Geotechnical Engineering Report

Paragon HUB Building
Lee's Summit, Missouri
July 28, 2021
Terracon Project No. 02215001

Prepared for:
Paragon Star LLC
Lee's Summit, Missouri

Prepared by:
Terracon Consultants, Inc.
Lenexa, Kansas

July 28, 2021

Paragon Star LLC
801 NW Commerce Drive
Lee's Summit, Missouri 64086-9381

Attn: Mr. Flip Short

Re: Geotechnical Engineering Report
Paragon HUB Building
I-470 and View High Drive
Lee's Summit, Missouri
Terracon Project No. 02215001

Dear Mr. Short:

We have completed a subsurface exploration and geotechnical engineering evaluation for the referenced project. This study was performed in general accordance with Terracon Proposal No. P02215001, dated January 5, 2021. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, retaining walls, and pavements for the 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 Consultants, Inc.

Kevin D. Friedrichs, P.E.
Project Engineer
Missouri: PE 2013010325

Kole C. Berg, P.E.
Senior Consultant
Missouri: PE 2002016417

REPORT TOPICS

Note: This report was originally delivered in a web-based format. **Orange 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 ***GeoReport*** logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

Geotechnical Engineering Report

Paragon HUB Building
I-470 and View High Drive
Lee's Summit, Missouri
Terracon Project No. 02215001
July 28, 2021

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering evaluation performed for the proposed Paragon Hub building to be located at I-470 and View High Drive in Lee's Summit, Missouri. This report describes the subsurface conditions encountered at the boring locations, presents the test data, and provides geotechnical recommendations for the following items:

- earthwork
- foundations
- floor slabs
- lateral earth pressures
- gravity wall design parameters
- seismic site class

Maps showing the site and boring locations are shown in the **Site Location and Exploration Plan** section. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs in the **Exploration Results** section.

SITE CONDITIONS

Item	Description
Project Location	The project is located at the Paragon Star Development northeast of I-470 and View High Drive in Lee's Summit, Missouri. Latitude/Longitude: 38.9378° N, 94.4446° W (approximate)
Existing Improvements	The site was recently mass-graded.
Existing Topography	Based on the provided site grading plan, the site slopes downward from west to east from an elevation of approximately 818 to an elevation of approximately 804 feet.

PROJECT DESCRIPTION

Item	Description
Project Description	The HUB building will be a single-story, steel-framed structure with a grade-supported concrete floor slab.

Item	Description
Finished Floor Elevation (FFE)	The planned FFE of the structure is 819.83 feet.
Maximum Loads	Anticipated structural loads for the new building were not provided. Based on our experience with similar structures, we have considered the following maximum loads: ■ Columns: 75 kips ■ Walls: 2 kips per linear foot ■ Slabs: 100 pounds per square foot
Grading/Slopes	Based on the provided site grading plan, we anticipate up to 15 feet of fill will be required to develop final grades. Final slope angles of 3H:1V (Horizontal: Vertical) or flatter are expected.
Below-Grade Structures	No below grade structures are planned.
Free-Standing Retaining Walls	A retaining wall is planned along the east property line. The wall will have a retained height of up to 7 feet. The wall type was not determined at the time this report was prepared. We understand that the wall may be a cast-in-place reinforced concrete wall or a gravity block wall. This report includes geotechnical design parameters for each of these wall types; however, Terracon should be notified once the final wall type is selected so we can provide supplemental recommendations, if required. Global stability of the wall and building configuration is not included in our scope of geotechnical services. Once the wall design has been prepared, we are available to analyze the global stability of the wall and building upon request for a supplemental fee.
Pavements	No borings were requested in the parking and drive areas. Therefore, recommendations regarding pavements and pavement subgrade preparation are not included in Terracon's scope of services.

GEOTECHNICAL CHARACTERIZATION

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

As part of our analyses, 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	**Fill**	Lean to fat clay (CL/CH) with gravel and concrete fragments
2	**Native Clay**	Lean to fat clay (CL/CH) very soft to stiff

The borings were observed during drilling and shortly after completion of drilling for the presence and level of water. Groundwater was observed at depths ranging from 16½ to 17 feet in Borings B-101, B-102, and B-104. Groundwater was not encountered in the other borings at these times. A longer period of time may be required for groundwater to develop and stabilize in a borehole. Longer term observations in piezometers or observation wells, sealed from the influence of surface water, are often required to define groundwater levels.

Groundwater levels may fluctuate due to seasonal variations in the amount of rainfall, runoff, and other factors not evident at the time the borings were performed. "Perched" water could occur above lower permeability soil layers and/or near the soil/bedrock interface, and "trapped" water could be present within existing fill materials. Therefore, groundwater conditions at other times may be different than the conditions encountered in our exploratory borings. The potential for water level fluctuations and perched water should be considered when developing design and construction plans and specifications for the project.

GEOTECHNICAL OVERVIEW

Based on conditions encountered at the boring locations, it appears feasible to support the new building on shallow spread footings bearing on medium stiff native clay or engineered fill materials.

Existing fill materials composed of lean to fat clay and concrete fragments were encountered to depths of about 8 feet at Boring B-105. Fill could extend to greater depths in other areas of the site where no borings were performed. Based on field and laboratory test data, it appears that some compactive effort was applied to portions of the fill encountered at the boring locations. However, no documentation regarding placement and compaction of the fill was provided for our review. Due to the potential for unpredictable performance and larger-than-tolerable foundation settlements, foundations should not be supported on or above the existing fill. However, since grade-supported floor slabs and pavements are more lightly-loaded than foundations and are generally more tolerant of subgrade movements, existing fill may be left in place below floor slabs and retaining walls provided it is observed, tested and approved by Terracon during construction.

Potentially expansive fat clay soils were encountered at the site. These materials have the potential to shrink and swell with seasonal fluctuations in the soil moisture content. We recommend the floor slabs be supported on at least 24 inches of low volume change (LVC) material. In areas that are currently above or less than 2 feet below the planned bottom of floor slab level, native fat clay soils should be undercut to accommodate placement of LVC material.

