Boender Wetland

Geotechnical Engineering Report

March 24, 2025 | Terracon Project No. 08245261-01

Prepared for:

Shive-Hattery Inc
4125 Westown Parkway, Suite 100
West Des Moines, Iowa 50266

I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.

3/24/2025

Brian A. Weiner, P.E. Date

License Number P28665

My license renewal date is December 31, 2025.

Pages or sheets covered by this seal: All pages .

600 SW 7th Street, Suite M
Des Moines, IA 50309
P (515) 244-3184
Terracon.com

March 24, 2025

Shive-Hattery Inc
4125 Westown Parkway, Suite 100
West Des Moines, Iowa 50266

Attn: Michael Otten
P: (515) 422-5537
E: motten@shive-hattery.com

Re: Geotechnical Engineering Report
Boender Wetland
2138 275th Street
Oskaloosa, Iowa
Terracon Project No. 08245261-01

Dear Michael Otten:

We have completed the scope of Geotechnical Engineering services for the above referenced project in general accordance with Terracon Proposal No. P082245261 dated November 27, 2024. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Brian A. Weiner, P.E.
Staff Engineer

Theresa M. Stromberg-Murphy, P.E.
Senior Engineer

Table of Contents

Figures

Attachments

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the Terracon logo will bring you back to this page. For more interactive features, please view your project online at **client.terracon.com**.

Refer to each individual Attachment for a listing of contents.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed earthen berm to be located at 2138 275th Street near Oskaloosa, Iowa. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Subsurface water conditions
- Site preparation and earthwork

The geotechnical engineering Scope of Services for this project included the advancement of five soil borings, laboratory testing, engineering analysis, and preparation of this report.

Drawings showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**, respectively. Results of the laboratory testing performed on samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in **Exploration Results**.

Project Description

Our final understanding of the project conditions is as follows:

Item	Description
Project Description	An earthen berm, with a low-head sheet pile weir, is planned to be placed across an existing drainageway to create a wetland area in Mahaska County, Iowa. We understand this project will fall under the 'low hazard' classification by the Iowa Department of Natural Resources (Iowa DNR).
Grading/Slopes	We understand the earthen berm will impound about 4 feet of water, and will have 4:1 (horizontal to vertical) slopes on the upstream and downstream sides. The earthen berm will have a top width of 14 feet.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration.

Item	Description
Parcel Information	The project is located northwest of the intersection of 2138 275th Street near Oskaloosa, Iowa. Latitude/Longitude (approximate) 41.2541°, -92.6528° See **Site Location**
Existing Improvements / Current Ground Cover	Grassland / pasture with a drainageway running from east to west along the center of the site. Taller vegetation and scattered trees are present near the drainageway.
Existing Topography	Site slopes down towards the drainageway with an overall slope down from east to west.

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based on our review of the subsurface exploration, laboratory data, geologic setting, and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical evaluation and recommendations of the site. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in **Exploration Results** and the GeoModel can be found in **Figures**.

As part of our review, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	**Existing Fill**	Variable material consisting of lean clay and fat clay soils with variable sand contents. Occasional shale and brick fragments and cinders.
2	**Native Clay**	Lean to fat, fat clay, and sandy lean clay. Possible Residual soil. Generally medium stiff to very stiff in consistency.
3	**Rock**	Highly weathered shale and sandstone.

Boreholes were observed while drilling for the presence and level of subsurface water. Subsurface water conditions may be different at the time of construction. Subsurface water was observed at depths ranging from about 6½ to 8 feet below the existing ground surface at the time of drilling. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level within 48 inches of ground natural surface. Groundwater conditions may change because of seasonal variations in

rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the Scope of Services for this project.

Geotechnical Overview

Borings 1 and 2, which were performed near the planned earthen berm location, encountered existing fill material consisting of clays with variable sand content to elevations of 733 and 736 feet (site datum). Native lean to fat clays and sandy lean clay were encountered below the existing fill and extended to boring termination in Boring 1. Boring 2 encountered weathered shale at an elevation of about 733, extending to boring termination.

