Terracon GeoReport

Geotechnical Engineering Report

Summit Square II Apartments

Lee's Summit, Missouri

May 11, 2018

Terracon Project No. 02185057

Prepared for:

NorthPoint Development

Riverside, Missouri

Prepared by:

Terracon Consultants, Inc.

Lenexa, Kansas

May 11, 2018

NorthPoint Development
4825 NW 41st Street, Suite 500
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Attn: Mr. Grant Barnes – Project Manager
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Re: Geotechnical Engineering Report
Summit Square II Apartments
NW Ward Road and NW Donovan Road
Lee's Summit, Missouri
Terracon Project No. 02185057

Dear Mr. Barnes:

We have completed a geotechnical exploration for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P02185057, dated March 7, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements 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 Consultants, Inc.

STATE OF MISSOURI
KEVIN D. FRIEDRICHS
NUMBER PE-2013010325
5/11/18
PROFESSIONAL ENGINEER

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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 Terracon GeoReport logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Geotechnical Engineering Report

Summit Square II Apartments
NW Ward Road and NW Donovan Road
Lee's Summit, Missouri

Terracon Project No. 02185057
May 11, 2018

INTRODUCTION

This report presents the results of our subsurface exploration and geotechnical engineering evaluation performed for the proposed Summit Square II Apartments to be located at the northeast corner (NEC) of NW Ward Road and NW Donovan Road in Lee's Summit, Missouri. Nineteen exploratory borings were performed at the site to depths ranging from approximately 10 to 15 feet below existing site grades. 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
- seismic site class
- pavements

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. 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 of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Project Location	The project is located at NW Ward Road and NW Donovan Road in Lee's Summit, Missouri. Latitude/Longitude: 38.92932˚ N/ 94.39168˚ W (approximate) See **Site Location**
Existing Improvements	The site is vacant and appears to have been rough graded. The property is surrounded by existing commercial and residential development.

Item	Description
Current Ground Cover	Grass covered and bare soil. There are some isolated stockpiles of excavated limestone, gravel and asphaltic concrete within the southwestern of the site.
Existing Topography	Based on the ALTA Survey prepared by Shafer, Klein & Warren (SKW) dated May 12, 2017, the elevations in Lot 2 range from 1010 feet in the southwest to 995 feet in the northeast. In Lot 1, to the north, elevations range from 1,005 feet at the north to 982 feet to the south. Along the southern boundary of Lot 1, there is an approximately 13-foot-high at about 5:1 (horizontal:vertical) slope.
Geology	Our experience near the vicinity of the proposed development and review of the above referenced report and available geologic maps indicates subsurface conditions consist of fill and residual clay soils over limestone and shale bedrock.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Project Description	The site consists of two lots (referred to as the Summit Orchard Lots 1 and 2): ■ Lot 1 [981 NW Ward Road] Parcel ID: 52-900-03-56-00-0-00-000 (4.6 acres) ■ Lot 2 [837 NW Donovan Road] Parcel ID: 52-900-03-57-00-0-00-000 (8.3 acres) The project is bounded by a NW Ward Road to the west, NW Tudor Road to the north, an electrical substation and the first phase to the east and NW Donovan Road to the south.
Proposed Structure	Based on the Preliminary Site Plan prepared by NSPJ Architecture, dated March 28, 2018, the project includes the following: **Lot 1- Northern portion of the site** ■ Building 4- 4/5-story split ■ Building 5- 4 story on grade **Lot 2- Southern portion of the site** ■ Building 1- 4 story on grade ■ Building 2- 4/5-story split ■ Building 3- 4/5-story split The site also has an associated pool/amenity area, center green space, dog park, driveways, parking lots, carports and garages.
Building Construction	The buildings will be constructed with wood framed walls, and the parking garage will be reinforced concrete and/or masonry block construction.

Item	Description
Finished Floor Elevation (FFE)	The finished floor elevations are expected to be as follows: ■ Building 1- 1,008.0 feet ■ Buildings 2 and 3- 995.5/1009.25 feet ■ Building 4- 995.25/1006.0 feet ■ Building 5- 988.9 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: 150 kips ■ Walls: 2 kips per linear foot ■ Slabs: 150 pounds per square foot
Grading/Slopes	Up to 5½ feet of cut and 8½ feet of fill will be required to develop final grade. Final slope angles of 3(H): 1(V) or flatter are expected.
Below Grade Structures	Buildings 2, 3 and 4 will have walk-out lower levels and elevator pits. A pool is planned east of Building 1.
Free-Standing Retaining Walls	No retaining walls were planned at the time this report was prepared.
Pavements	No information regarding anticipated vehicle types, axle loads, or traffic volumes was provided. We anticipate that both concrete and asphalt pavements will be considered. We anticipate the pavements will be utilized primarily by passenger vehicles (cars, pickup trucks, SUV's) with occasional panel delivery trucks and trash collection trucks.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting and planned construction. The following table provides our geotechnical characterization.

The geotechnical characterization forms the basis of our geotechnical calculations and evaluation of site preparation, foundation options and pavement options. As noted in **General Comments**, the characterization is based upon widely spaced borings across the site, and variations are likely.

Lot 1 (Northern portion of the site)

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency
1	1 to 3 feet	Fill: Fat Clay - with limestone fragments	N/A
2	5 to 6 feet [1]	Fat clay (CH)	Stiff to very stiff

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency
3	5½ to 11½ feet [2]	Shale	Highly weathered
4	Undetermined: Borings terminated within this stratum at auger refusal at approximately 5½ to 12 feet	Limestone	Highly weathered

1. Not encountered at Boring B-4, B-14 and B-15
2. Not encountered at Boring B-1

Lot 2 (Southern portion of the site)

Stratum	Approximate Depth to Bottom of Stratum	Material Description	Consistency
1	1 to 7 feet	Fill: Fat Clay - with limestone fragments	N/A
2	3½ to 8½ feet [1]	Lean clay (CL) and Fat clay (CH)	Very stiff to hard
3	Undetermined: Borings terminated within this stratum at a planned depth of approximately 10 to 15 feet in shale or auger refusal at approximately 8½ to 9 feet	Shale and/or limestone	N/A

1. Only encountered in Boring B-6, B-8, B-10, B-16, B-18 and B-19

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The boreholes were observed during drilling for the presence and level of groundwater. Perched groundwater was observed in borehole B-3 at a depth of 3 feet (11 feet at the completion of drilling) during our subsurface exploration. Water was not observed the other borings. Long-term observations in piezometers or observation wells, sealed from the influence of surface water, would be needed to develop more detailed groundwater information. Groundwater level fluctuations occur due to variations in rainfall, runoff, and other factors not evident at the time we performed the borings. The potential for groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