In areas where more than 2 feet of fill will be placed below the bottom-of-floor-slab level, at least the upper 24 inches of new engineered fill should consist of LVC material. Placement of a layer of LVC material below floor slabs, as recommended in this report, will not eliminate all future subgrade volume change and resultant floor slab movements. However, use of an LVC zone should reduce the potential for subgrade volume change. Details regarding the LVC zone are provided in **Earthwork**.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and at least minor cracking in the structure could still occur. The severity of cracking and other cosmetic damage caused by movement of the floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive soils. Eliminating the risk of movement and cosmetic distress may not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. We would be pleased to discuss other construction alternatives with you upon request. The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Site preparation, excavation, subgrade preparation and placement of engineered fills should conform to recommendations presented in this section. The recommendations presented for design and construction of earth-supported elements including foundations and floor slabs are contingent upon the recommendations outlined in this section being followed. We recommend earthwork on this project be observed and evaluated by Terracon. The evaluation of earthwork should include observation and testing of subgrade preparation, engineered fill, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Vegetation, topsoil, and any loose, soft or otherwise unsuitable soils present within the proposed construction areas should be stripped. Based on information obtained at the boring locations, stripping depths on the order of 3 inches should be anticipated to remove the root zone materials. However, greater stripping depths may be required in areas not explored by the borings. Organic soils removed during site preparation should not be used as fill beneath the proposed new building and pavement areas.

The soils within the planned building area should be further undercut as necessary to accommodate placement of the recommended 24-inch thick LVC layer below floor slabs. The undercut areas should extend a minimum of 5 feet laterally outside the building wall lines. Undercutting to facilitate placement of the LVC layer would not be necessary in areas where more than 2 feet of fill will be placed to develop the floor slab subgrade level.

Following initial stripping and any necessary undercutting, the exposed soils should be proofrolled. A Terracon representative should observe the proofrolling. Proofrolling can be accomplished using a loaded tandem-axle dump truck with a gross weight of at least 20 tons, or similarly loaded equipment. Areas that display excessive deflection (pumping) or rutting during proofroll operations should be improved by scarification/compaction or by removal and replacement with engineered fill.

Fill Material Types

A sample of each fill material type should be tested prior to being used on the site. Our professional opinions concerning suitability of fill materials are presented in the following table.

Fill Type [1]	USCS Classification	Acceptable Location for Placement
Low Volume Change (LVC) material	GM [2] or CL (LL<45 and PI<23)	All locations and elevations, except where free-draining material is required
On-site soils	CH or CL (LL≥45 and PI≥23) (native clay soils and existing fill soils)	Pavement areas and at depths greater than 24 inches below building finished grade Existing fill should be observed, tested and approved by Terracon. Organics, rock/rubble fragments larger than 3 inches, debris, or other unsuitable materials should be removed prior to re-use of the existing fill in engineered fill sections.
Well-graded granular	GW [3]	Where free-draining material is required

1. Engineered 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.
2. MoDOT Type 5 or an approved alternate gradation of crushed limestone aggregate.
3. Granular materials with less than 5 percent fines (material passing the #200 sieve), such as ASTM C33 Size No. 57 aggregate or an approved alternate gradation.

Low volume change (LVC) material placed below the building floor slabs can consist of well-graded crushed stone aggregate (e.g., MoDOT Type 5). Lean clay soils with a liquid limit less than 45 and plasticity index less than 23 could also be used as LVC material, but these soils would be susceptible to softening and disturbance if they become wetted by surface water and precipitation. Soils that meet the LVC criteria were not encountered during our exploration. Therefore, the use of imported LVC materials should be expected. If a granular leveling course (such as crushed stone aggregate) is used immediately below the floor slabs, this material can be considered part of the LVC zone.

Fill Compaction Requirements

Item		Description
Lift Thickness (maximum)		9 inches in loose thickness when large, self-propelled compaction equipment is used 4 inches when small, hand-guided equipment (plate or "jumping jack" compactor) is used
Minimum Compaction Requirements [1]		At least 95 percent of the material's maximum dry density [1]
Moisture Content of Clay Soil	LL<45	-2 to +2 percent of optimum moisture content value [1]
	LL>45	0 to 4 percent above the optimum moisture content value [1]
Moisture Content of Granular Material		Sufficient to achieve compaction without pumping when proofrolled

1. As determined by the standard Proctor test (ASTM D 698)

We recommend that engineered fill be tested for moisture content and compaction during placement. If the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of clay fill to reduce the infiltration and conveyance of surface water through the trench backfill.

Utility trenches are common sources of water infiltration and migration. All utility trenches that penetrate beneath buildings should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the building. We recommend constructing an effective "trench plug" that extends at least 5 feet out from the face of the building exterior. The plug material should consist of clay compacted as recommended in **Earthwork**. The clay fill should be placed to completely surround the utility line and be compacted in accordance with recommendations in this report. Alternatively, flowable fill could be used to construct the trench plug.

Grading and Drainage

During construction, grades should be developed to direct surface water flow away from or around the site. Exposed subgrades should be sloped to provide positive drainage so that saturation of subgrades is avoided. Surface water should not be permitted to accumulate on the site. Final surrounding grades should promote rapid surface drainage away from the structures. Accumulation of water adjacent to the structure could contribute to significant moisture increases in the subgrade soils and subsequent softening/settlement or expansion/heave.

After construction of the building and pavements have been completed, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the building should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

Earthwork Construction Considerations

Terracon should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during subgrade preparation, proofrolling, placement and compaction of engineered fill, backfilling of excavations into completed subgrades, and just prior to construction of foundations, slabs, and pavements.

Care should be taken to avoid disturbance of prepared subgrades. Unstable subgrade conditions can develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. If unstable subgrade conditions develop, stabilization measures will need to be employed. Construction traffic over the completed subgrade should be avoided to the extent practical. If the subgrade becomes frozen, desiccated, saturated, or disturbed, the affected materials should be removed or these materials should be scarified, moisture conditioned, and compacted prior to floor slab construction.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for footing construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction. In our experience, dewatering of excavations in clay soils can typically be accomplished using sump pits and pumps.