The remaining borings, located in potential borrow areas, encountered existing fill material consisting of lean to fat clays with variable sand content and extended to boring terminations at about 15 feet below existing grades, with the exception of Boring 3 where native sandy lean clay was encountered beneath the existing fill at elevation 751.5 and extended to elevation 749 where weathered sandstone was encountered.

The recommendations contained in this report are based on the results of field and laboratory testing (presented in the **Exploration Results**), engineering review, and our current understanding of the proposed project. The **General Comments** section provides an understanding of the report limitations.

Earthwork

Earthwork is anticipated to include clearing and grubbing, excavations, and structural fill placement (i.e., construction of the earthen berm). The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for earthen berm construction.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed. Complete stripping of the topsoil should be performed in the proposed earthen berm location.

Subgrade Preparation

Prior to placement of fill in areas below design grade and after completion of rough grading in cut areas of the site, the exposed subgrade should be scarified to a depth of 9 inches, moisture conditioned, and compacted to the density and water content ranges recommended for structural fill. The surficial compaction will aid in providing a firm base for compaction of new fill and delineating soft or disturbed areas that may exist at or near the exposed subgrade level. Unstable areas observed at this time should be improved through use of subgrade stabilization.

Where fill is placed on existing slopes steeper than 5:1 (horizontal to vertical), benches should be cut into the existing slopes prior to fill placement. The benches should have a minimum vertical face height of 1 foot and a maximum vertical face height of 3 feet and should be cut wide enough to accommodate the compaction equipment. This benching will help provide a positive bond between the fill and natural soils and reduce the possibility of failure along the fill/natural soil interface.

Soil Stabilization

If unsuitable areas are observed, subgrade improvement will be necessary to establish a suitable subgrade support condition. Potential methods of subgrade improvement are described below. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size and depth of area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs.

- **Scarification and Compaction** - Soils can be scarified, moisture conditioned (i.e., dried or wetted), and compacted. The success of this procedure depends primarily on favorable weather and sufficient time to manipulate the soils.
- **Crushed Stone** - The use of crushed stone, crushed concrete, and/or gravel could be considered to improve subgrade stability. To limit depths of undercuts, the use of a geogrid could be considered. The manufacturer's specifications for each reinforcement product should be verified prior to material purchase/delivery and placement at the site.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grade should be classified as structural fill (i.e., materials used to construct the earthen berm) and general fill (i.e., materials used to modify grades beyond the earthen berm).

Reuse of On-Site Soil: The on-site soils are variable, and careful sorting by the Contractor will be required to ensure unsuitable materials are not used as structural fill. In general, the on-site soils consist of:

- Existing Fill (GeoModel Layer 1): These materials generally appear suitable for use as earthen berm fill, provided careful sorting is performed to remove bricks, rock fragments, and other deleterious objects.
- Native Clay (GeoModel Layer 2): These materials generally appear suitable for use as earthen berm fill.

Fill Material Properties: Fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. Material property requirements for general fill and structural fill are noted in the table below:

Property	Structural Fill	General Fill
Composition	Free of deleterious material	Free of deleterious material
Maximum particle size	3 inches	6 inches (or 2/3 of the lift thickness)
Plasticity	Liquid limit of 60 or less	Not limited
GeoModel Layer(s) Expected to be Suitable [1]	1 and 2	1 and 2

1. Based on the materials encountered in the borings. Actual material suitability should be determined in the field at time of construction.

Soil Type [1]	USCS Classification	Acceptable Placement (for Structural Fill)
On-site Cohesive	CL, CH	Earthen berm and general site grading
Imported Granular	GW, GP, GM, GC, SW, SP, SM, SC	Specific material requirements will need to be satisfied based on the intended use

1. Structural and general fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to Terracon for evaluation prior to use on this site.

Fill Placement and Compaction Requirements

Structural and general fill should meet the following compaction requirements.

Item	Structural Fill	General Fill
Maximum Lift Thickness	9 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 inches in loose thickness when hand-guided equipment (i.e., jumping jack or plate compactor) is used	Same as structural fill
Minimum Compaction Requirements [1,2,3]	Cohesive: 95% of maximum Granular: 98% of maximum	92% of maximum
Water Content Range [1]	Cohesive: 0 to +4% of optimum Granular: workable moisture levels for compaction to be achieved without the granular material bulking during placement or pumping during proofrolling	As required to achieve min. compaction requirements

1. Maximum density and optimum water content as determined by the standard Proctor test (ASTM D698).
2. If the granular material is a coarse sand or gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D4253 and D4254). Materials not amenable to density testing should be placed and compacted to a stable condition while being observed by Terracon.
3. Moderate to high plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.