Existing fill materials were encountered at most of the boring locations. The fill was composed primarily of clay soils with limestone fragments and extended to depths of 1 to 7 feet below the ground surface. Limestone fragments ranging from gravel to cobble size were encountered within the fill at varying depths below the ground surface. Based on field and laboratory test data, included SPT blow counts and density measurements, it appears that compactive effort was applied to the fill; however, no documentation regarding placement and compaction of the fill was provided for our review. Since samples of the fill recovered from our borings consisted of inorganic clays and rock fragments, and the fill appears to have been compacted when it was placed, it appears feasible to support the proposed buildings on conventional shallow footing foundations that bear on observed and tested existing fill, new engineered fill, and/or native clay soils. Support of footings on or above existing fill involves a risk of unpredictable performance, but this risk can be mitigated by thorough observation and testing during construction. If the owner is not willing to accept the risk, significantly more expensive methods could be used to reduce or eliminate this risk (e.g., complete removal and replacement of the fill, installation of a ground improvement system, or support of the buildings on deep foundations).

Provided the owner accepts the risks associated with support of building floor slabs and pavements over the existing fill in exchange for reduced construction costs, stable portions of the existing fill could also be left in place for support of building floor slabs and pavements. Where existing fill will be left in place in these areas, a representative from Terracon should evaluate the condition of the fill by observing a proof-roll and/or test pit excavations.

It should be noted that undocumented fill may contain loose or soft soils or other unsuitable materials; these conditions may not be disclosed by the widely-spaced, small-diameter borings. If these conditions are present and are not discovered and corrected during construction, larger than normal settlement could occur, possibly resulting in cracking or other damage to building elements supported on or above the existing fill. These risks can be reduced by thorough observation and testing during construction. Foundation excavations should be observed and probed, and the slab and pavement subgrade soils should be proofrolled. Where unsuitable conditions are observed, corrective procedures should be implemented (e.g., extending footing excavations deeper to suitable materials, improvement of slab subgrade soils by scarification/compaction, or removal of unsuitable materials and replacement with engineered fill).

We understand that post-tensioned slabs may be utilized for the apartment buildings at this site. Recommendations regarding post-tensioned slabs are provided in **Floor Slabs**. Recommendations for conventional grade-supported concrete floor slabs has also been provided as an alternative.

The fat clay soils and shale encountered at this site have the potential to shrink and swell with seasonal fluctuations in the soil moisture content. We recommend that conventional grade-

supported concrete floor slabs be supported on at least 24 inches of low volume change (LVC) material, such as low plasticity clay. In areas that are currently above or less than 2 feet below the planned bottom of floor slab level, native fat clay soils and shale should be undercut to accommodate placement of LVC material. In areas where the exposed grade (following stripping of organic soils) will be 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 this report in **Floor Slabs**. LVC materials would not be required for post-tensioned floor slabs.

The clay soils encountered at the site will shrink and swell as their moisture contents fluctuate. 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 structures could still occur. The severity of cracking and other cosmetic damage caused by movement of floor slabs, pavements, and sidewalks 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, slabs, and pavements 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

All stockpile soils should be removed from the site prior to commencement of construction operations at this site. Where vegetation/topsoil is currently present within proposed construction areas, the vegetation and organic soils should be stripped. It is possible that the vegetation/topsoil

may not have been stripped prior to placement of the existing stockpiles; any remaining vegetation/topsoil should be removed after removal of the existing stockpiles. Removal depths will likely vary across the site and should be adjusted based on conditions encountered during site preparation. Organic soils removed during site preparation should not be used as fill beneath the proposed new building areas.

The soils within the proposed building area should be further undercut as necessary to accommodate placement of the recommended 24-inch thick LVC layer below the floor slab. Undercutting for the LVC layer should extend at least 5 feet outside the building wall lines. Where post-tensioned slabs will be utilized, this undercut and placement of LVC would not be required.

Following initial stripping and any necessary undercutting, the exposed soils should be proofrolled. A Terracon representative should observe the proofrolling. Particular attention should be paid to areas where existing fill is exposed following stripping and initial undercutting. 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

All materials incorporated in engineered fill sections must be free of organic matter and debris. Fill materials should not be frozen and should not be placed on a frozen subgrade. A sample of each material type should be tested prior to being used on the site. Soil is commonly used as fill in this locale, but not all soils are suitable. Our professional opinions concerning suitability of fill materials are presented in the following table.

Suitability as Fill	Description	Unified Soil Classification	
		Group Symbol	**Group Name**
Suitable	Clean Gravel	GW	Well-graded gravel
		GP	Poorly graded gravel
	Gravel with fines	GM	Silty gravel
		GC	Clayey gravel
	Clean sand	SW	Well-graded sand
		SP	Poorly-graded sand
	Sand with fines	SM	Silty sand
		SC	Clayey sand
	Description	**Group Symbol**	**Group Name**
Marginally Suitable[1]	Silt	ML	Silt[2]
	Clay	CL	Lean clay[3]
	Clay	CH	Fat clay[4]
	Description	**Group Symbol**	**Group Name**
Unsuitable	Highly organic soils	MH	Elastic silt
		OL & OH	Organic clay & organic silt
		PT	Peat

1. Depends on location and intended use. Can be used if approved by geotechnical engineer.
2. Highly susceptible to frost action; unstable when wet. Should not be used directly below pavements and exterior slabs without prior approval of geotechnical engineer.
3. Can be expansive if dry or if liquid limit is 45 or greater. Requires approval of geotechnical engineer.
4. Expansive. Not recommended immediately below floors and other movement-sensitive features. Must be placed with strict moisture and density control to reduce swell potential.

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 in the borings. 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.

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 structures and pavements have been completed, we recommend verifying final grades to document that effective drainage has been achieved. Grades around the structures 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 controlled compacted fills, 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.

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.

Bedrock strata were encountered at relatively shallow depths at some of the boring locations. Rock excavation methods may be required for deeper excavations, such as utility trenches, depending upon the depth of excavation and the type of rock encountered. In our experience, completely to highly weathered bedrock strata that can be easily penetrated with a flight auger can typically be excavated using track-hoes with rock teeth or ripper equipped dozers. Excavation of harder bedrock will likely require the use of jackhammers or pneumatic breakers. Excavation

of rock in confined areas (such as trenches) is usually difficult, even above the level of auger refusal.

SHALLOW FOUNDATIONS

Foundation Design Parameters

The depth to bedrock varied across the site. Each building should be evaluated individually and the bearing material should be determined prior to construction. The footings for each individual building should either bear entirely on native soil and engineered fill or entirely on bedrock. Bearing on multiple material types may result in abrupt differential settlement resulting in cracking and differential movement of buildings.

