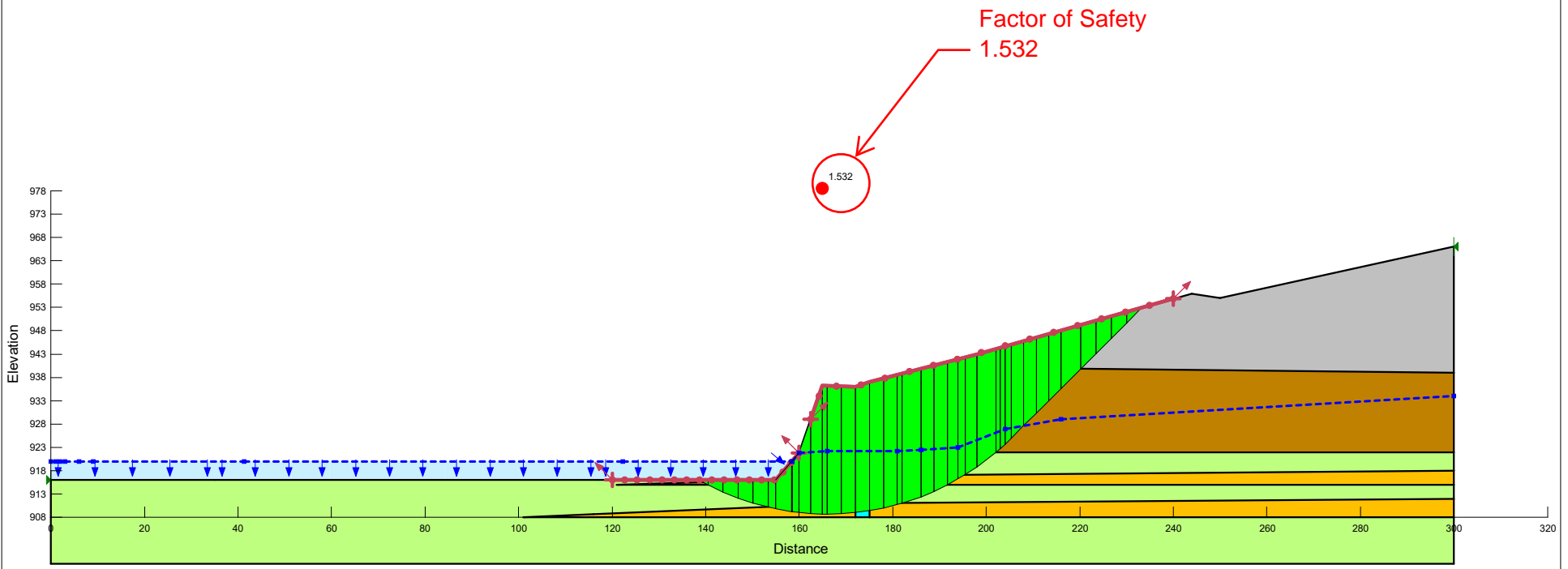
- Materials**
- Silty Clay
 - Silty Clay (Softened)
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



Run 5C - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Circular Wedge - FS ~ 1.5 (Overall Failure)



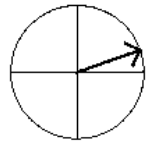
- Materials**
- Silty Clay
 - Silty Clay (Softened)
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



Run 5C - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Circular Wedge - FS ~ 1.5 (Overall Failure)

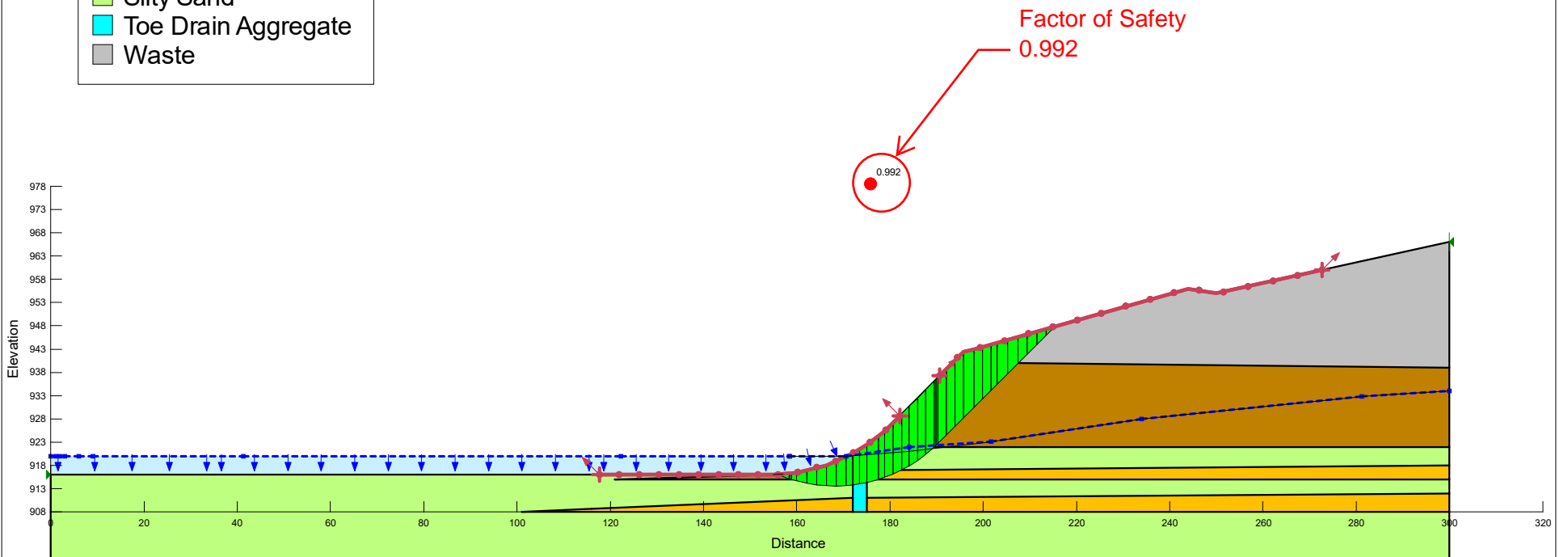
PROGRESSION OF SLOPE FAILURE

Slip plane at FS ~ 1 as new riverbank surface (Run 5B)



Materials

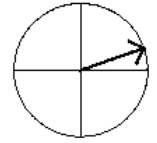
- Silty Clay
- Silty Clay (Softened)
- Silty Sand
- Toe Drain Aggregate
- Waste



Run 6A - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Circular Wedge - FS ~ 1