Earthwork Construction Considerations

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the Contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the Contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be observed by Terracon during construction of the earthen berm. Observation should include documentation of adequate removal of surficial materials (vegetation and topsoil), and delineation of areas requiring subgrade stabilization.

Each lift of structural fill should be tested, evaluated, and reworked, as necessary, as recommended by Terracon prior to placement of additional lifts. Each lift of structural fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the earthen berm location.

General Comments

Our analysis and opinions are based on our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained during construction, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the Owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance on the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost

estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with Contractor means and methods and are not addressed in this report. The Owner and Contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

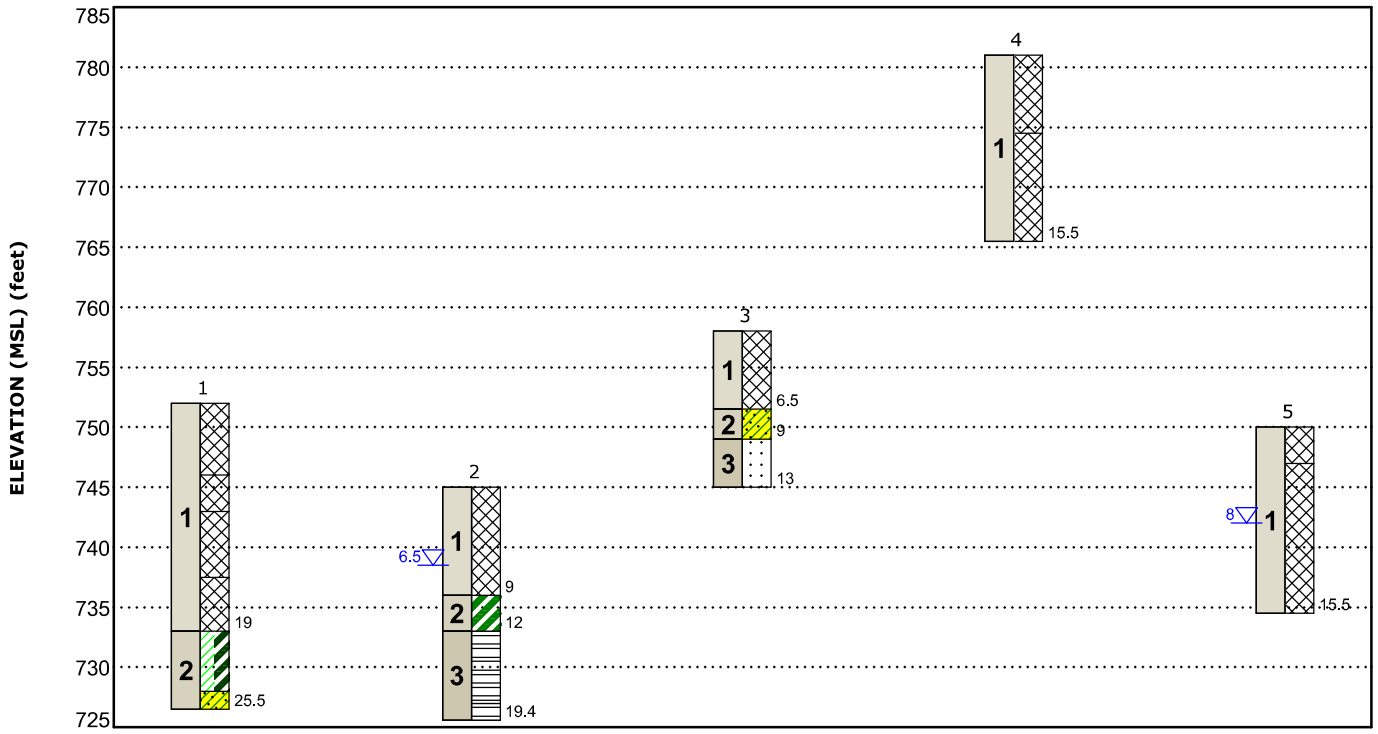
Figures

Contents:

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

600 SW 7th St, Ste M
Des Moines, IA

GeoModel



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description
1	Existing Fill	Variable material consisting of lean clay and fat clay soils with variable sand contents. Occasional shale and brick fragments and cinders.
2	Native Clay	Lean to fat clay, fat clay, and sandy lean clay. Possible residual soil. Generally medium stiff to very stiff consistency.
3	Rock	Highly weathered shale and sandstone.