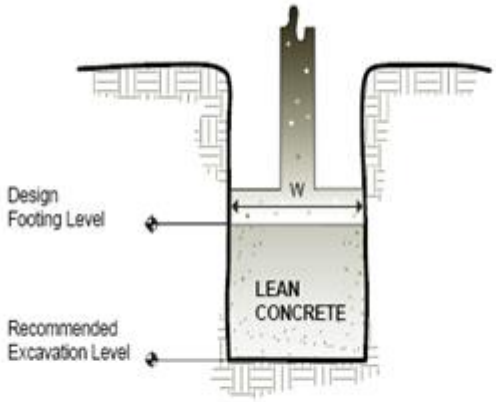
Description	Value
Maximum net allowable bearing pressure [1]	**Bearing on Native Clay, Engineered Fill, Tested and Approved Existing Fill or Completely Weathered Shale:** 3,000 psf **Bearing on Highly to Moderately Weathered Shale or Limestone:** 5,000 psf
Minimum embedment below finished grade for frost protection [2]	3 feet [3]
Minimum footing widths	Isolated footings: 30 inches Continuous footings: 16 inches
Estimated total settlement [4]	1 inch or less
Estimated differential settlement [4]	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. Footings can be supported at a shallower depth on competent limestone that is free of fractures. Terracon should review the rock conditions where any footings are planned to extend to depths less than those recommended in this report.
4. 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 materials 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.



Lean Concrete Backfill

NOTE: Excavations in sketches shown vertical for convenience. Excavations should be sloped as necessary for safety.

SEISMIC CONSIDERATIONS

Code	Site Classification
2012 International Building Code (IBC)	C [1]

1. The 2012 International Building Code (IBC) site profile determination is based on average properties of the subsurface profile to a depth of 100 feet. The exploratory borings extended to a maximum depth of approximately 14 feet, with all borings terminating in shale or limestone bedrock. Our opinion of site classification is based on boring conditions and our knowledge of local geological and geotechnical conditions.

FLOOR SLABS

Post-tensioned Floor Slab Design

We understand that post-tensioned slab-on-grade floors may be utilized for the buildings. Based on our analysis of the field and laboratory data, design parameters were developed using the 2004 Third Edition Design of Post-Tensioned Slabs-On-Ground Manual prepared by the Post-Tensioning Institute (PTI).

The moisture beneath the shallow foundation will change in response to wetting and drying conditions around the foundation perimeter. The maximum moisture variation distance is termed the edge moisture variation distance, e_m, and is an important factor governing the design of post-tensioned floor slabs. The e_m is related to the percent fine clay and climatic conditions as well as other parameters, such as soil fabric factor and unsaturated diffusion coefficient.

The plasticity index of the soil, type and amount of clay mineral in the soil, and the moisture conditions from the time of construction through the life of the structure are parameters that should be considered in design of a slab-on-grade. The plasticity index and the clay mineral are values of the soil that can be estimated by laboratory tests and, although variable from location to location, remain relatively constant with time.

The moisture condition has a significant effect on slab behavior and is highly variable with time, changing seasonally, with annual climate conditions, drainage patterns, ground cover, and vegetation.

Based on our laboratory test data and our experience with similar soils, the post-tensioned slabs at this site should be designed using criteria outlined by the Post-Tensioning Institute using the following parameters:

Parameter	Value
Depth of seasonal moisture change	Approximately 5 feet
Liquid Limit	60
Plasticity Index	35
Percentage of material passing #200 sieve	95
Percent finer than 2 microns	30
Soil fabric factor, F_f	1.0
Approximate Thornthwaite Moisture Index, I_m [1]	+20
Estimated constant soil suction, pF	3.4
Range of soil suction, pF	2.5 to 4.5
Estimated edge moisture variation distance, e_m	**For center lift:** 3.8 feet **For edge lift:** 7.0 feet
Estimated differential soil movement, y_m	**For center lift:** 0.59 inches **For edge lift:** 1.1 inches

1. The estimated movements do not consider the effects of non-climatic factors which might arise from conditions beyond the control of Terracon. The conditions include, but are not limited to, location of planters and trees around the building, poor drainage, and operations of the owner/contractor on the site subsequent to our explorations.

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 or concrete and corrective action may be required.

We recommend the subgrade be evaluated immediately prior to placing the granular leveling course. Where unsuitable conditions are located within the floor slab subgrade soils, the soils should be repaired by removing and replacing the affected material with properly compacted fill. All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the granular material and concrete.

Conventional Floor Slab Design

If conventional grade-supported concrete floor slabs are to be used, the following design recommendations should be applied.

Item	Description
Floor Slab Support	24 inches of low volume change (LVC) material over native soils, engineered fill soils or shale bedrock
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., MDOT 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 in the floor slab that develop 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.

Conventional Floor Slab Construction Considerations

If LVC materials consist of clay, the subgrade should be maintained in a relatively moist condition 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 recommended subgrade moisture content and density 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.

BELOW-GRADE STRUCTURES

Swimming Pool

We understand the swimming pool bottom slab, walls, and deck will be constructed using conventional concrete forming and placement techniques. Based on the site grading plan, soils surrounding the swimming pool are expected to consist of engineered fill material.

The swimming pool walls should be designed to resist the at-rest lateral earth pressures provided in the **Lateral Earth Pressures** section. These parameters are based on drainage being provided behind the pool walls to prevent hydrostatic loading on the walls.

A free-draining granular material (e.g., open-graded crushed stone such as ASTM C 33, Size No. 57 aggregate) should be used to backfill a minimum 2-foot zone extending laterally beyond the pool walls. The granular section behind the pool walls should be hydraulically connected to the drainage layer below the pool bottom slab. A geotextile filter fabric (e.g., Mirafi 160N, Contech C60NW, or an approved equivalent) should be placed between the granular material and the adjacent engineered fill soils to help prevent infiltration of fines into the granular material. If the pool walls will be constructed using any method other than conventional formed, cast-in-place concrete, Terracon should be contacted so we can provide supplemental recommendations. In particular, pool walls constructed by spraying of gunite directly on excavation sidewalls would require special geotechnical considerations that are not addressed in this report.

At least 24 inches of LVC material (refer to the **Fill Materials** section) should be placed at the base of the pool excavation (below the pool bottom slab). The upper 12 inches of the LVC layer below the pool bottom slab should consist of free-draining granular material (e.g., open-graded crushed stone such as ASTM C 33, Size No. 57 aggregate). A system of collector drains should

be constructed at the base of the free-draining granular layer. The drains should outlet to a sump or other suitable outlet where water can be collected and removed.