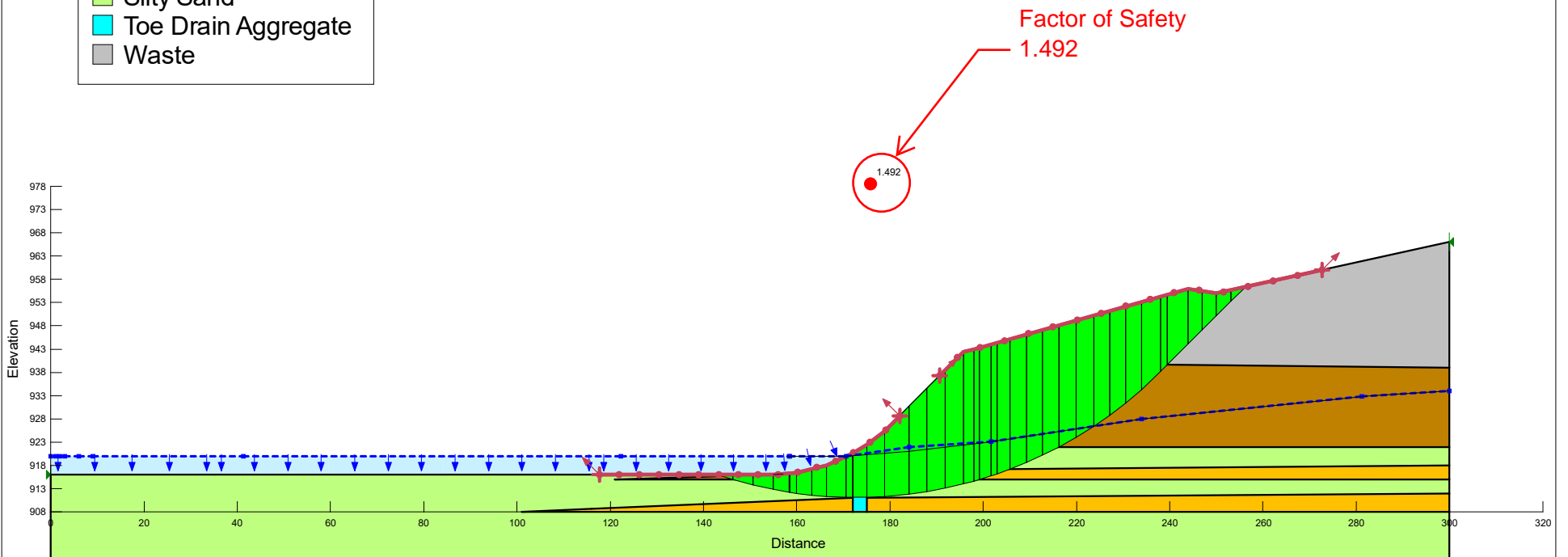
PROGRESSION OF SLOPE FAILURE

Slip plane at FS ~ 1 as new riverbank surface (Run 5B)



Materials

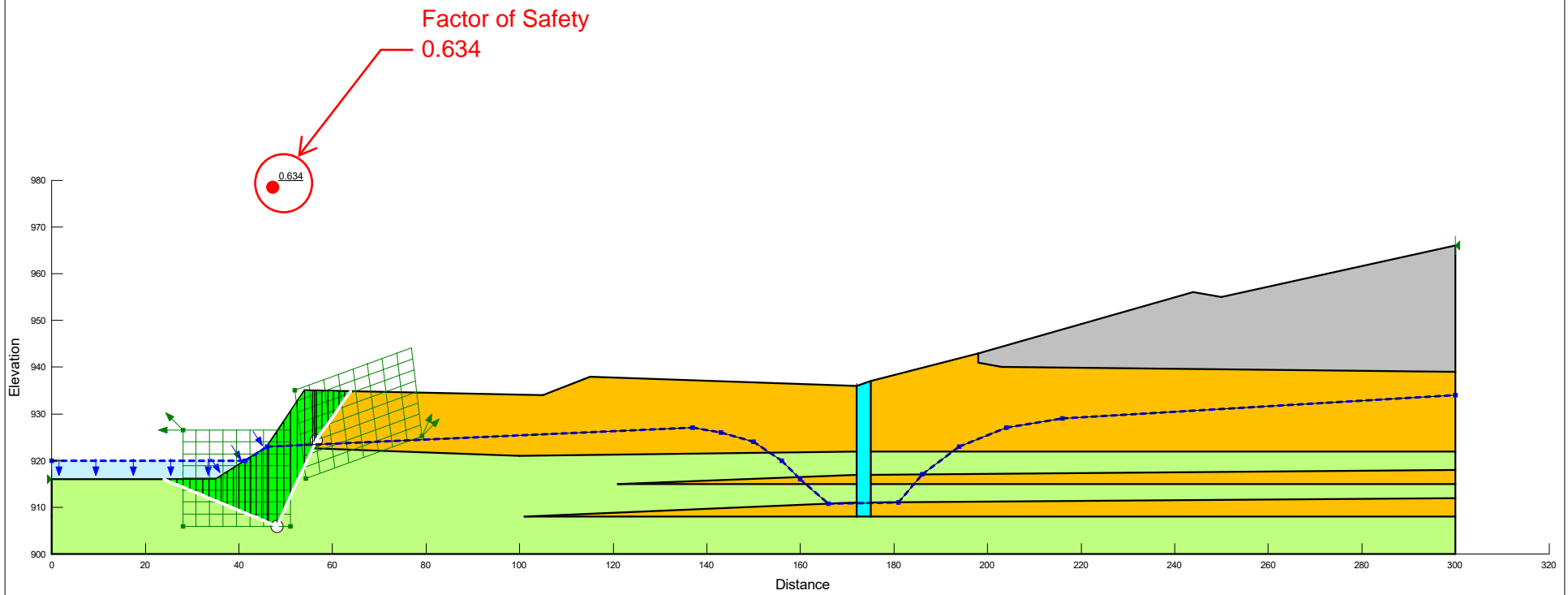
- Silty Clay
- Silty Clay (Softened)
- Silty Sand
- Toe Drain Aggregate
- Waste



Run 6B - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Circular Wedge - FS ~ 1.5 (Overall Failure)