Legend

- Fill
- Lean Clay/Fat Clay
- Sandy Lean Clay
- Fat Clay
- Highly Weathered Shale
- Sandstone

▽ First Water Observation

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time.
Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

NOTES:
Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project.
Numbers adjacent to soil column indicate depth below ground surface.

Attachments

Exploration and Testing Procedures

Field Exploration

Boring Numbers	Approximate Boring Depth (feet)	Location
1 and 2	25½ and 19.4	Earthen berm
3, 4, and 5	13 to 15½	Potential borrow areas

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment and referencing existing site features.

Approximate ground surface elevations were obtained by interpolation from the topography shown on the "2025-03-07_Boender Wetland Plans" provided by Shive, dated January 31, 2025. True surface elevations at the exploration locations could differ due to interpolation and other differences that occur from superposing approximate locations on the mapping system utilized. The ground surface elevations indicated on the logs are approximate and have been rounded to the nearest foot.

The locations and elevations of the borings are considered accurate only to the degree implied by the means and methods used to define them. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a rotary drilling rig using continuous flight solid stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded subsurface water levels during drilling and sampling. Each boring was backfilled with auger cuttings after their completion.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our laboratory for testing. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and the driller's interpretation of the subsurface

conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and in conjunction with input from Shive, assigned laboratory tests. The laboratory testing program included the following types of tests:

- Water Content
- Unit Weight
- Unconfined Compression
- Atterberg Limits
- Grain size analysis (sieve and hydrometer)

Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Site Location and Exploration Plans

Contents:

Note: All attachments are one page unless noted above.