The deck area surrounding the pools should be sloped to allow surface drainage. The pool deck slabs should be constructed on a minimum 24-inch thick layer of LVC material (as discussed in the **Fill Materials** section), and the upper 6 inches of the LVC layer should consist free draining aggregate. Subdrains should be installed at regular intervals below the pool deck slabs to collect and remove water from the free draining aggregate layer. Subdrains could consist of 4-inch diameter, perforated plastic pipes encapsulated in filter fabric and placed in shallow trenches at the base of the granular layer. The subdrains should slope to a suitable discharge point. All joints within the pool deck area should be properly sealed and maintained to prevent downward migration of water to the underlying subgrade soils.

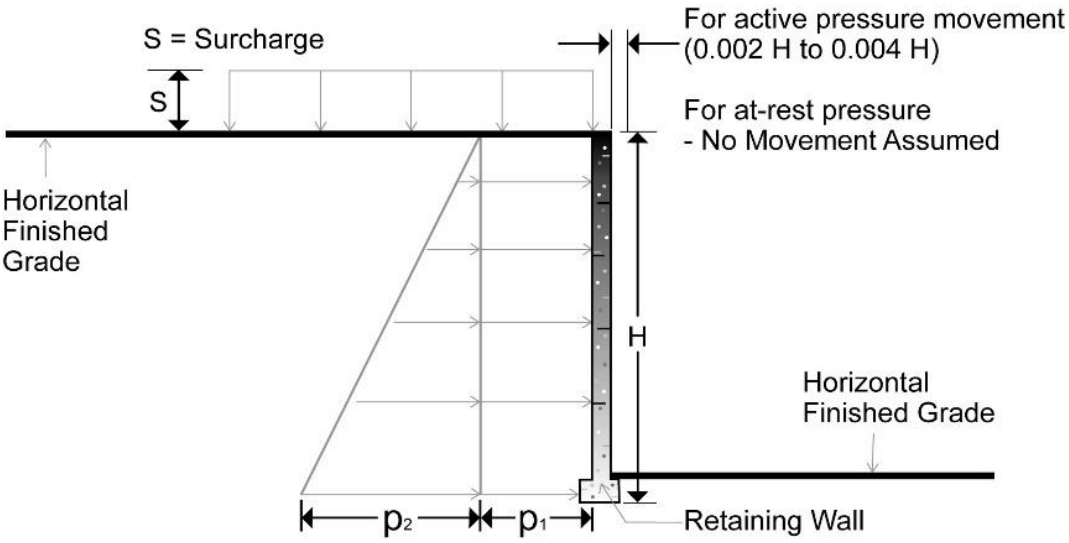
If groundwater levels rise above the bottom of the pool when the pool is empty, uplift loads could be imposed on the pool bottom slab and hydrostatic pressure could be imposed on the pool walls, which could cause heaving, cracking or other damage to the pool bottom slab and walls. We anticipate that the pool design will include pressure relief valves that will allow backflow of groundwater into the empty pool in order to help reduce the potential for hydrostatic loading and subsequent heaving, cracking, or other damage.

Although specific details regarding the pool utilities were not provided to us, in our experience, swimming pools usually include several utility pits/basins (e.g., a pump pit, surge basin, backwash basin and recirculation pump pit). The lateral earth pressure, drainage, and fill placement recommendations provided above for the pool are also applicable to these structures. Permanent drainage systems should be installed at the base of all below grade pits/basins to remove groundwater and help reduce the potential for hydrostatic loading on below grade walls and slabs.

LATERAL EARTH PRESSURES

Design Parameters

Below grade walls with unbalanced backfill levels on opposite sides should be designed for at-rest earth pressures at least equal to those indicated in the following table. 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	--- ---	--- ---

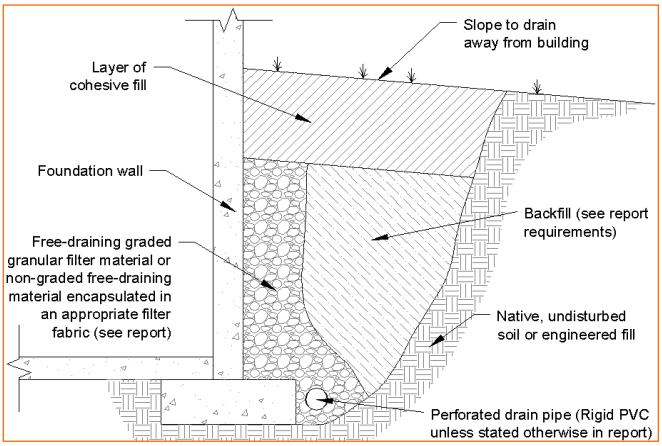
Applicable conditions to the above include:

- 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.

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.

PAVEMENTS

Pavement Subgrade Preparation

Pavement subgrades are expected to consist of on-site native clay soils. The pavement subgrades should be proofrolled as recommended in **Earthwork**. If soft or otherwise unsuitable areas are observed, additional over-excavation and replacement will be needed.

If limestone bedrock is encountered at pavement subgrade elevation, the bedrock should be over-excavated at least 6 inches to accommodate placement of a compacted crushed aggregate layer. If seepage from the limestone is suspected, the aggregate layer should consist of free-draining aggregate (ASTM C 33 No. 57), which should be day-lighted at down-gradient locations so water will not accumulate below pavements. If interception and transmission of seepage is not a concern, the aggregate layer can consist of densely graded aggregate such as MDOT Type 5.

Grading and paving are commonly performed by separate contractors and there is often a time lapse between the end of grading operations and the commencement of paving. Subgrades prepared early in the construction process may become disturbed by construction traffic. Non-uniform subgrades often result in poor pavement performance and local failures relatively soon after pavements are constructed. Depending on the paving equipment used by the contractor, measures may be required to improve subgrade strength to greater depths for support of heavily loaded concrete/asphalt trucks.

We recommend the moisture content and density of the subgrade be evaluated and the pavement subgrades be proofrolled (using a loaded tandem-axle dump truck with a minimum gross weight of 20 tons or similarly loaded rubber-tire equipment) within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be scarified, moisture conditioned, and compacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. The subgrade should be in its finished form at the time of the final review.

Opinions of Minimum Pavement Thickness

Pavement thickness depends upon many factors including but not limited to:

- applied wheel/axle loads and number of repetitions
- subgrade and pavement material characteristics
- climate conditions
- site and pavement drainage

Specific information regarding anticipated vehicle types, axle loads and traffic volumes was not provided at the time of this report. The "Parking Lots" pavement section considers 4-tire, 2-axle personal vehicle traffic only (cars, vans, pickups and SUVs). The "Drives" pavement section considers personal vehicle traffic and a maximum of ten delivery trucks/trash collection trucks per week. Our recommendations for full depth asphaltic cement concrete (ACC) pavement, ACC pavement over aggregate base, and Portland cement concrete (PCC) pavement sections are outlined in the following table.