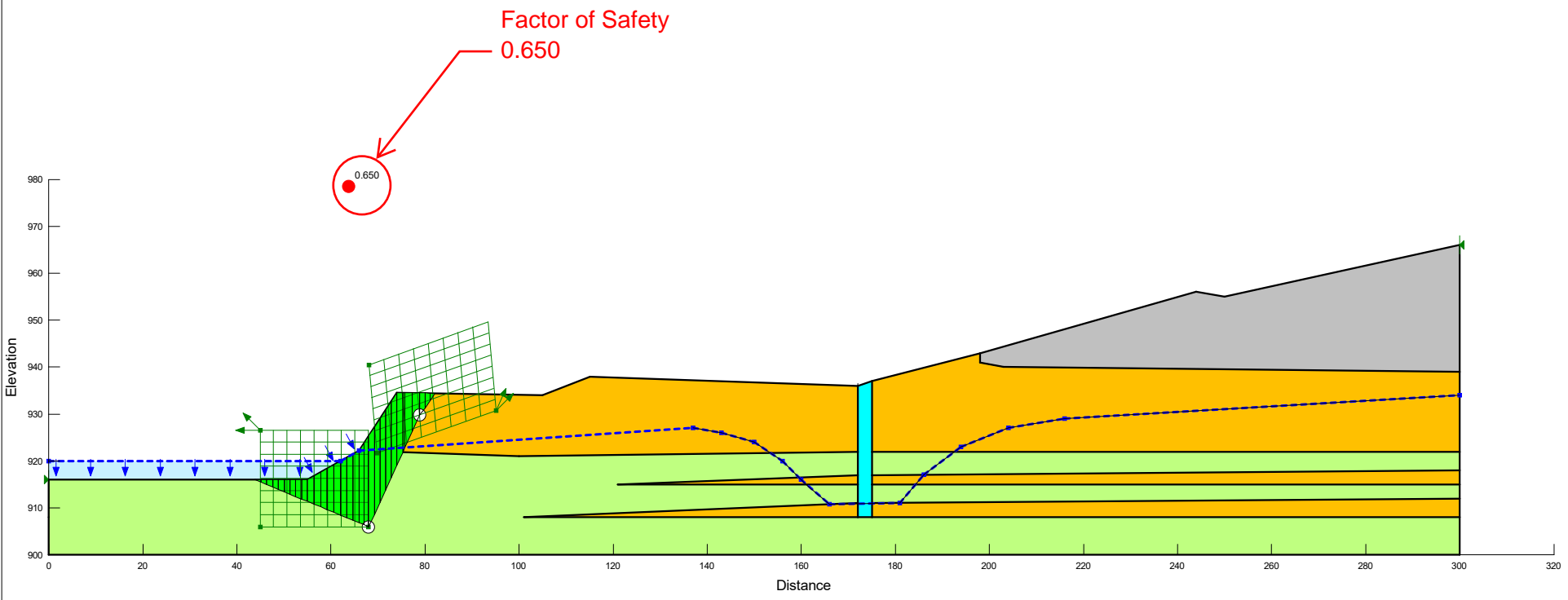
SLIDING BLOCK FAILURE SCENARIOS

- Materials**
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



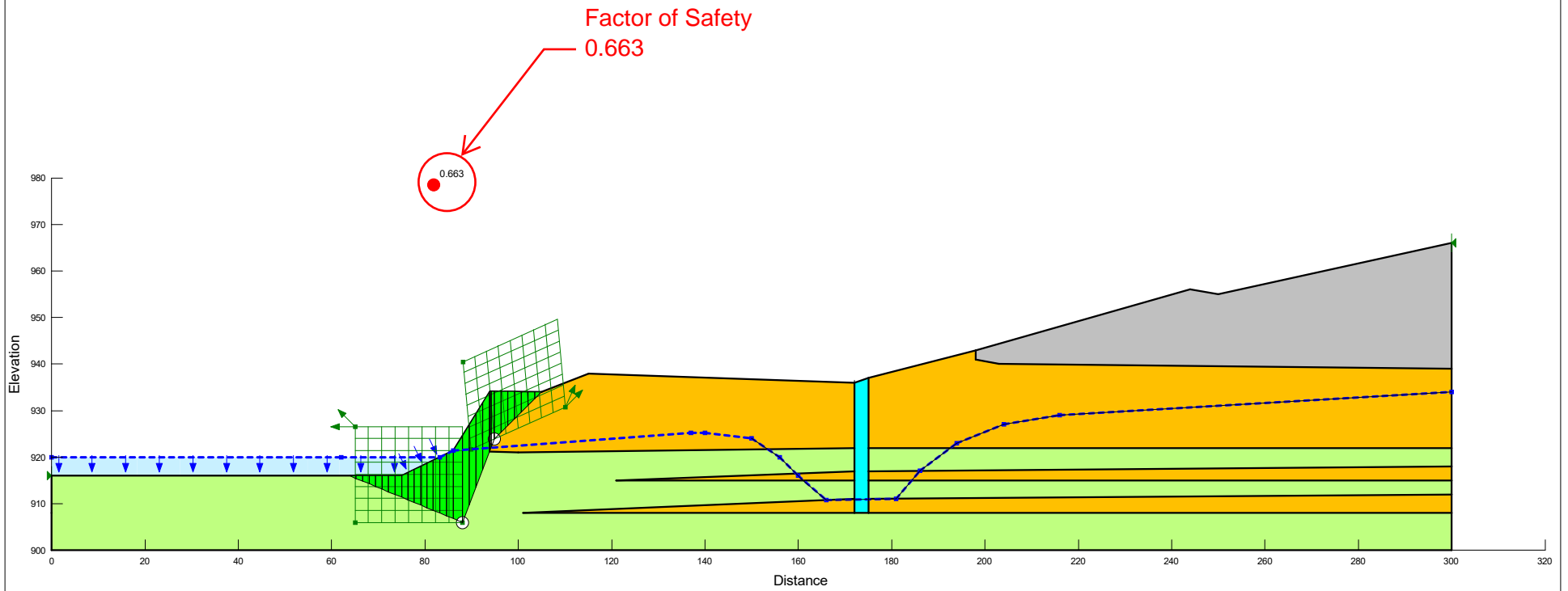
Run 7 - Base Model - Sliding Block (Critical Slip Surface)

- Materials
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



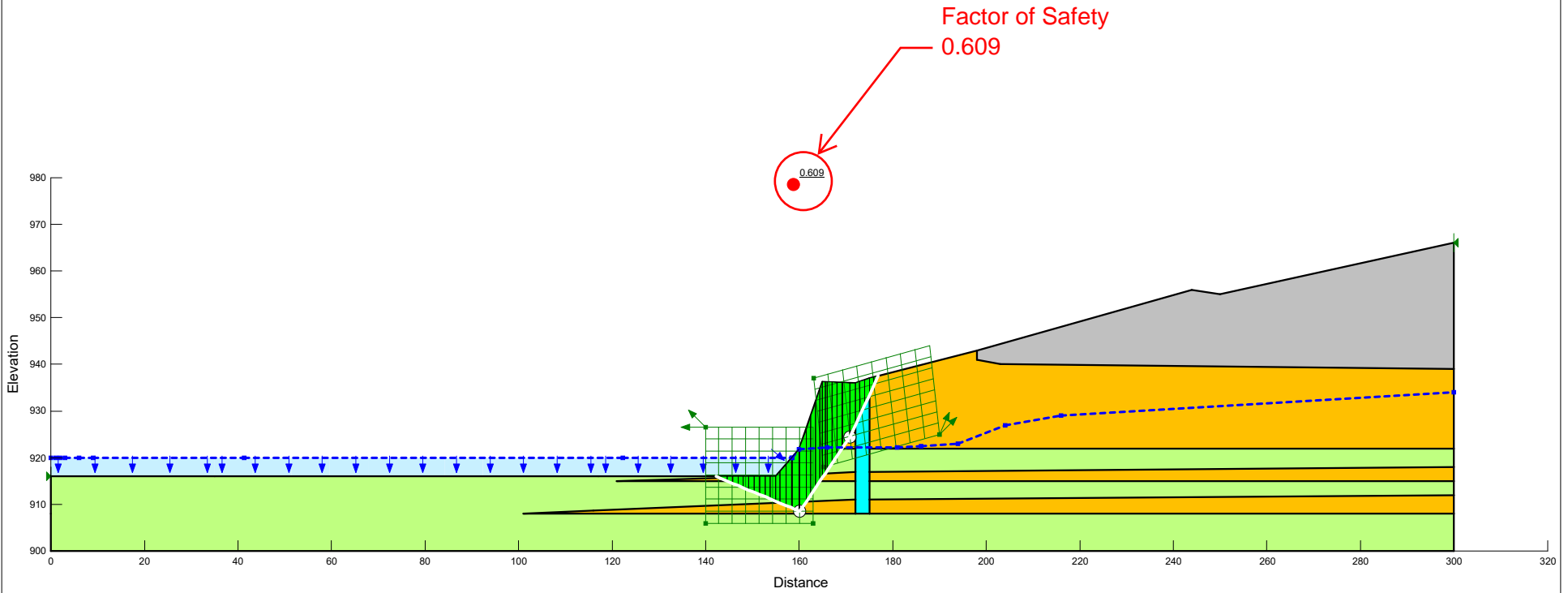
Run 8 - Riverbank 20 ft. NE - Sliding Block (Critical Slip Surface)