Site Location

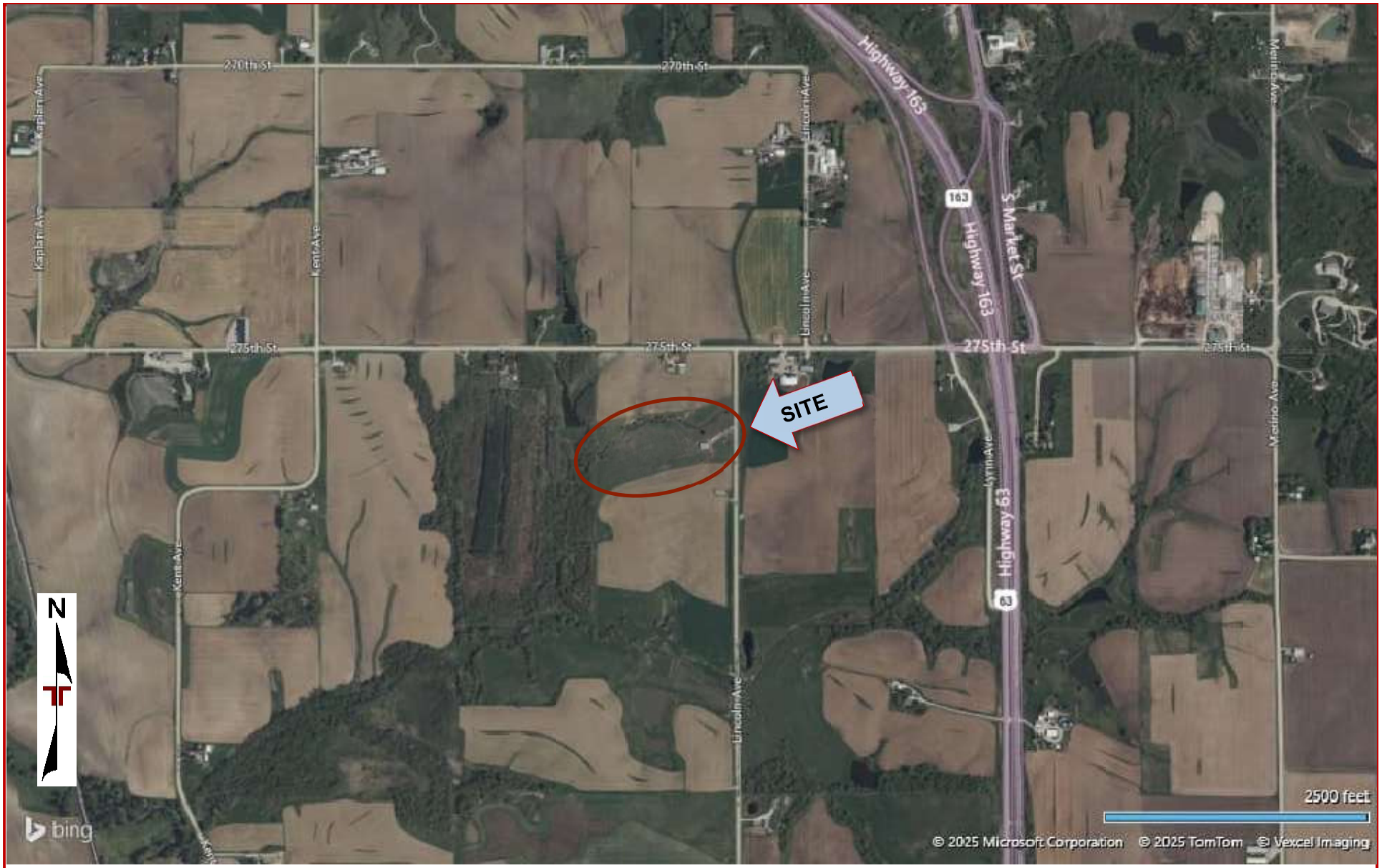


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS, OVERLAY PROVIDED BY I&S GROUP

Exploration and Laboratory Results

Contents:

Note: All attachments are one page unless noted above.

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

Terracon
600 SW 7th St, Ste M
Des Moines, IA

Boring Log No. 1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 41.2540° Longitude: -92.6550° Depth (Ft.) Approximate Elevation: 752 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
		Approx. 3" Root Zone **FILL - SANDY LEAN CLAY**, yellow brown with dark gray											
					X	16	3-4-5 N=9	1		25.0			
			5		■	15		2	5030	21.1	105		
		6.0 746											
		FILL - SANDY LEAN CLAY, with brick fragments, trace gravel, red brown			X	16	4-6-5 N=11	3		26.0			
		9.0 743											
1		**FILL - SANDY FAT CLAY**, trace gravel and cinders, brown and gray			■	24		4	5500	21.8	104		
		14.5 737.5	10										
		FILL - FAT CLAY, trace sand, gravel, and cinders			X	18	2-3-5 N=8	5		23.0			
		19.0 733	15										
2		**LEAN TO FAT CLAY (CL/CH)**, trace sand, gray, medium stiff			X	18	1-2-2 N=4	6		24.0			
		24.0 728	20										
		SANDY LEAN CLAY (CL), trace gravel, gray, medium stiff, (residual soil)			X	18	2-3-2 N=5	7		26.0			
		25.5 726.5	25										
		Boring Terminated at 25.5 Feet											

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
None Observed While Drilling

None Observed Shortly After Completion

Drill Rig
603

Hammer Type
Automatic

Driller
SZ

Logged by

Boring Started
02-14-2025

Boring Completed
02-14-2025

Notes

Advancement Method
Power Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

Terracon
600 SW 7th St, Ste M
Des Moines, IA

Boring Log No. 2

Location: See Exploration Plan

Latitude: 41.2536° Longitude: -92.6546°

Depth (Ft.) Approximate Elevation: 745 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0										
				X	12	1-2-2 N=4	1		31.1			
		5			24		2	110	28.3	92		
			▽									
				X	18	2-2-2 N=4	3		23.0			
		9.0										
2		736										
		10			12		4	1590	24.7	98		
		12.0										
3		733										
		15		X	16	10-14-17 N=31	5		15.2			
		18.0										
		727										
		19.4		X	5	50/5"	6		16.7			
		725.6										