Pavement Type	Parking Lots	Drives
Full depth ACC	2 inches ACC surface 4 inches ACC base	2 inches ACC surface 6 inches ACC base
ACC over aggregate base	2 inches ACC surface 2 inches ACC base 6 inches aggregate base (MoDOT Type 5 or similar)	2 inches ACC surface 4 inches ACC base 6 inches aggregate base (MoDOT Type 5 or similar)
PCC	5 inches PCC 4 inches open graded rock (ASTM C33 Size No. 57 aggregate or similar)	6 inches PCC 4 inches open graded rock (ASTM C33 Size No. 57 aggregate or similar)

1. For trash container pads, we recommend a PCC pavement section be used consisting of 7 inches (minimum) of PCC over 4 inches (minimum) of open graded rock (ASTM C33 Size No. 57 aggregate or similar) on a compacted soil subgrade. The trash container pad should be large enough to support the container and the tipping axle of the collection truck.

PCC pavements will perform better than ACC in areas where short-radii turning and braking are expected (i.e., entrance/exit aprons) due to better resistance to rutting and shoving. In addition, PCC pavement will perform better in areas subject to heavy static loads.

Construction traffic on the pavements was not considered in developing our opinions of minimum pavement thickness. If the pavements will be subject to construction equipment/vehicles, the pavement sections should be revised to consider the additional loading.

Pavements and subgrades will be subject to freeze-thaw cycles and seasonal fluctuations in moisture content. Pavement thickness design methods are intended to provide adequate thickness of structural materials over a particular subgrade such that wheel loads are reduced to a level that the subgrade can support. The subgrade support parameters for pavement thickness design do not account for shrink/swell movements of a subgrade constructed of expansive clay soils. Therefore, the pavement may be adequate from a structural standpoint, yet still experience cracking and deformation due to shrink/swell related movement of the subgrade.

The pavement sections provided above consider that the subgrade soils will not experience significant increases in moisture content. Paved areas should be sloped to provide rapid drainage of surface water and to drain water away from the pavement edges. Pavements should be designed so water does not accumulate on or adjacent to the pavement, since this could saturate and soften the subgrade soils and subsequently accelerate pavement deterioration.

Periodic maintenance of the pavements will be required. Cracks should be sealed, and areas exhibiting distress should be repaired promptly to help prevent further deterioration. Even with

periodic maintenance, some movement and related cracking may still occur and repairs may be required.

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, and cost estimating including, 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.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

The borings were located in the field by Terracon personnel using a hand-held GPS unit with a horizontal accuracy of ±20 feet. Ground surface elevations indicated on the boring logs were interpolated from the SKW topographic map.

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. Boring B-11 was extended through the limestone bedrock using N-series rock coring procedures. The underlying shale was sampled using the split-barrel sampling spoon.

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

In the laboratory, water content, dry unit weight, and Atterberg limits were performed on selected samples. 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

SITE LOCATION

Summit Square II Apartments ■ Lee's Summit, MO
May 9, 2018 ■ Terracon Project No. 02185057

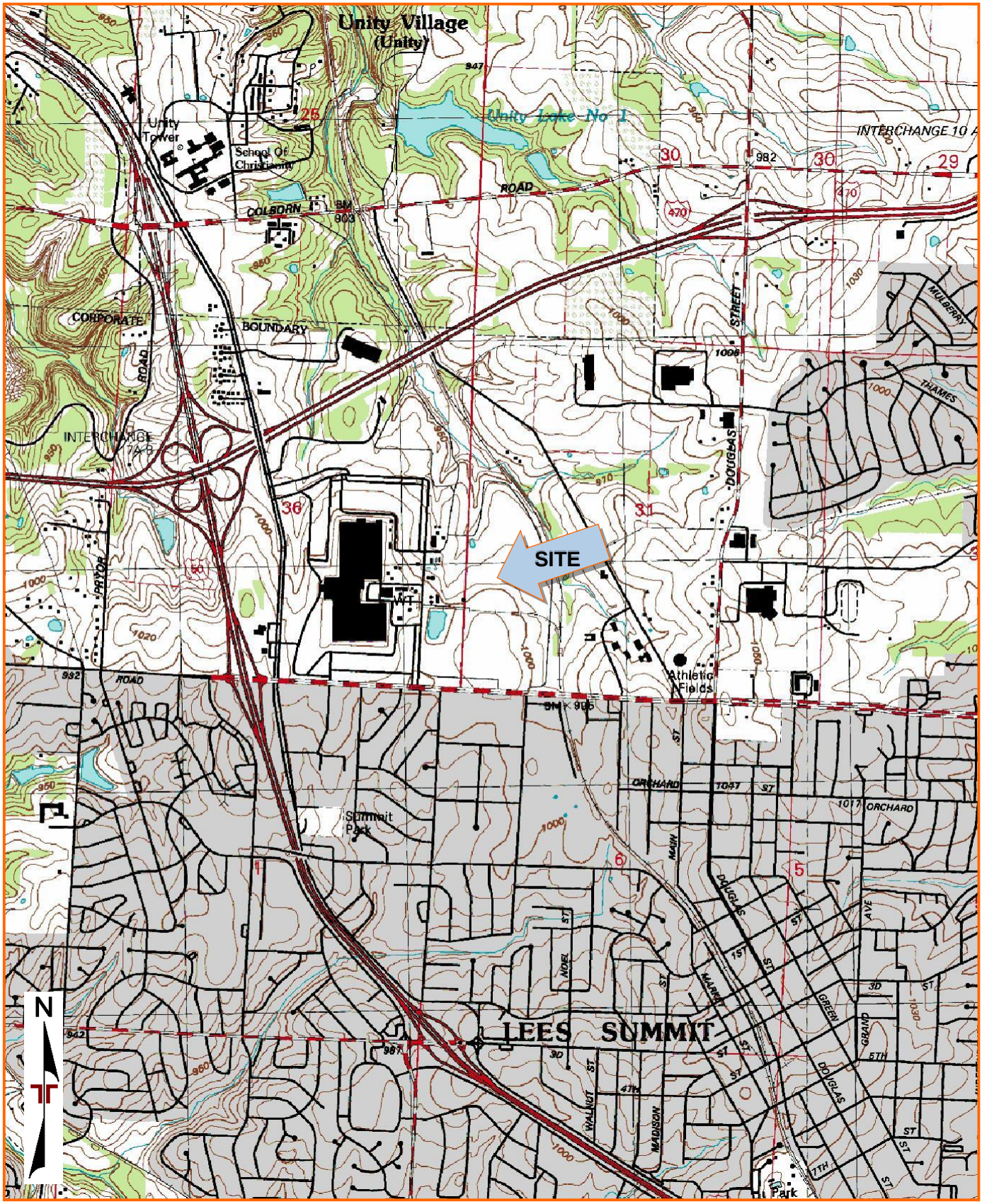


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

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

EXPLORATION PLAN

Summit Square II Apartments ■ Lee's Summit, MO
May 9, 2018 ■ Terracon Project No. 02185057