- Materials
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



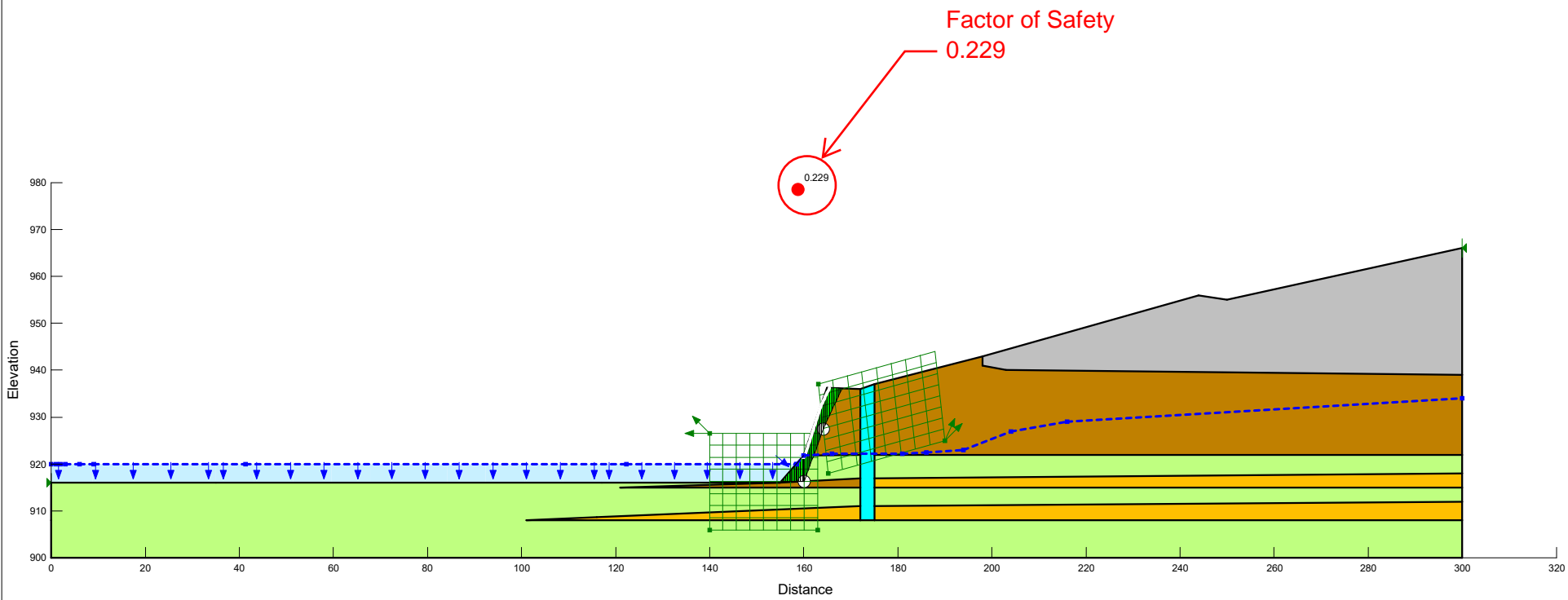
Run 9 - Riverbank 40 ft. NE - Sliding Block (Critical Slip Surface)

- Materials
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



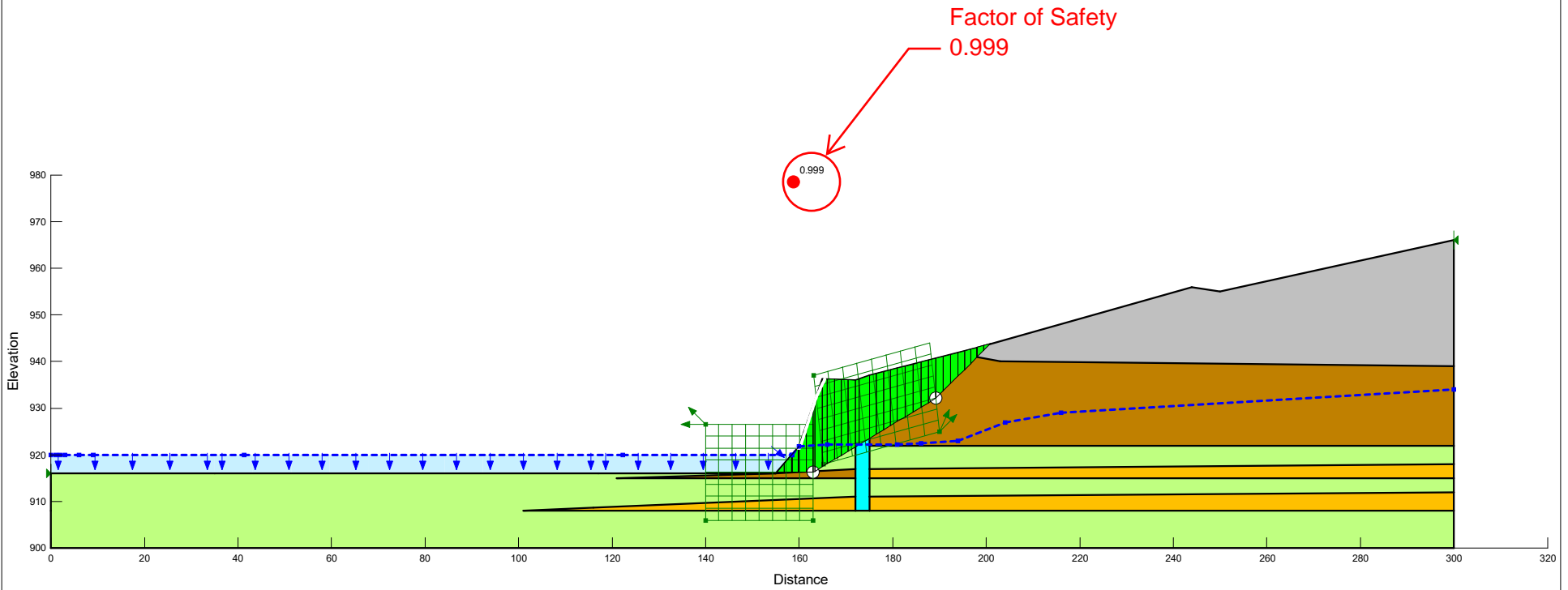
Run 10 - Toe Drain Collapse - Riverbank 120 ft. NE - Sliding Block (Critical Slip Surface)

- Materials**
- Silts Clay (Softened)
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



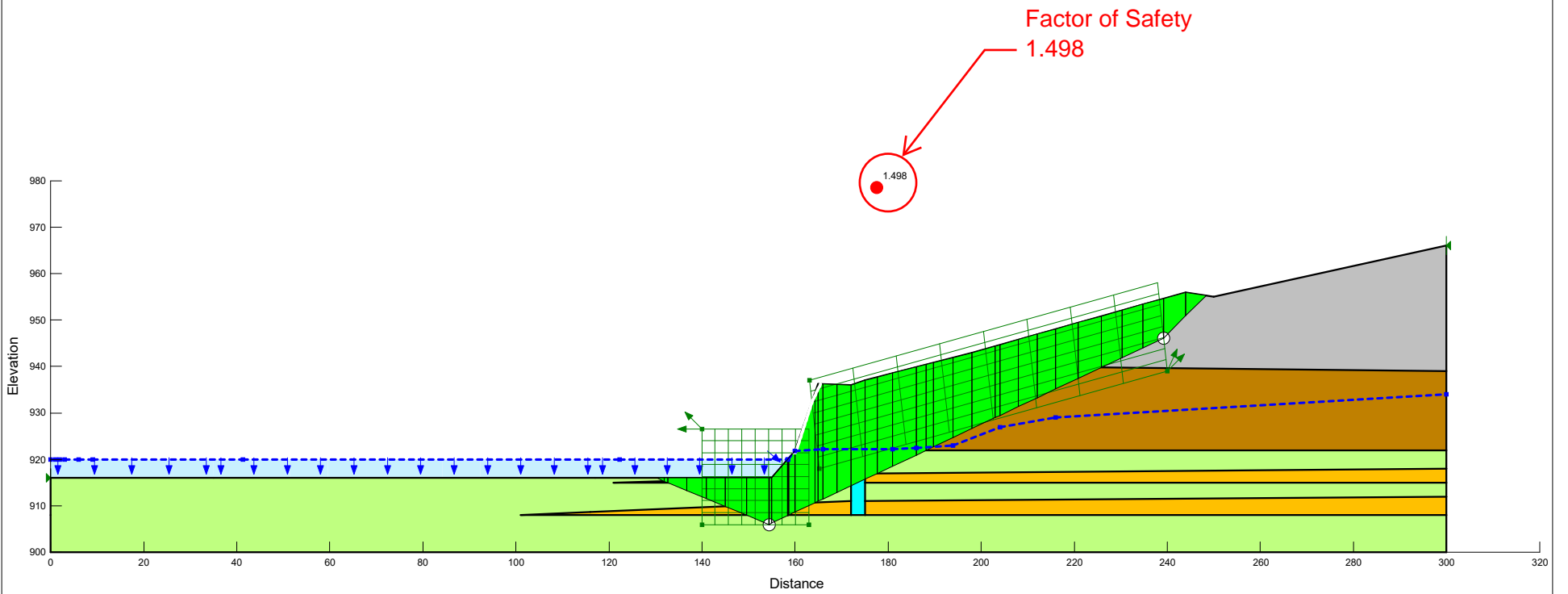
Run 11A - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Sliding Block (Critical Slip Surface)

