REPORT OF GEOTECHNICAL EXPLORATION
JOHN KNOX VILLAGE – ASSISTED LIVING 400 UNIT
LEE'S SUMMIT, MISSOURI

Presented to:

JOHN KNOX VILLAGE
Lee's Summit, Missouri

Attn: Mr. David Gorden

Prepared by:
Otto J. Kruger, Jr., P.E.
Tadele M. Akalu

Kruger Technologies, Inc.
Lenexa, Kansas

KTI Project No. 218178G

October 8, 2018

KRUGER TECHNOLOGIES, INC.

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October 8th, 2018

Mr. David Gorden
John Knox Village
602 NW Pryor Road
Lee's Summit, MO 64081

Re: John Knox Village-Assisted Living 400 Unit
Lee's Summit, Missouri
KTI Project No. 218178G

Dear Mr. Gorden:

KTI has completed the subsurface exploration and geotechnical report for the above referenced project. The purpose of this report is to describe the surface and subsurface conditions encountered at the site, analyze and evaluate this information, and prepare a summary of existing conditions, subsurface material characteristics, and geotechnical design recommendations.

We thank you for the opportunity to work with John Knox Village. If you have any questions, please contact us at 913.498.1114.

Respectfully submitted,
Kruger Technologies, Inc.

O. J.
KRUGER, JR.
OJK
NUMBER
PE-23994
09 Oct 18

Otto J. Kruger, Jr., P.E.
Missouri: PE 23994

Tadele M. Akalu
Laboratory Manager

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REPORT OF GEOTECHNICAL EXPLORATION
JOHN KNOX VILLAGE – ASSISTED LIVING 400 UNIT
LEE'S SUMMIT, MISSOURI

AUTHORIZATION

The following table presents the authorization documentation history for the work performed and presented in this report by Kruger Technologies, Inc.

Project: John Knox Village Assisted Living 400 Unit		
Document:	**Date:**	**Requested/Provided:**
Request for Proposal	9-20-18	Mr. David Gorden – John Knox Village
KTI Proposal 18GT175	9-21-18	Dylan Kruger– Kruger Technologies, Inc.
Notice to Proceed	9-21-18	Mr. David Gorden – John Knox Village

PURPOSE AND SCOPE

The purpose of this investigation was to further explore the surface and subsurface conditions present within the site and provide additional recommendations regarding the following:

- Seismic Considerations
- Site Preparation and Engineered Fill
- Lateral Earth Pressures
- Shallow and Deep Building Foundations Options
- Slab on Grade
- Surface and Subsurface Drainage
- Excavation Considerations
- Trench Backfill Recommendations
- Manhole/Inlet Structure Backfill Recommendations
- Pavement Recommendations

SITE CONDITIONS

The exploration site was located at 1708 NW O'Brien Road in Lee's Summit, Missouri. At the time of drilling, the majority of the site was covered with a three-story unoccupied structure. There are existing parking lots to the south and west of the site and an open courtyard area to the north.

PROJECT DESCRIPTION

It is our understanding that the project consists of the demolition the existing three-story building at the project site and the construction of a new single-story 25 bed 20,000 square foot assisted living facility and related site improvements to located at 1708 NW O'Brien Road in Lee's Summit, Missouri. It is understood that new facility will be slab on grade construction and that the basement area of the existing structure will be infilled during the demolition phase. The new facility will tie into the existing building located to the east, west and northwest of the project site.

FIELD EXPLORATION PROCEDURES

Nine (9) test borings were completed in or around the proposed building areas for the above referenced project on September 28, 2018. The borings were selected and laid out by KTI with the site plan provided by the client.

The borings were drilled using an ATV CME-55 drill rig. Advancement of the test holes was accomplished using 4-inch O.D. continuous flight augers. Soil sampling was performed by hydraulically pushing thin wall steel (Shelby) tubes and by driving split-barrel samplers (Standard Penetration Test).