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, state, and federal safety regulations. The contractor should be aware that slope height, slope inclination, and excavation depth should in no instance exceed those specified by these safety regulations. Flatter slopes than those dictated by these regulations may be required depending upon the soil conditions encountered and other external factors. These regulations are strictly enforced and if they are not followed, the owner, contractor, and/or earthwork and utility subcontractor could be liable and subject to substantial penalties. Under no circumstances should the information provided in this report be interpreted to mean that Terracon is responsible for construction site safety or the contractor's activities. Construction site safety is the sole responsibility of the contractor who shall also be solely responsible for the means, methods, and sequencing of the construction operations.

SHALLOW FOUNDATIONS

Foundation Design Parameters

Based on the conditions encountered at the borings, the building can be supported on conventional shallow footing foundations that bear on medium stiff to stiff native clay soil and/or engineered fill.

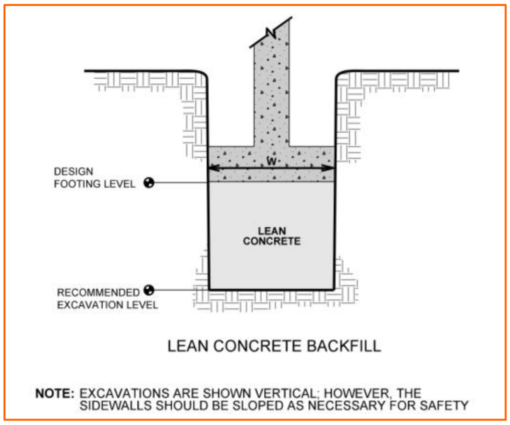
Description	Value
Maximum net allowable bearing pressure [1]	1,500 psf
Minimum embedment below finished grade for frost protection [2]	3 feet
Minimum footing widths	Isolated footings: 30 inches Continuous footings: 16 inches
Estimated total settlement [3]	1 inch or less
Estimated differential settlement [3]	1/2 to 2/3 of the total settlement over a horizontal distance of 50 feet

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This pressure assumes that any soft soils or other unsuitable materials, if encountered, will be undercut and replaced with engineered fill.
2. This embedment depth is recommended for perimeter footings and footings beneath unheated areas to provide frost protection and to reduce the effects of seasonal moisture variations in the foundation bearing soils. Interior footings in heated areas may be supported at shallower depths, provided they are not exposed to freezing conditions during construction.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of engineered fill below the footings, and the quality of the earthwork operations and footing construction.

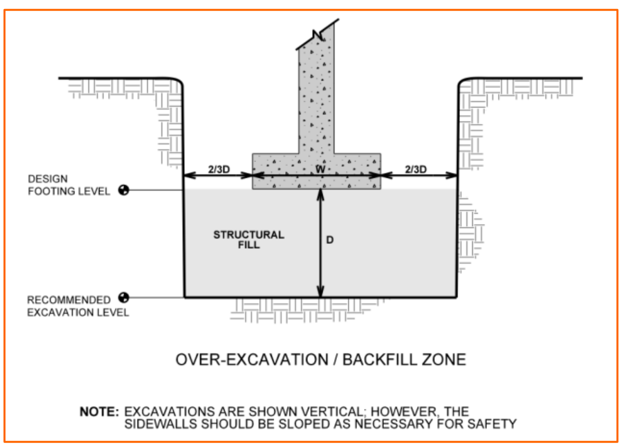
Foundation Construction Considerations

The base of all foundation excavations should be free of water and loose materials prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. If the soils at the bearing level become excessively dry, disturbed, saturated, or frozen, the affected soil should be removed prior to placing concrete. If the excavations must remain open overnight or for an extended period of time, placement of a lean concrete mud-mat over the bearing soils should be considered.

All footing bearing surfaces should be observed and tested by Terracon. If unsuitable conditions are encountered, footing excavations should be extended deeper to suitable bearing materials. Footings can bear directly on suitable soils at the lower level or on lean concrete backfill as shown in the following figure.



The footings could also bear on properly compacted backfill extending down to suitable soils as shown in the following figure. Overexcavation for compacted engineered fill placement below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing elevation. The overexcavation should then be backfilled up to the footing base elevation with well graded granular material (e.g., MoDOT Type 5 aggregate or an approved alternate gradation) placed and compacted as recommended in **Earthwork**.



GROUND IMPROVEMENT

The client could consider ground improvement as a means of improving the existing soft to medium stiff native soils encountered at the site. A ground improvement system (such as rammed aggregate piers or stone columns) could be utilized to increase the bearing capacity of the on-site soils and decrease the potential settlement. A ground improvement system generally consists of aggregate-filled piers, which results in partial replacement of on-site soils and improves the foundation support capability of the adjacent remaining soils. Where ground improvement will be used, it may be necessary to place a layer of crushed stone aggregate to protect the subgrade from disturbance by the construction equipment. Once the ground improvement system is installed, the buildings could then be supported on conventional shallow footing foundations bearing above the improved soil. Ground improvement systems are procured on a design-build basis from specialty contractors. The design-build specialty contractor would use the subsurface information summarized on the attached boring logs and other project information from the design team to perform their analysis, formulate a design, and prepare a cost estimate. Upon request, Terracon can provide contact information for specialty contractors experienced in these ground improvement methods.

SEISMIC CONSIDERATIONS

Code	Site Class
2018 International Building Code (IBC)	D[1]

1. The 2018 International Building Code (IBC) seismic site class definitions are based on average properties of the subsurface profile to a depth of 100 feet. The exploratory borings terminated within native alluvial clay at a maximum depth of 25 feet. Our opinion of site class is based on boring data and our knowledge of local geological and geotechnical conditions.