- Materials**
- Silts Clay (Softened)
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



Run 11B - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Sliding Block - FS ~ 1

- Materials**
- Silts Clay (Softened)
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste

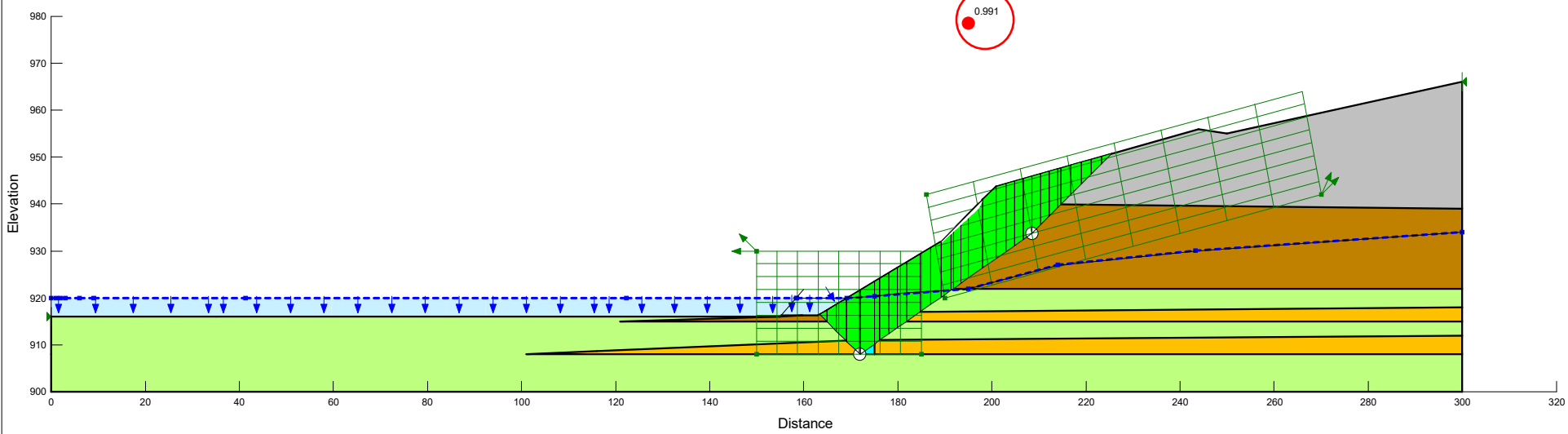


Run 11C - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Sliding Block - FS ~ 1.5 (Overall Failure)

- Materials**
- Silts Clay (Softened)
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste

PROGRESSION OF SLOPE FAILURE

Slip plane at FS ~ 1 as new riverbank surface (Run 11B)

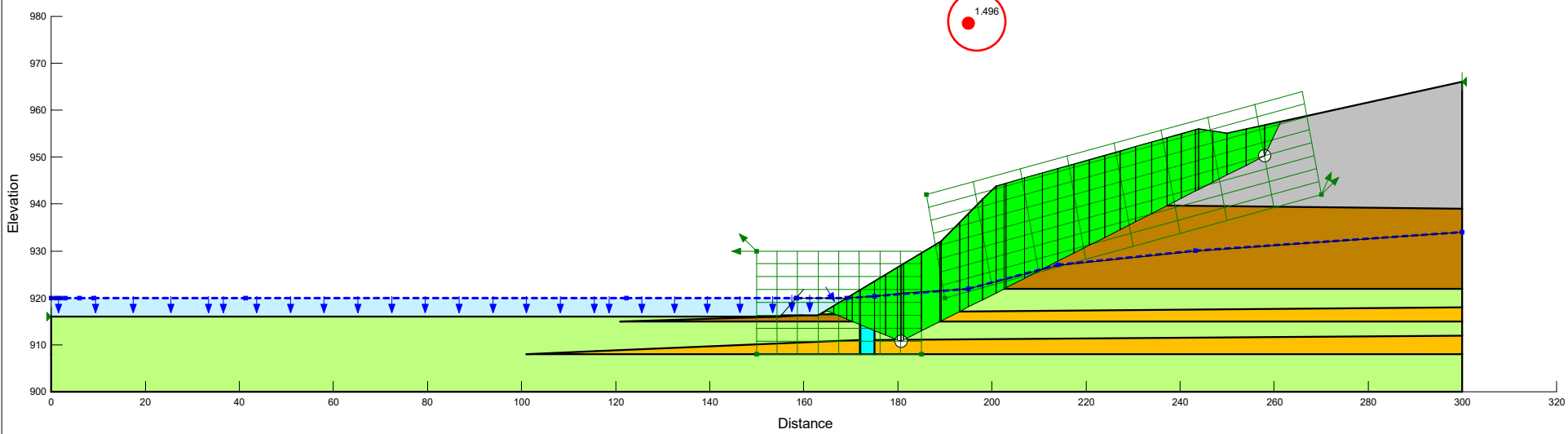


Run 12A - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Sliding Block - FS ~ 1

- Materials**
- Silts Clay (Softened)
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste

PROGRESSION OF SLOPE FAILURE

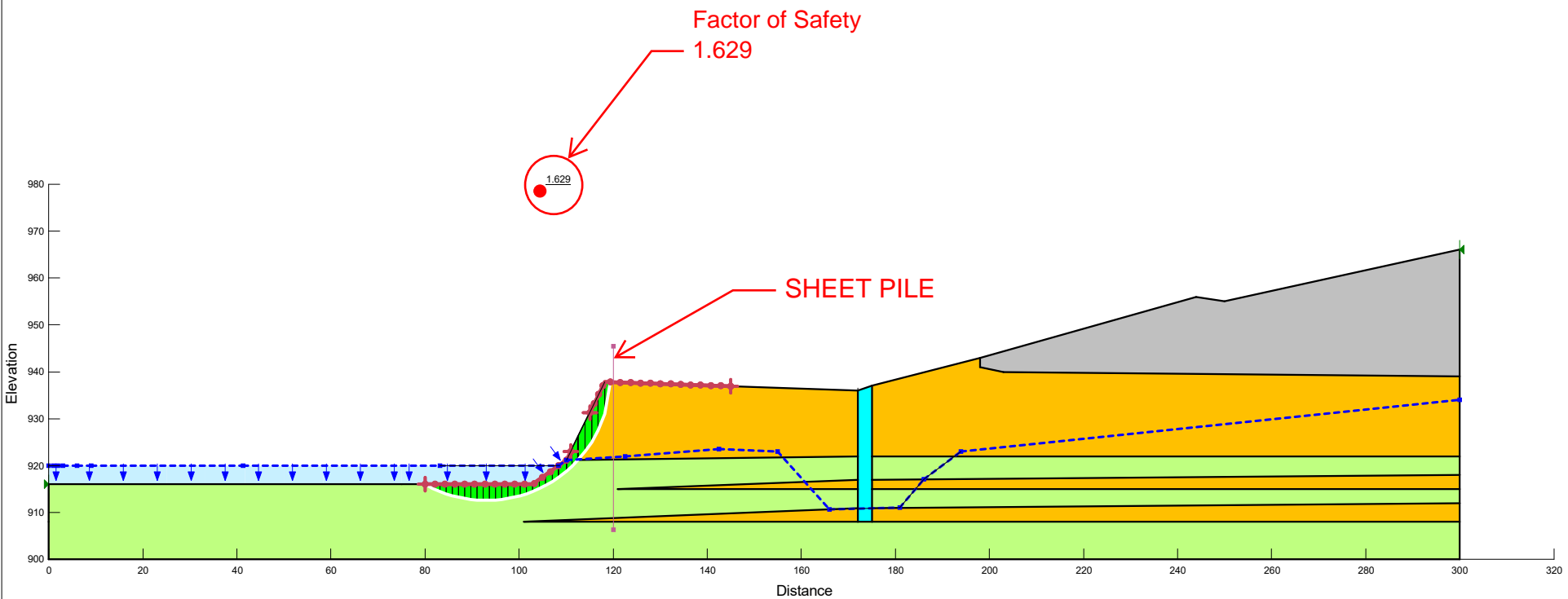
Slip plane at FS ~ 1 as new riverbank surface (Run 11B)