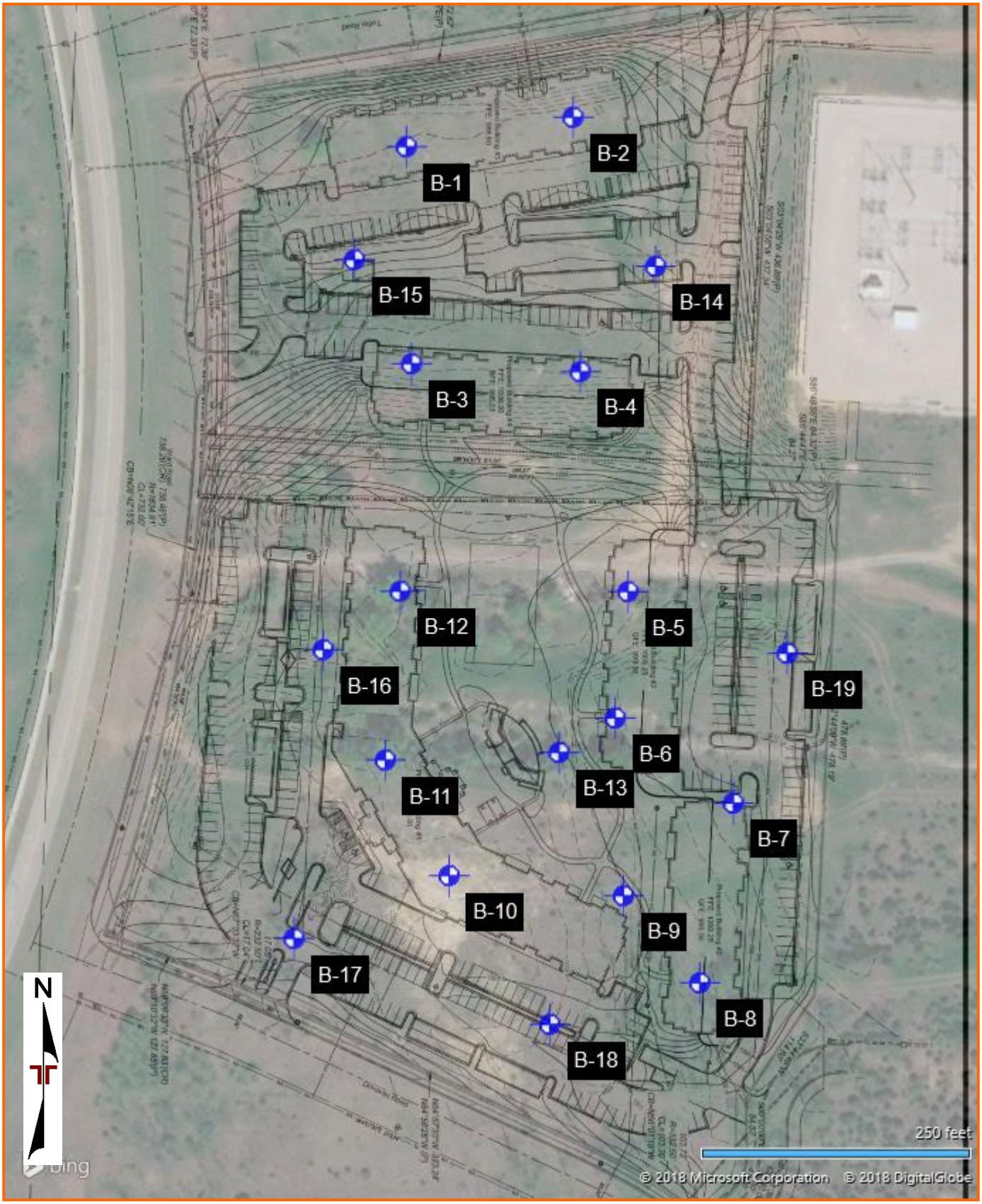


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. B-1

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.930207° Longitude: -94.391645°

Approximate Surface Elev: 985 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	FILL - FAT CLAY, trace limestone fragments, brown									
					13					
3.0	982+/-									
	FAT CLAY (CH), brown to light brown, very stiff				19		2.75	27	96	75-24-51
		5								
6.0	979+/-									
6.5	**LIMESTONE**, gray, highly weathered 978.5+/-				0	50/0"				
	Auger Refusal at 6.5 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-23-2018 | Boring Completed: 03-23-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-2

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.930282° Longitude: -94.391099°

Approximate Surface Elev: 985 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
FILL - FAT CLAY, with limestone fragments, brown								
1.5	983.5+/-							
FAT CLAY (CH), brown, very stiff				10				
				16	3.0	24	107	
5.0	980+/-	5						
5.5 **SHALE**, light brown, highly weathered	979.5+/-							
5.7 **LIMESTONE**, gray, highly weathered	979.5+/-							
Auger Refusal at 5.7 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-23-2018 | Boring Completed: 03-23-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-3

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.929654° Longitude: -94.391628°

Approximate Surface Elev: 992 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION
0.0	992+/-	**FILL - FAT CLAY**, with limestone fragments, brown
1.0	991+/-	**FAT CLAY (CH)**, brown and gray brown, very stiff
6.0	986+/-	**SHALE**, gray brown, completely to highly weathered
11.5	980.5+/-	
12.0	980+/-	**LIMESTONE**, gray, highly weathered
		Auger Refusal at 12 Feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
5		24		2.5	26	100	
		18					
		17		4.5+	18	114	
10		14	13-28-50/2"		16		

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-23-2018 | Boring Completed: 03-23-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-4

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.929634° Longitude: -94.391075°

Approximate Surface Elev: 992 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	FILL - FAT CLAY, with limestone fragments, brown								
1.0	991+/-								
	SHALE, light brown to gray, completely weathered			18		3.5	25	103	
	- highly weathered below 3.5 feet			11	21-50/6"		16		
		5		8	32-50/4"		19		
8.5	983.5+/-								
8.8	**LIMESTONE**, gray, highly weathered 983+/-			0	50/1"				
	Auger Refusal at 8.8 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-25-2018 | Boring Completed: 03-25-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-5