FLOOR SLABS

Floor Slab Design Parameters

Item	Description
Floor Slab Support	At least 24 inches of low volume change (LVC) material
Modulus of Subgrade Reaction	100 pounds per square inch per inch of deflection (psi/in or pci) for point loading conditions
Granular Leveling Course Layer Thickness [1,2]	4 inches (minimum)

1. Well graded crushed stone (e.g., MoDOT Type 5 aggregate) or open-graded crushed stone (e.g. ASTM C33, Size No. 57 aggregate) can be used as the leveling course.
2. These granular materials may be considered part of the LVC zone.

Joints should be constructed in slabs at regular intervals as recommended by the American Concrete Institute (ACI) to help control the location of cracks. Joints or any cracks that develop in the floor slab should be sealed with a water-proof, non-extruding compressible compound.

Loads on footings that support structural walls and column loads are typically greater than floor slab loads. Consequently, footings should be expected to settle more than the adjacent floor slabs. The structural engineer should consider the potential for differential movement between foundations and grade-supported floor slabs.

Typically, some increase in the floor slab subgrade moisture content will occur because of gradual accumulation of capillary moisture, which would otherwise evaporate if the floor slab had not been constructed. The use of a vapor retarder should be considered beneath concrete slabs-on-grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Floor Slab Construction Considerations

The subgrade should be maintained within the moisture content range recommended for engineered fill until the floor slab is constructed. If the subgrade becomes desiccated prior to construction of the floor slab, the affected material should be removed or the materials should be scarified, moistened, and compacted. Upon completion of grading operations in the building area, care should be taken to maintain the subgrade within the moisture content and density ranges recommended for engineered fill prior to construction of the building floor slab.

On most project sites, the site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, rainfall etc. As a result, the floor slab subgrade soils may not be suitable for placement of the granular course and/or concrete at the time of building construction, and corrective action may be required.

Terracon should evaluate the condition of the floor slab subgrades immediately prior to placement of the granular leveling course and construction of the slabs. Particular attention should be paid to areas containing backfilled trenches and high traffic areas that were previously disturbed during construction. Where unsuitable conditions are located within the floor slab subgrade soils, the subgrade should be improved by removing and replacing the affected material with properly compacted fill.

GRAVITY RETAINING WALLS

Gravity retaining walls (e.g., large-block walls) with maximum exposed heights of approximately 7 feet, are presently planned along the east side of the HUB building and parking areas. Based on available laboratory tests performed for this project, our experience with similar soils, and drained shear strength correlations in the published literature [1,2,3,4,5], we developed the following geotechnical design parameters for use in the analysis.

Material Type	Total Unit Weight (pcf)	Effective Stress (Drained) Shear Strength Parameters	
		c′, psf	ϕ′, degrees
Wall Backfill (MoDOT Type 5 Aggregate or Similar) [1]	130	0	35
New Fill: Lean to Fat Clay	115	50	24
Native Alluvial Clay	110	50	24

1. For these values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical.

Gravity retaining walls are typically subcontracted as design-build structures, since design details are often manufacturer specific. We recommend the following considerations be included in the project specifications for the wall design.

The retaining wall designer should specify the material strength parameters assumed for the backfill in the design so that materials not meeting these specifications are not allowed in the backfill zone during construction. The designer should also state the assumed parameters for the foundation soils and retained soils. The stability analyses for the wall should take into account slopes and loading conditions (e.g., surcharges from foundations, pavements, etc.), above and below the proposed wall. We understand that building foundations will not be supported in the reinforced zone or the retained soil zone, so the wall is not expected to affect the building performance.

The wall contractor should be required to provide the plans, specifications, and calculations for the retaining wall design based on the planned final cross section, including the topography above and below the wall and the subsurface conditions considered in the wall design. We recommend Terracon be retained to review and comment on the wall system design prior to construction of the wall.

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[1] *Kulhawy, F. H., & Mayne, P. W. (1990). Manual on Estimating Soil Properties for Foundation Design, Final Report EL-6800. Cornell University, Ithaca, New York. Palo Alto, CA: EPRI.*

[2] *Stark, T. D., & Eid, H. T. (1994). Drained Residual Strength of Cohesive Soils. J. Geotech. Eng., 120 (5), 856-871.*

[3] *Stark, T. D., & Eid, H. T. (1997). Slope Stability Analyses in Stiff Fissured Clays. J. Geotech. Geoenviron. Eng., 123 (4), 335-343.*

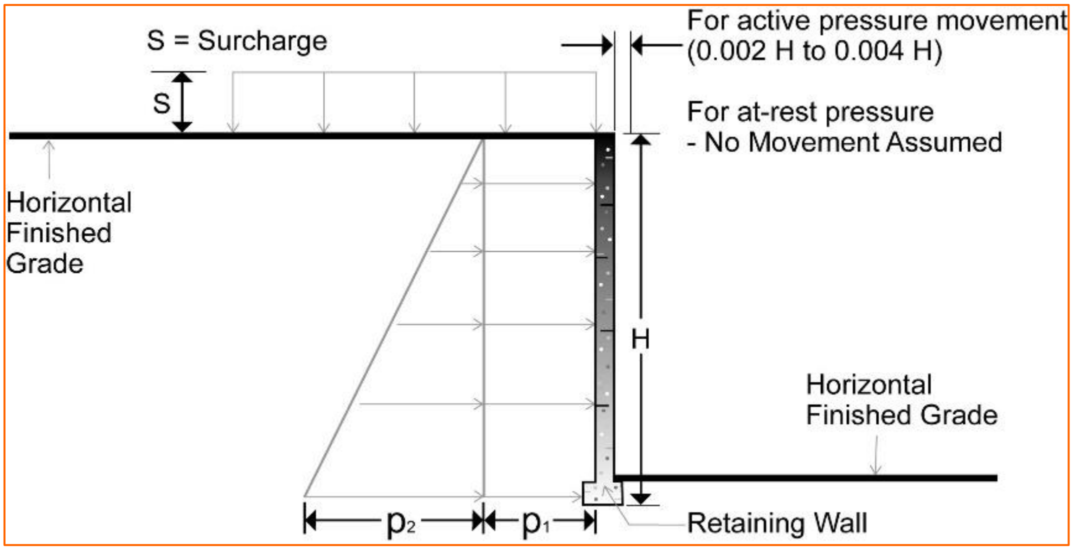
[4] *Stark, T.D., Choi, H., & McCone, S. (2005). Drained Shear Strength Parameters for Analysis of Landslides. J. Geotech. Geoenviron. Eng., 131 (5), 575-588.*

[5] *Stark, T. D., & Hussain, M. (2013). Empirical Correlations: Drained Shear Strength for Slope Stability Analyses. J. Geotech. Geoenviron. Eng. , 139 (6), 853-862.*

LATERAL EARTH PRESSURES

Lateral Earth Pressure Design Parameters

Reinforced concrete cantilever retaining walls and foundation walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls where wall movement is permitted. The at-rest condition considers no wall movement is permitted. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.