Run 12B - Toe Drain Collapse - Clay Softened - Riverbank 120 ft. NE - Sliding Block - FS ~ 1.5 (Overall Failure)

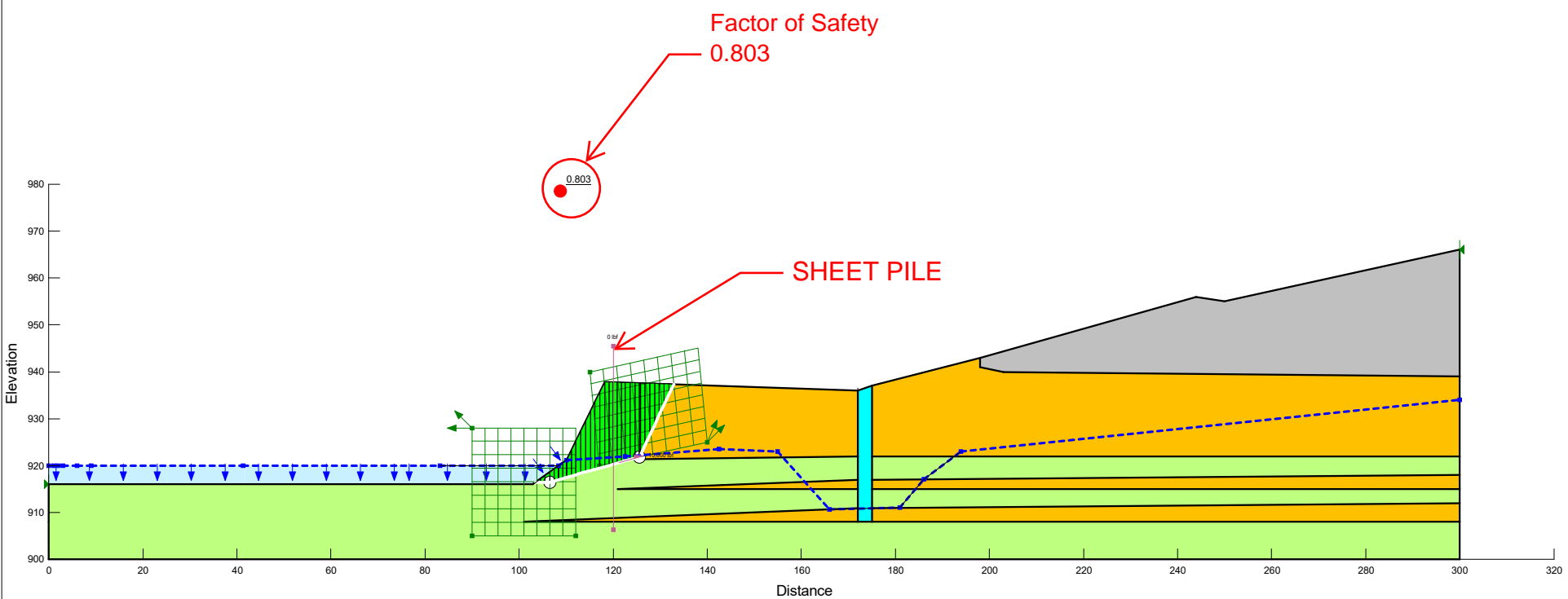
RIVERBANK PROTECTIVE MEASURES

- Materials**
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



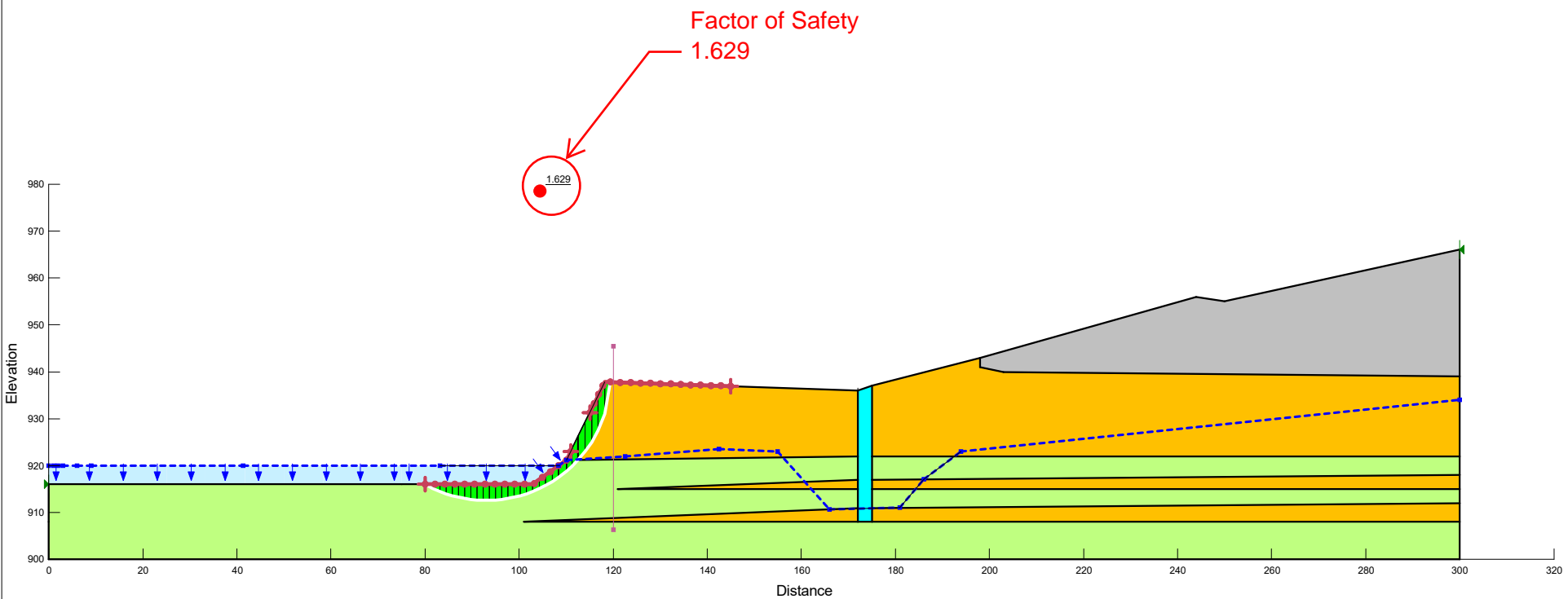
Run 13A - Riverbank 70 ft. NE - Sheet pile shear strength 15,000 lbf - Circular Wedge (Critical Slip Surface)