Approx. 3" Root Zone
FILL - LEAN CLAY, with sand, gray to dark gray

FAT CLAY (CH), occasionally sandy, yellow brown, gray, and dark gray, medium stiff, (residual soil)

HIGHLY WEATHERED SILTY SHALE*, very degraded, occasionally sandy, gray

HIGHLY WEATHERED CARBONACEOUS SHALE*, degraded, occasional coal stringers, dark gray

Boring Terminated at 19.4 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

*Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Water Level Observations
▽ 6.5' During Drilling

Drill Rig
603

Hammer Type
Automatic

Driller
SZ

Logged by

Boring Started
02-14-2025

Boring Completed
02-14-2025

Notes

Advancement Method
Power Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

Terracon
600 SW 7th St, Ste M
Des Moines, IA

Boring Log No. 3

Location: See Exploration Plan

Latitude: 41.2531° Longitude: -92.6549°

Depth (Ft.) Approximate Elevation: 758 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		**Approx. 3" Root Zone** **FILL - FAT CLAY**, occasionally sandy, brown and gray										
					10	3-3-4 N=7	1		29.5		55-27-28	87.2
		5			15		2	3800	22.4	101		
		6.5 751.5										
2		**SANDY LEAN CLAY (CL)**, light brown, very stiff			12	6-10-11 N=21	3		15.4			
		9.0 749										
3		**HIGHLY WEATHERED SANDSTONE***, broken, very fine to fine grained, light brown			8	36-50/2"	4		10.6			
		10										
		13.0 745										
		Auger Refusal at 13 Feet										

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

*Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Water Level Observations
None Observed While Drilling

None Observed Shortly After Completion

Drill Rig
603

Hammer Type
Automatic

Driller
SZ

Logged by

Boring Started
02-14-2025

Boring Completed
02-14-2025

Notes

Advancement Method
Power Auger

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

Terracon
600 SW 7th St, Ste M
Des Moines, IA

Boring Log No. 4

Location: See Exploration Plan

Latitude: 41.2530° Longitude: -92.6542°

Depth (Ft.) Approximate Elevation: 781 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
1		0										
					12	3-3-4 N=7	1		20.1		40-22-18	78.6
		5			10	4-6-7 N=13	2		21.3			
					14	5-6-8 N=14	3		18.5			
		10			18	6-8-9 N=17	4		20.1			
		15			18	7-8-8 N=16	5		19.0			

Approx. 3" Root Zone
FILL - SANDY LEAN CLAY, trace shale and brick fragments, red brown with dark gray

6.5 774.5

FILL - FAT CLAY, occasionally sandy, brown and gray

15.5 765.5

Boring Terminated at 15.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
None Observed While Drilling

None Observed Shortly After Completion

Drill Rig
603

Hammer Type
Automatic

Driller
SZ

Notes

Advancement Method
Power Auger

Logged by

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Boring Started
02-14-2025

Boring Completed
02-14-2025

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

Terracon
600 SW 7th St, Ste M
Des Moines, IA

Boring Log No. 5

Location: See Exploration Plan

Latitude: 41.2541° Longitude: -92.6527°

Depth (Ft.) Approximate Elevation: 750 (Ft.)

Model Layer	Graphic Log	Depth (Ft.)	Water Level Observations	Sample Type	Recovery (In.)	Field Test Results	SAMPLE ID	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	Percent Fines
					14	4-4-5 N=9	1		22.4			86.9
		5			6	4-5-5 N=10	2		20.6		48-24-24	
1			▽		16		3	1740	23.5	104		
		10			7	4-3-3 N=6	4		19.3			
		15			6	3-2-4 N=6	5		27.1			

Approx. 3" Root Zone
FILL - LEAN CLAY, trace sand, dark brown
3.0 747

FILL - LEAN TO FAT CLAY, trace sand, dark gray
15.5 734.5

Boring Terminated at 15.5 Feet

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevation Reference: Elevations were interpolated from a topographic site plan.