Lateral Earth Pressure Parameters

Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Unit Weight (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (K_a)	Granular - 0.3 Clay - 0.42	40 50	(0.3)S (0.42)S	(40)H (50)H
At-Rest (K_o)	Granular - 0.47 Clay - 0.60	60 70	(0.47)S (0.60)S	(60)H (70)H
Passive (K_p)	Granular - 3.3 Clay - 2.4	420 290	--- ---	--- ---

Applicable conditions to the above include:

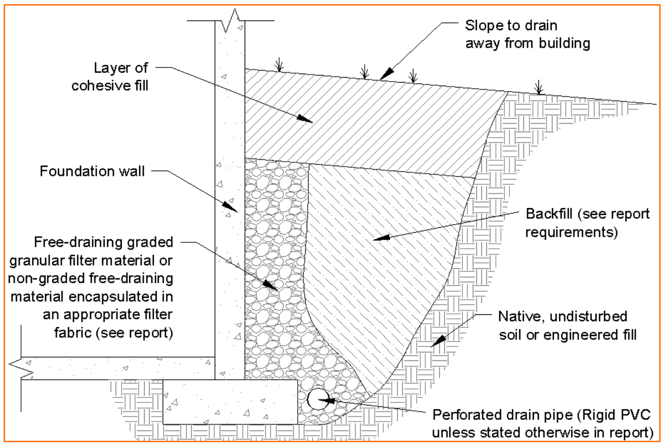
- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 H to 0.004 H, where H is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- Clay soil backfill: unit weight = 120 pcf (maximum), and ϕ = 24 degrees (minimum)
- Granular material backfill: unit weight = 130 pcf (maximum), and ϕ = 32 degrees (minimum)
- Horizontal backfill, compacted as recommended in the report
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No loading from nearby footing or slabs
- No dynamic loading
- No safety factor included in soil parameters
- Ignore passive pressure in frost zone

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active and at-rest cases, and at an angle of 60 degrees from vertical for the passive case. To calculate the resistance to sliding, a value of 0.3 should be used as the ultimate coefficient of friction where the footing bears on native clay soils or engineered fill

Gravity walls (e.g., large-block walls) require different design parameters than those provided in this section. If gravity walls will be utilized instead of a reinforced concrete cantilever type walls the parameters provided in **Gravity Walls** should be used in the design.

Subsurface Drainage for Below Grade Walls

To prevent hydrostatic pressure on below-grade walls, we recommend drains be installed at the foundation level. Each drain line should be sloped to provide positive gravity drainage and should be surrounded by free-draining granular material graded to prevent the intrusion of fines, or an alternative free-draining granular material encapsulated with suitable filter fabric. At least a 2-foot wide section of free-draining granular fill should be used for backfill above the drain line and adjacent to the wall. The free-draining granular fill should extend to within 2 feet of final grade and should be capped with compacted cohesive fill to minimize infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion, and is fastened to the wall prior to placing backfill.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between boring 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 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 or collaboration through this system 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 upon 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.

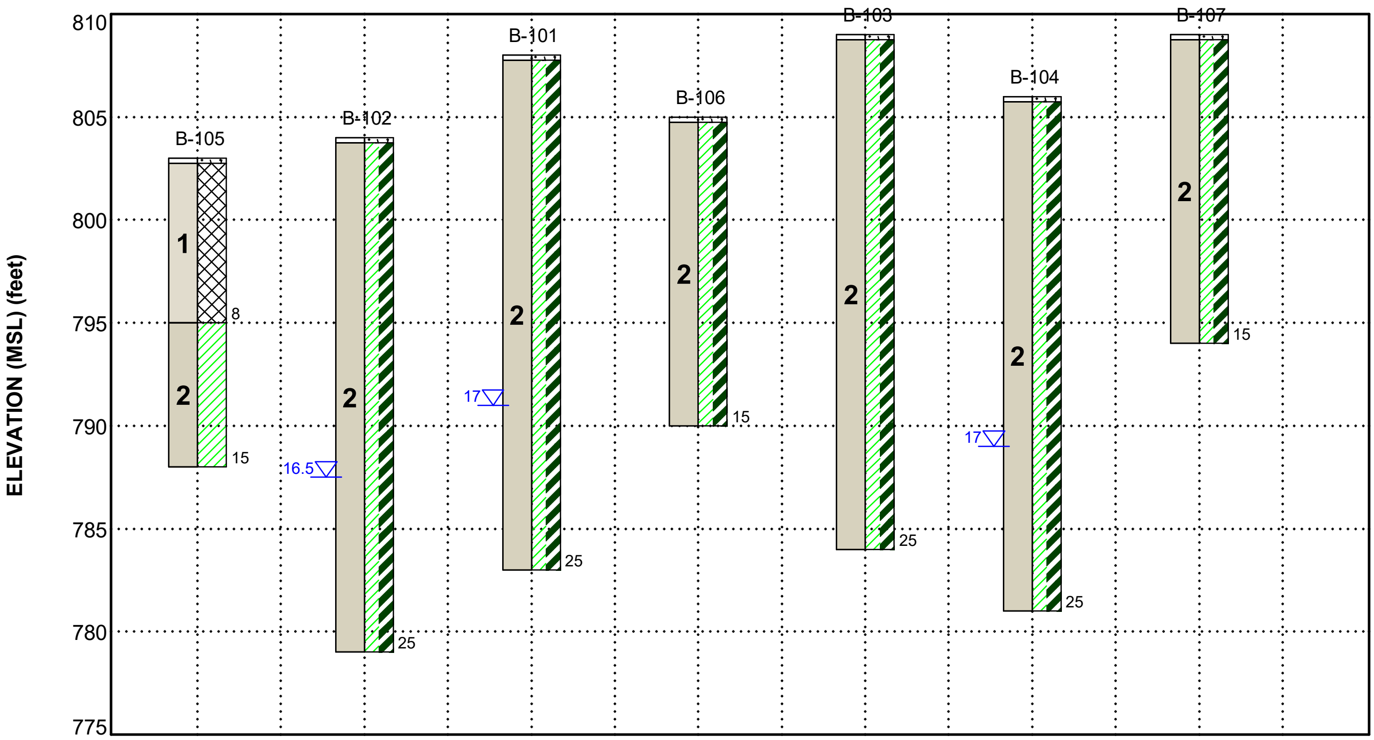
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation 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, cost estimating, excavation support, and dewatering requirements/design are the responsibility of others. 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:

GEOMODEL

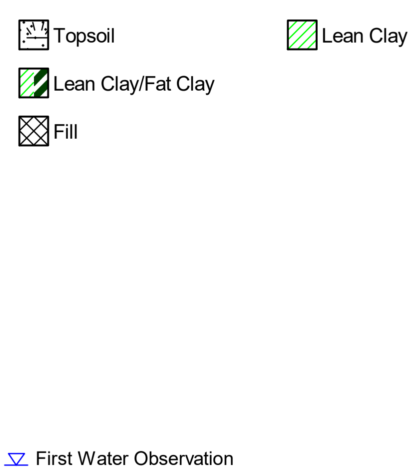
Paragon HUB Building ■ Lee's Summit, MO
Terracon Project No. 02215001



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	Fill	Lean to fat clay (CL/CH) with gravel and concrete fragments
2	Native Clay	Lean to fat clay (CL/CH) very soft to stiff

LEGEND



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

The borings were located in the field by the project surveyor. Ground surface elevations indicated on the boring logs were estimated by interpolation from a topographic plan.

The borings were drilled with a track-mounted, rotary drill rig using solid-stem, continuous flight augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using thin-walled tube and split-barrel sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outside diameter split-barrel sampling spoon is 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.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. The drill crew backfilled the borings with auger cuttings after completion of drilling/sampling and prior to leaving the site.

The drill crew prepared a field log of each boring to record data including visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. The final boring logs included with this report represent the engineer's interpretation of the subsurface conditions at the borings based on field and laboratory data and observation of the samples.

Laboratory Testing

Representative soil samples were tested in the laboratory to measure their natural water content, dry unit weight, and Atterberg limits. A pocket penetrometer was used to estimate the consistency of selected cohesive samples. The test results are provided on the boring logs included in **Exploration Results**.

The soil samples were classified in the laboratory based on visual observation, texture, plasticity, and the laboratory testing described above. The soil descriptions presented on the boring logs are in accordance with the enclosed General Notes and Unified Soil Classification System (USCS). The estimated USCS group symbols for native soils are shown on the boring logs, and a brief description of the USCS is included in this report.

The bedrock materials encountered in the borings were described in accordance with the appended Description of Rock Properties on the basis of drilling characteristics and visual classification of disturbed auger cuttings. Petrographic analysis and rock core may indicate other rock types.