- Materials**
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



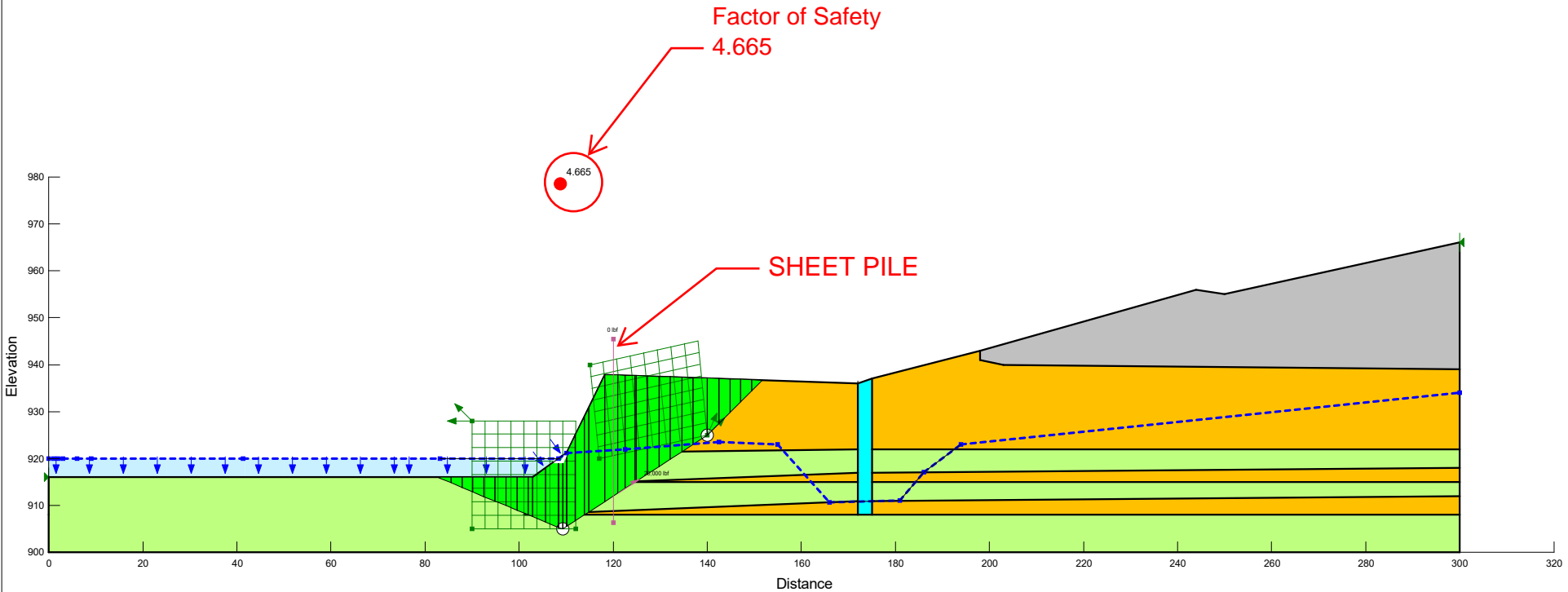
Run 13B - Riverbank 70 ft. NE - Sheet pile shear strength 15,000 lbf - Sliding Block (Critical Slip Surface)

- Materials
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



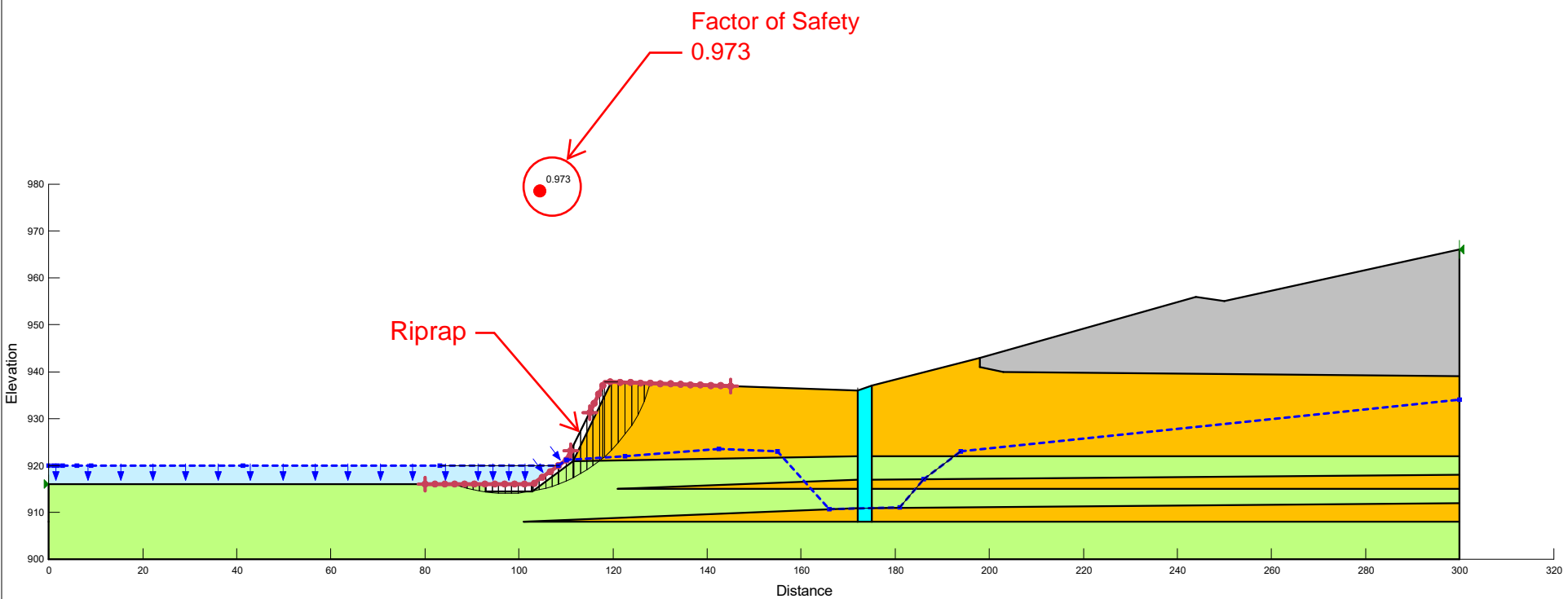
Run 14A - Riverbank 70 ft. NE - Sheet pile shear strength 30,000 lbf - Circular Wedge (Critical Slip Surface)