Water Level Observations
▽ 8' During Drilling

Drill Rig
603

Hammer Type
Automatic

Driller
SZ

Notes

Advancement Method
Power Auger

Logged by

Abandonment Method
Boring backfilled with auger cuttings upon completion.

Boring Started
02-14-2025

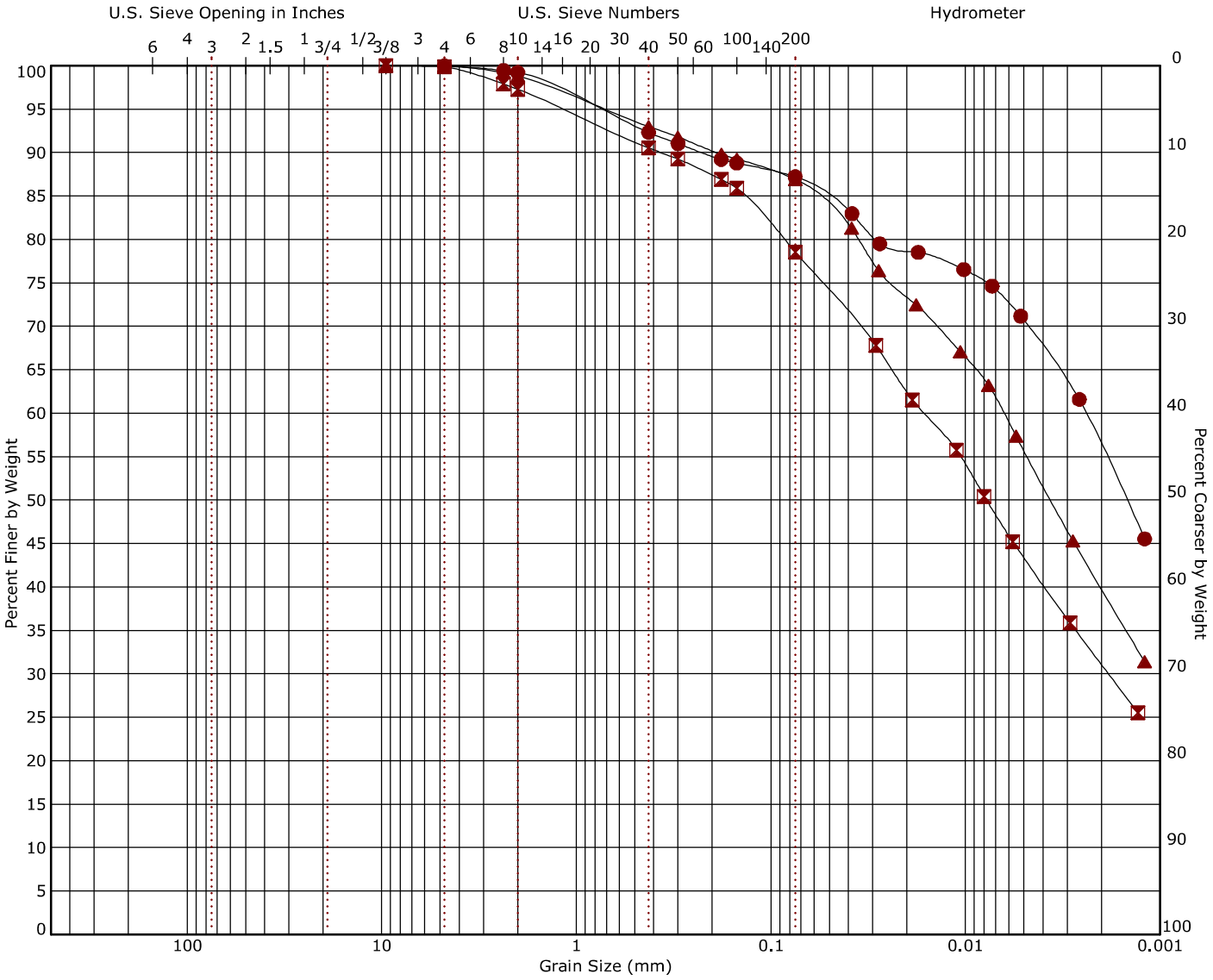
Boring Completed
02-14-2025

Boender Wetland
2138 275th St. | Oskaloosa, Iowa
Terracon Project No. 08245261

Terracon
600 SW 7th St, Ste M
Des Moines, IA

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	Description	USCS	LL	PL	PI	Cc	Cu
●	3	1.5 - 3	FAT CLAY	CH	55	27	28		
⊠	4	1.5 - 3	LEAN CLAY with SAND	CL	40	22	18		
▲	5	1.5 - 3	LEAN CLAY	CL					