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.929073° Longitude: -94.390919°

Approximate Surface Elev: 1006.5 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
FILL - FAT CLAY, with limestone fragments, brown and gray								24		
				X	0	19-20-10 N=30				
3.5	1003+/-									
SHALE, light brown, completely weathered										
		5		X		9-21-35 N=56		20		
- highly weathered below 6 feet				X	12	29-50/6"		17		
- moderately weathered, gray below 8 feet										
				X	5	50/5"		15		
		10								
				X	2	50/6"		10		
14.0	992.5+/-									
Boring Terminated at 14 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 03-24-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-6

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928751° Longitude: -94.390961°

Approximate Surface Elev: 1001 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
		FILL - FAT CLAY, with limestone fragments, brown						
			8		2.0	15	111	
			12		2.0	15	121	
6.0	995+/-							
		LEAN CLAY (CL), gray, very stiff	7	15-9-8 N=17		19		36-17-19
8.5	992.5+/-							
		SHALE, gray, moderately weathered	4	50/6"		10		
13.8	987+/-		2	50/3"		9		
		Boring Terminated at 13.8 Feet						

DEPTH (Ft.): 5, 10

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 03-24-2018
Drill Rig: B53 | Driller: RM
Project No.: 02185057

BORING LOG NO. B-7

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928534° Longitude: -94.390574°

Approximate Surface Elev: 999 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
		FILL - FAT CLAY, trace limestone fragments, brown
2.0	997+/-	**SHALE**, gray, highly weathered
		- moderately weathered below 3.5 feet
13.8	985+/-	***Boring Terminated at 13.8 Feet***

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)
		16		18	107
		5	50/6"	11	
5		3	50/3"	10	
		4	50/5"	9	
10		2	50/3"	9	

GRAPHIC LOG | WATER LEVEL OBSERVATIONS | HAND PENETROMETER (tsf) | ATTERBERG LIMITS (LL-PL-PI)

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 03-24-2018
Drill Rig: B53 | Driller: RM
Project No.: 02185057

BORING LOG NO. B-8

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928076° Longitude: -94.390684°

Approximate Surface Elev: 1002 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
0	1002	**FILL - FAT CLAY**, with limestone fragments, brown
1.5	1000.5+/-	**FAT CLAY (CH)**, brown to light brown
3.5	998.5+/-	**LIMESTONE**, gray, highly weathered
5.5	996.5+/-	**SHALE**, with limestone seams, gray, highly weathered
13.6	988.5+/-	***Boring Terminated at 13.6 Feet***

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
		12	3-3-4 N=7
		1	50/1"
5		13	20-50/3"
		4	30-20-50 N=70
10		1	50/1"

WATER LEVEL OBSERVATIONS

HAND PENETROMETER (tsf)

WATER CONTENT (%)

DRY UNIT WEIGHT (pcf)

ATTERBERG LIMITS

LL-PL-PI

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 04-11-2018 | Boring Completed: 04-11-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-9

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928298° Longitude: -94.390934°

Approximate Surface Elev: 1004 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DESCRIPTION	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)
		FILL - FAT CLAY, with limestone fragments, brown	11	4-4-7 N=11	
			0	50/1"	
7.0	997+/-	**SHALE**, light brown to gray, highly to moderately weathered	10	10-19-26 N=45	12
			2	50/2"	14
13.7	990.5+/-	***Boring Terminated at 13.7 Feet***	2	50/2"	11

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

3 feet while drilling

11 feet upon completion

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 03-24-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-10

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928349° Longitude: -94.391505°

Approximate Surface Elev: 1008.5 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
1.0	1007.5+/-	**FILL - FAT CLAY**, trace limestone fragments, brown
4.5	1004+/-	**FAT CLAY**, light brown, hard
5.5	1003+/-	**LIMESTONE**, gray, highly weathered
8.5	1000+/-	**SHALE**, gray, highly weathered
8.8	999.5+/-	**LIMESTONE**, gray, highly weathered
		Auger Refusal at 8.8 Feet

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
5							
		11		4.5+	28	95	
		5	5-50/4"		16		
		3	50/3"				

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 04-11-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-11

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928644° Longitude: -94.391714°

Approximate Surface Elev: 1007 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
FILL - FAT CLAY, with limestone fragments, brown								
			18	7-13-14 N=27	3.0	22		
3.5	1003.5+/-							
LIMESTONE, gray, highly to moderately weathered			0	50/1"				
		5		REC = 90% RQD = 90%				
9.5	997.5+/-							
SHALE, brown to light brown, completely weathered		10	18	7-10-11 N=21				
11.0	996+/-							
Boring Terminated at 11 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 04-11-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-12

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.929074° Longitude: -94.391665°

Approximate Surface Elev: 1005 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1.0	1004+/-							
FILL - FAT CLAY, with limestone fragments, brown and gray brown								
SHALE, light brown, completely weathered			18		4.5+	23	109	
- highly weathered below 3 feet			14	19-25-35 N=60		18		
		5						
			11	36-50/6"		16		
			9	34-50/4"		16		
- moderately weathered, gray below 10 feet		10						
13.8	991+/-		3	50/4"		11		
Boring Terminated at 13.8 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 03-24-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-13

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928663° Longitude: -94.391145°

Approximate Surface Elev: 1006 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)
		FILL - FAT CLAY, with limestone fragments, brown to dark brown	12	4-4-4 N=8	21
4.5	1001.5+/-	**SHALE**, light brown, completely to highly weathered	15	7-10-32 N=42	21
			5	10-32-50/5"	15
		- moderately weathered, gray below 8 feet	3	50/4"	12
13.8	992+/-		3	50/3"	9
		Boring Terminated at 13.8 Feet			

DEPTH (Ft.): 5, 10

WATER LEVEL OBSERVATIONS

SAMPLE TYPE

HAND PENETROMETER (tsf)

DRY UNIT WEIGHT (pcf)

ATTERBERG LIMITS: LL-PL-PI

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-24-2018 | Boring Completed: 03-24-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-14

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.929902° Longitude: -94.390829°

Approximate Surface Elev: 988 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	FILL - FAT CLAY, with limestone fragments, brown									
1.0	987+/-									
	SHALE, light brown, completely to highly weathered				16					
					11	30-25-18 N=43	2.75	19		
		5								
7.0	981+/-									
7.2	**LIMESTONE**, gray, highly weathered 981+/-									
	Auger Refusal at 7.2 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-25-2018 | Boring Completed: 03-25-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-15

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.929919° Longitude: -94.391815°