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

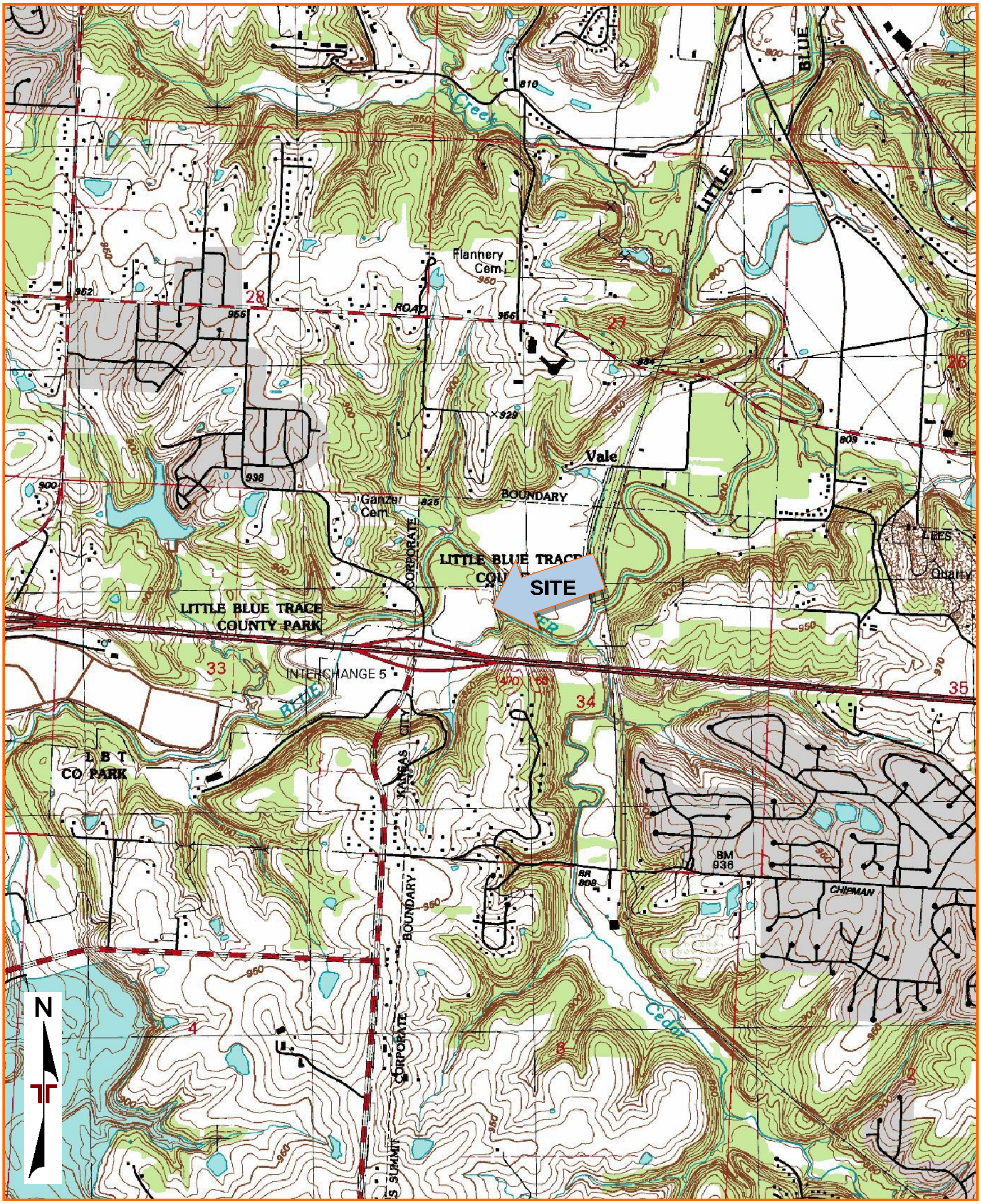


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: LEES SUMMIT, MO (1/1/1996).

EXPLORATION PLAN

Paragon HUB Building ■ Lee's Summit, MO

July 21, 2021 ■ Terracon Project No. 02215001

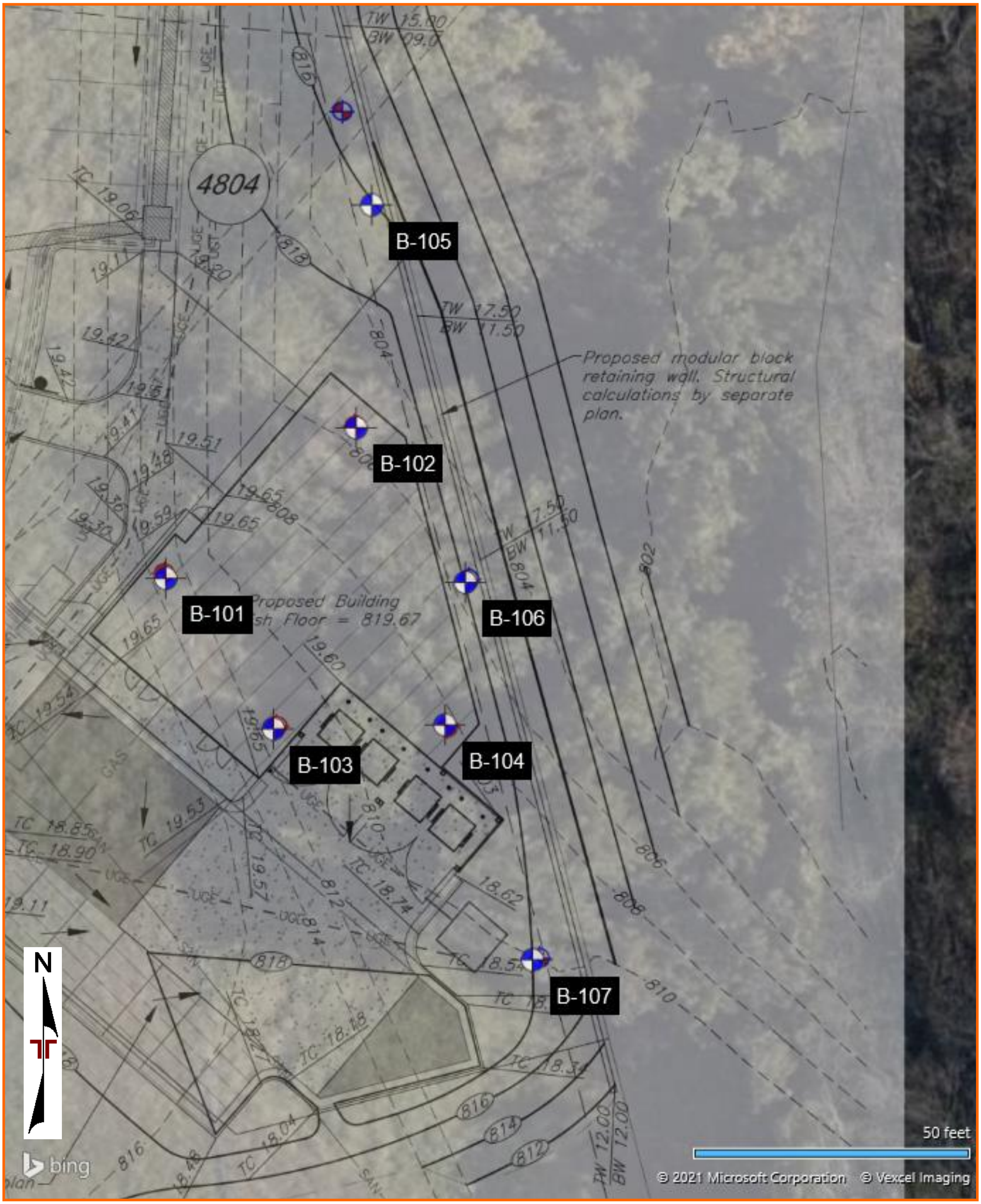


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs (B-101 through B-107)

Note: All attachments are one page unless noted above.