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	3	1.5 - 3	4.75	0.002			0.0	0.0	12.8		16.6	70.6
⊠	4	1.5 - 3	9.5	0.016	0.002		0.0	0.1	21.3		35.2	43.4
▲	5	1.5 - 3	9.5	0.006			0.0	0.0	13.0		31.2	55.7

Supporting Information

Contents:

Note: All attachments are one page unless noted above.

Terracon
600 SW 7th St, Ste M
Des Moines, IA

General Notes

Sampling

Shelby Tube

Standard Penetration Test

Water Level

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Cave In Encountered

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

Field Tests

N	Standard Penetration Test Resistance (Blows/Ft.)
(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
UC	Unconfined Compressive Strength
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Relative Density of Coarse-Grained Soils (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		Consistency of Fine-Grained Soils (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			Bedrock	
Relative Density	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**	**Unconfined Compressive Strength Qu (psf)**	**Standard Penetration or N-Value (Blows/Ft.)**	**Standard Penetration or N-Value (Blows/Ft.)**	**Consistency**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1	< 20	Weathered
Loose	4 - 9	Soft	500 to 1,000	2 - 4	20 - 29	Firm
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8	30 - 49	Medium Hard
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15	50 - 79	Hard
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30	>79	Very Hard
		Hard	> 8,000	> 30		

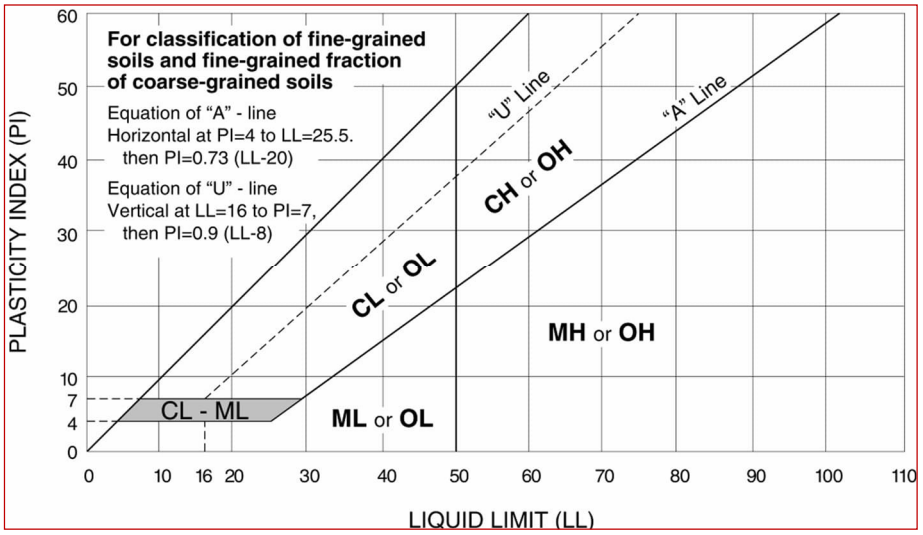
Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu≥4 and 1≤Cc≤3 [E]	GW	Well-graded gravel [F]
			Cu<4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu≥6 and 1≤Cc≤3 [E]	SW	Well-graded sand [I]
			Cu<6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots above "A" line [J]	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic silt [K, L, M]
		Organic:	$\frac{LL\ oven\ dried}{LL\ not\ dried} < 0.75$	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.
[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.



Rock Classification Notes

WEATHERING	
Term	**Description**
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi**
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Intensely fractured	< 2.5 inches	**Laminated**	< ½-inch
Highly fractured	2.5 – 8 inches	**Very thin**	½ – 2 inches
Moderately fractured	8 inches to 2 feet	**Thin**	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	**Medium**	1 – 3 feet
Very slightly fractured	> 6.5 feet	**Thick**	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.