- Materials**
- Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



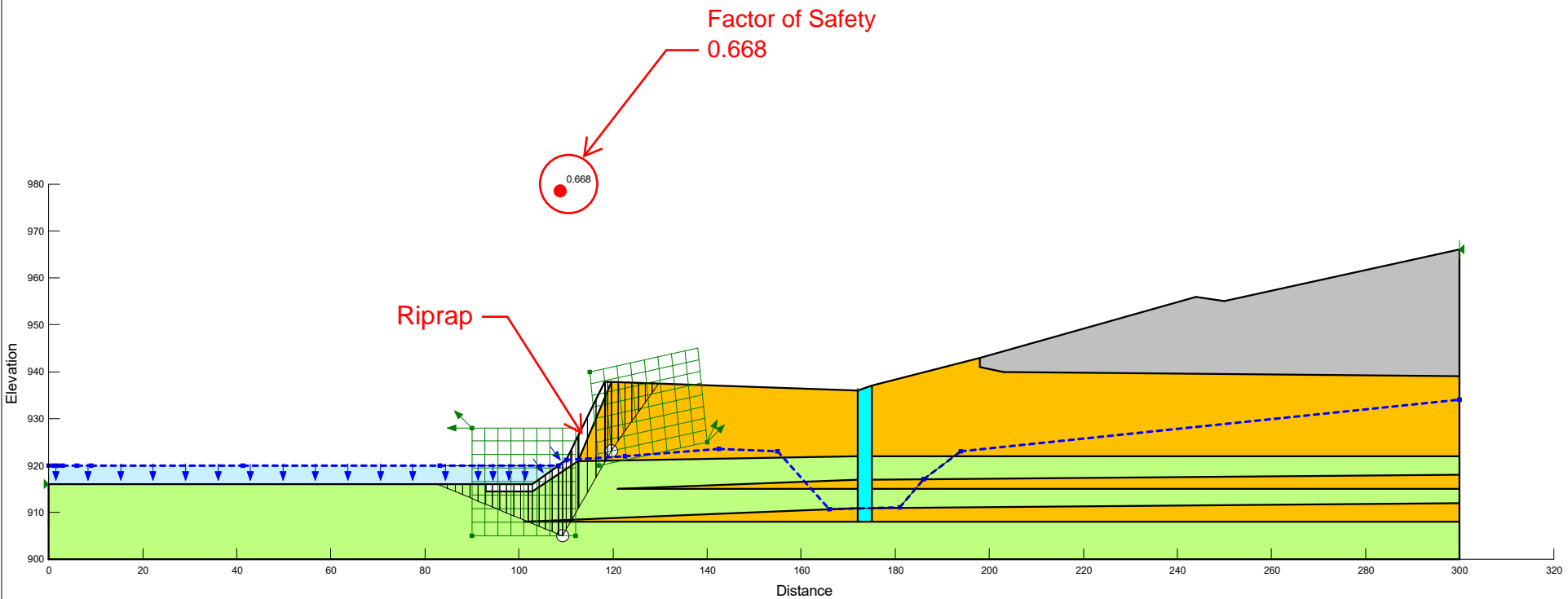
Run 14B - Riverbank 70 ft. NE - Sheet pile shear strength 30,000 lbf - Sliding Block

- Materials**
- Riprap
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



Run 15A - Riverbank 70 ft. NE - 18 in. Riprap - Circular Wedge

- Materials**
- Riprap
 - Silty Clay
 - Silty Sand
 - Toe Drain Aggregate
 - Waste



Run 15B - Riverbank 70 ft. NE - 18 in. Riprap - Sliding Block



Attachment C

Seismic-Hazard Map



Unified Hazard Tool



Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the [U.S. Seismic Design Maps web tools](#) (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

^ Input

Edition

Spectral Period

Latitude

Decimal degrees

Time Horizon

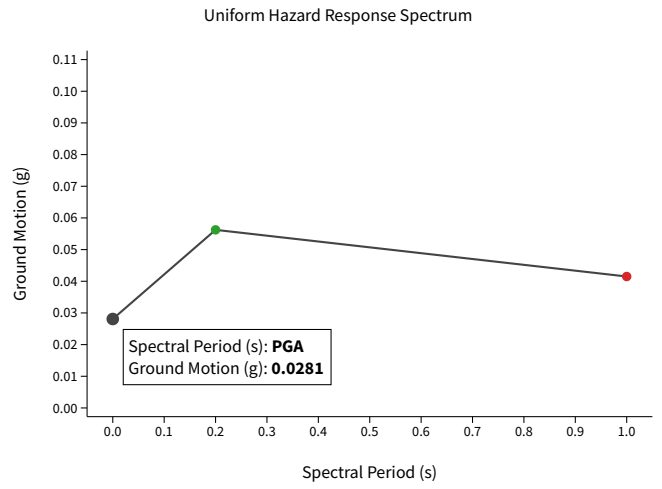
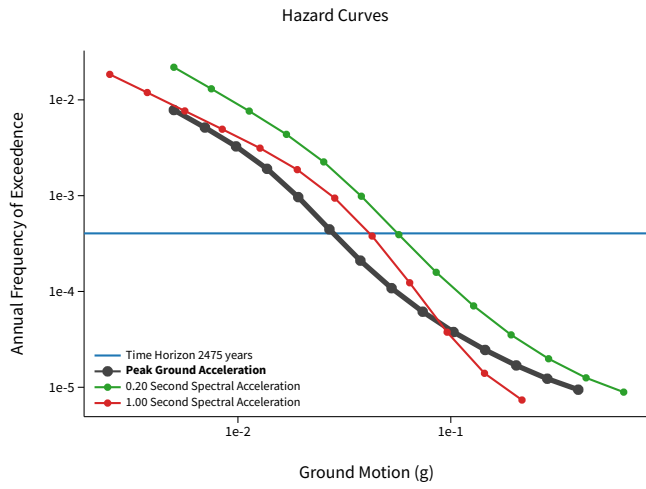
Return period in years

Longitude

Decimal degrees, negative values for western longitudes

Site Class

^ Hazard Curve



[View Raw Data](#)

Appendix E

March 16, 2026

MICHAEL MCCOY
METRO WASTE AUTHORITY
300 E LOCUST ST STE 100
DES MOINES IA 50309-1864

Re: Metro Park West Landfill (20 335th St, Perry, IA 50220)
Permit No. 08-SDP-03-84
Emergency Action Plan ([Doc #115626](#))

Dear Mr. McCoy:

The Iowa Department of Natural Resources (DNR) has reviewed the Emergency Acton Plan (EAP), dated January 9, 2026 ([Doc #115626](#)), as submitted by HDR. The DNR has the following comments.

The EAP calls for the initiation of designing, permitting, and installation of permanent bank stabilization to start when the North Raccoon River top of bank is 40 feet (trigger distance) from monitoring well MW-2BR. However, the associated report ([Doc #115626](#)) includes slope stability calculations with a factor of safety less than one, which is indicative of imminent failure. Further, the report states that "The localized slope stability for the riverbank should be addressed immediately."

While the DNR acknowledges that a single slope failure of the documented bank location may not negatively impact the waste mass, cutoff trench, or toe drain, the DNR is concerned that rapid and multiple slope failures could occur during a flooding event, which are not reflected in the average year-to-year bank erosion rate presented in the report.

Therefore, the DNR requires that the initiation of designing, permitting, and installation of permanent bank stabilization start by **May 30, 2026**, with installation completed by December 31, 2027. Meanwhile, please proceed with the monitoring plan action items, which are hereby approved (exclusive of the trigger distance), and implement immediately.

In addition, the EAP shall be updated and submitted to the DNR by **April 1, 2026** to reflect the above as well as include interim action items that may be necessary to respond to slope failure(s) that occurs prior to installation of the permanent bank stabilization. This shall include agreements or other relevant documentation to show that consultants, contractors, and others are available to respond in a timely manner during an emergency or other situation to protect human health and the environment.

As part of the EAP, monthly reports shall be submitted to the DNR by the 15th of each month, starting with the first report by **April 15, 2026**. The reports shall document the progress made since the last report and the proposed work for the next reporting period for all items in the EAP and related documents.

The monthly reports shall also include the observations and documentation for the action items in the monitoring plan. It should be noted that if the monitoring or other situations trigger any actions that the DNR's Field Office and Central Office shall be notified immediately.

In closing, the DNR believes time is of the essence and expects progress parallel to any actions or approvals by the DNR.

If you have any questions or comments, please contact me at [\(515\) 229-8356](tel:5152298356) or mike.smith@dnr.iowa.gov.

Sincerely,

Michael W. Smith, P.E.
Environmental Engineer Senior
Land Quality Bureau

cc: Katie Kinley, P.E.
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