BORING LOG NO. B-101

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9383° Longitude: -94.4444°

MODEL LAYER	DEPTH	Material Description
	0.3	**3" ROOT ZONE**
2		**LEAN TO FAT CLAY (CL/CH)**, silty, dark brown to gray, medium stiff to stiff - soft below 18 feet
	25.0	***Boring Terminated at 25 Feet***

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		13	3-4-4 N=8	20.8		50-18-32
5		15		21.2	100	
		18	3-4-6 N=10	23.1		
10		18	3-2-3 N=5	25.9		
15		16	2-2-3 N=5	27.4		
	▽					
20		18	0-0-1 N=1	30.5		
25		18	1-1-2 N=3	32.8		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

▽ *17 feet while drilling*

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-20-2021	Boring Completed: 07-20-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

BORING LOG NO. B-102

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9384° Longitude: -94.4443°

MODEL LAYER	GRAPHIC LOG	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.3 **3" ROOT ZONE**								
2		**LEAN TO FAT CLAY (CL/CH)**, silty, light gray to brown, medium stiff			Split spoon	18	3-3-3 N=6	25.4		
					Shelby tube	13		23.7	98	
			5							
					Split spoon	18	3-2-3 N=5	22.8		
					Split spoon	18	3-3-2 N=5	23.0		
			10							
		- soft below 13 feet			Split spoon	16	2-1-2 N=3	23.3		
			15	∇						
					Split spoon	18	1-1-2 N=3	32.0		
			20							
		25.0			Split spoon	18	0-0-1 N=1	30.7		
		Boring Terminated at 25 Feet	25							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

∇ *16.5 feet while drilling*

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-20-2021	Boring Completed: 07-20-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

BORING LOG NO. B-103

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9382° Longitude: -94.4443°

MODEL LAYER	DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	0.3	**3" ROOT ZONE**								
2		**LEAN TO FAT CLAY (CL/CH)**, silty, light brown to gray, medium stiff to stiff								
					Split spoon	18	3-3-3 N=6	22.8		48-18-30
			5		Shelby tube	24		12.9	112	
					Split spoon	16	3-4-5 N=9	24.0		
			10		Split spoon	12	2-2-2 N=4	22.5		
		- soft below 13 feet								
			15		Split spoon	16	2-2-1 N=3	22.9		
			20		Split spoon	18	0-0-1 N=1	32.2		
	25.0		25		Split spoon	18	1-1-2 N=3	30.3		
		Boring Terminated at 25 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-20-2021	Boring Completed: 07-20-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

BORING LOG NO. B-104

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9382° Longitude: -94.4442°

Model Layer	Depth	Description
	0.3	**3" ROOT ZONE**
2		**LEAN TO FAT CLAY (CL/CH)**, silty, light brown to gray, medium stiff
		- soft below 18 feet
	25.0	***Boring Terminated at 25 Feet***

Depth (Ft.)	Water Level Observations	Recovery (In.)	Field Test Results	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
1.5–3 (approx.)		13	3-3-4 N=7	23.2		
3–5 (approx.)		15		22.8	103	
6–7.5		8	4-3-4 N=7	21.4		
8.5–10		18	3-3-3 N=6	23.0		
13.5–15		18	3-3-3 N=6	26.5		
17	▽					
18.5–20		18	0-1-1 N=2	32.6		
23.5–25		18	1-1-1 N=2	32.8		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

▽ *17 feet while drilling*

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-20-2021	Boring Completed: 07-20-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

BORING LOG NO. B-105

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9385° Longitude: -94.4443°

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		0.3	**3" ROOT ZONE**								
1			**LEAN TO FAT CLAY (CL/CH)**, with concrete fragments, dark brown				8	3-3-4 N=7	21.6		50-20-30
							24		24.4	102	
				5							
		8.0					10	7-12-7 N=19	22.9		
2			**LEAN CLAY (CL)**, silty, light brown to gray, medium stiff to stiff				18	3-6-7 N=13	20.2		
				10							
		15.0		15			18	3-3-4 N=7	26.9		
			Boring Terminated at 15 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-19-2021	Boring Completed: 07-19-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

BORING LOG NO. B-106

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9383° Longitude: -94.4442°

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
2		0.3	**3" ROOT ZONE**								
			LEAN TO FAT CLAY (CL/CH), silty, light brown to gray, medium stiff to stiff								
						Split spoon	18	3-4-4 N=8	23.8		49-20-29
				5		Shelby tube	15		23.5	95	
						Split spoon	18	4-5-5 N=10	22.3		
				10		Split spoon	18	3-3-4 N=7	22.4		
		15.0		15		Split spoon	17	3-3-3 N=6	25.7		
			Boring Terminated at 15 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-19-2021	Boring Completed: 07-19-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

BORING LOG NO. B-107

PROJECT: Paragon HUB Building

CLIENT: Paragon Star LLC
Lees Summit, MO

SITE: I-470 and View High Drive
Lee's Summit, MO

LOCATION See Exploration Plan

Latitude: 38.9381° Longitude: -94.4441°

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
2		0.3	**3" ROOT ZONE**								
			LEAN TO FAT CLAY (CL/CH), silty, dark brown to gray, medium stiff to stiff				13	3-4-5 N=9	21.8		43-20-23
				5			20		22.6	99	
							15	3-3-4 N=7	19.8		
				10			18	4-5-6 N=11	24.3		
		15.0		15			16	3-2-4 N=6	24.9		
			Boring Terminated at 15 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Continuous Flight Augers

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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.

Elevations were interpolated from a topographic site plan

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
15620 W 113th St
Lenexa, KS

Boring Started: 07-19-2021	Boring Completed: 07-19-2021
Drill Rig: 556	Driller: SF
Project No.: 02215001	

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Paragon HUB Building ■ Lee's Summit, MO

Terracon Project No. 02215001

Terracon GeoReport

SAMPLING

Shelby Tube

Split Spoon

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		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELEVANCE OF SOIL BORING LOG

The soil boring logs contained within this document are intended for application to the project as described in this document. Use of these soil boring logs for any other purpose may not be appropriate.

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 on or above "A" line [J]		CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]		ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay [K, L, M, N]
			Liquid limit - not dried			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:	Liquid limit - oven dried	< 0.75	OH	Organic clay [K, L, M, P]
			Liquid limit - not dried			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.