Approximate Surface Elev: 988.5 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
1.0	987.5+/-	**FILL - FAT CLAY**, with limestone fragments, brown
		SHALE, light brown and gray, completely to highly weathered
8.5	980+/-	
8.8	979.5+/-	**LIMESTONE**, gray, highly weathered
		Auger Refusal at 8.8 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
			13					
			15	10-12-13 N=25		22		
5								
			0	50/1"				

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-25-2018 | Boring Completed: 03-25-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-16

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928925° Longitude: -94.391917°

Approximate Surface Elev: 1002 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
					16		2.0	22	111	
4.0	998+/-				14		4.5+	20	107	56-22-34
8.9	993+/-	5			3	50/5"		12		

FILL - FAT CLAY, with limestone fragments, brown

SHALE, light brown to gray, highly to moderately weathered

Boring Terminated at 8.9 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-25-2018 | Boring Completed: 03-25-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-17

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928189° Longitude: -94.392013°

Approximate Surface Elev: 1009.5 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	HAND PENETROMETER (tsf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
	FILL - FAT CLAY, with limestone fragments, brown									
				X	6	10-50/1"		23		
3.0	1006.5+/-									
	LIMESTONE, with shale seams, gray, highly weathered	5								
7.5	1002+/-									
	SHALE, gray, highly weathered									
8.8	1001+/-			X	3	50/3"				
	Boring Terminated at 8.75 Feet									

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-25-2018 | Boring Completed: 04-11-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-18

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.92797° Longitude: -94.391175°

Approximate Surface Elev: 1008 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	WATER CONTENT (%)
	FILL - FAT CLAY, with limestone fragments, brown					
1.0	1007+/-					
	FAT CLAY (CH), light brown to gray, hard			12	21-15-16 N=31	16
				13	11-13-50/2"	16
4.2	1004+/-					
	LIMESTONE, with shale seams, gray, highly weathered	5				
8.5	999.5+/-					
8.7	**SHALE**, gray, highly weathered 999.5+/-			2	50/2"	
	Boring Terminated at 8.7 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 03-25-2018 | Boring Completed: 04-11-2018

Drill Rig: B53 | Driller: RM

Project No.: 02185057

BORING LOG NO. B-19

PROJECT: Summit Square II Apartments

CLIENT: NorthPoint Development
Riverside, Missouri

SITE: Donovan & Ward Road
Lee's Summit, Missouri

LOCATION See Exploration Plan

Latitude: 38.928916° Longitude: -94.390398°

Approximate Surface Elev: 1003 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS
		FILL - FAT CLAY, with limestone fragments, brown				
1.5	1001.5+/-					
		FAT CLAY (CH), brown to light brown, stiff			10	7-5-5 N=10
3.5	999.5+/-					
		SHALE, with limestone seams, gray, highly to moderately weathered	5		2	50/2"
					11	28-30-50 N=80
8.6	994.5+/-					
		Boring Terminated at 8.6 Feet			1	50/1"

WATER LEVEL OBSERVATIONS

ATTERBERG LIMITS: LL-PL-PI

HAND PENETROMETER (tsf)

WATER CONTENT (%)

DRY UNIT WEIGHT (pcf)

Stratification lines are approximate. In-situ, the transition may be gradual.
Classification of rock materials has been estimated based on observation of disturbed samples. Core samples and/or petrographic analysis may reveal other rock types.

Hammer Type: Automatic

Advancement Method:
Continuous flight solid-stem augers

Abandonment Method:
Boring backfilled with Auger Cuttings and/or Bentonite

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:
All descriptions taken from driller's field log.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13910 W 96th Ter
Lenexa, KS

Boring Started: 04-11-2018 | Boring Completed: 04-11-2018

Drill Rig: B53 | Driller: RM

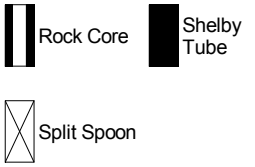
Project No.: 02185057

SUPPORTING INFORMATION

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

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**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. 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

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

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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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]		GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]		SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.

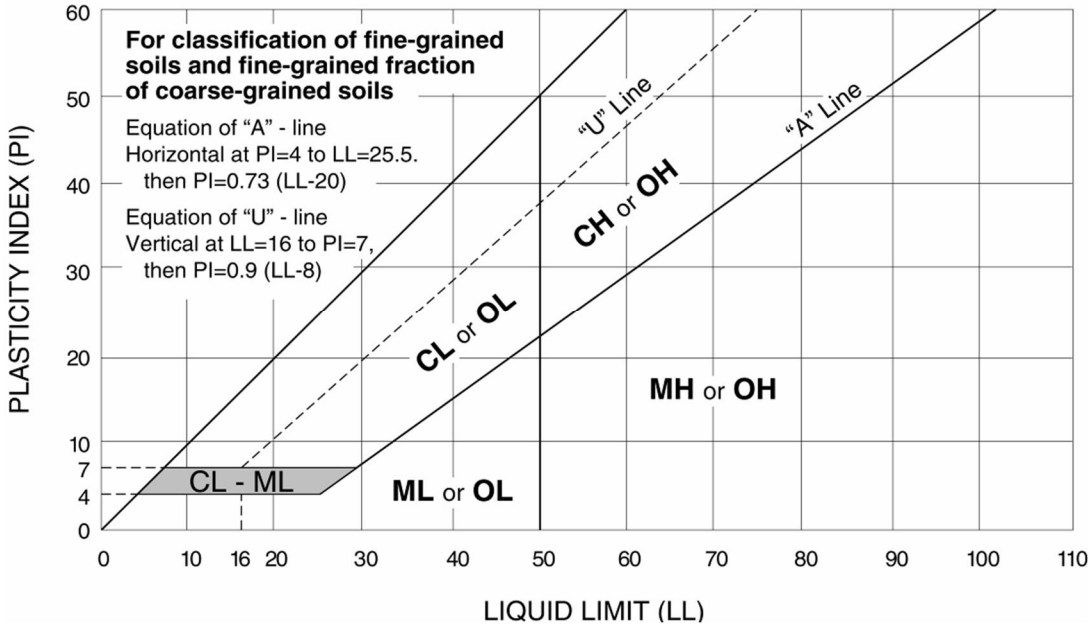
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.



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DESCRIPTION OF ROCK PROPERTIES

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, PSI (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft (50 – 300 mm)
Moderate	8 in – 2 ft (200 – 600 mm)	**Medium**	1 ft – 3 ft (300 – 900 mm)
Wide	2 ft – 6 ft (600 mm – 2.0 m)	**Thick**	3 ft – 10 ft (900 mm – 3 m)
Very Wide	6 ft – 20 ft (2.0 – 6 m)	**Massive**	> 10 ft (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0 degree angle.

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

*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.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements

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