Site soils were visually and manually classified in general accordance with ASTM D 2488 by the drill crew chief as drilling progressed. All of the soil samples were delivered to the laboratory for verification of the field classifications. The boring logs were created as the borings were advanced and supplemented with information for lab test results; the boring logs are attached in Appendix I.

LABORATORY TESTS

Laboratory tests were performed on the recovered samples to determine the engineering characteristics and for additional verification of the field classifications in accordance with ASTM D 2487. The results of these tests, including in-situ moisture content, dry density, plasticity (Atterberg Limits), unconfined compressive strength, moisture density relationship (ASTM D698), and California Bearing Ratio (CBR) are presented in Appendix II.

GEOLOGY/SUBSURFACE CONDITIONS

Topsoil depths of 6 to 12 inches were encountered at all borings, with the exception of B-1 and B-2 which were located on the existing parking lot. Possible fill was encountered at all borings to a depth of 3 to 5 feet from the existing ground. The site soils were found to be primarily high plasticity (fat) clays with some lean plasticity clays and weathered shale identified at various depths below existing grade. Auger refusal was encountered prior to drilling plan depth at Borings B-1, B-4, B-5, and B-6 at depths ranging from 11.0 to 14.0 feet from the existing ground.

During advancement of the borings, free water was encountered at Borings B-1 and B-2 at 10 feet and 11 feet below existing grade. It should be noted that water level determinations made in relatively impervious (clay) soils might not present a reliable indication of the actual water table. However, water level determinations made in relatively pervious (sand/silt) soils are considered an accurate indication of the water table at the time that those measurements are made. Fluctuations in the water table should be expected with changing seasons and annual differences.

DESIGN CRITERIA AND RECOMMENDATIONS

Laboratory test results of the recovered samples showed the following characteristics that were used as criteria for determining the recommendations for bearing values and design data:

In-Situ Moisture	17.0 to 34.2 %
Dry Density	87.2 to 109.2 pcf
Liquid Limit	50 to 77 %
Plasticity Index	28 to 57 %
Unconfined Compressive Strength	2,472 to 24,611psf

Seismic Considerations

Based on the International Building Code (IBC) Section 1615.1.1 ande the subsurface stratigraphy the general Site Class Definition for the structures bearing on soil is Site Class C.

Site Preparation and Engineered Fill

The following recommendations are presented in the event that additional fill or backfill is required. Areas to receive fill should be stripped of vegetation, topsoil, pavement, and any other deleterious materials. Any isolated areas of soft or deleterious materials encountered at subgrade elevation should be removed and replaced with engineered fill. The moisture content of the subgrade soils should be appropriate to achieve the required compaction.

Proper drainage of the construction area should be provided to protect foundations, floor slabs, and pavement subgrades from the detrimental effects of weather conditions. Excavations should be kept as dry as possible. Any loose or soft materials which accumulate or develop on subgrade or bearing surfaces should be removed prior to the placement of concrete or pavement sections. The natural soil is lean and silty and by nature easily disturbed by construction traffic. Construction traffic, including foot traffic, should be minimized. Concrete should be placed in footing excavations as soon as possible after excavations are complete.

Trucks and other heavy construction vehicles should be restricted as much as possible from trafficking on the finished subgrade in the building to prevent unnecessary disturbances of subgrade soils. Excessive rutting or pumping of the subgrade could occur from construction traffic, particularly during periods of wet weather. If such disturbed areas develop, the subgrade may have to be excavated and replaced with properly compacted fill.

Concrete for foundations should be placed as soon after completion of the excavations as possible to avoid disturbance of the bearing material by inflow of surface water, groundwater, or precipitation.

Supplemental engineered fill should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Engineered fill should be compacted to a minimum of 95 percent of maximum density as determined by ASTM D698 (standard Proctor test) at moisture content between 0 and 4 percent above optimum moisture for high plasticity clay material and from -2 to +2 from optimum moisture content for low plasticity clays. The existing site soils may be used for fill material so long as they meet the requirements presented in the Building Pad Fill or Parking Lot Fill sections below.

Building Pad – It is recommended that fill consist of cleaner soil materials with a maximum particle size of 3 inches. The use of material larger than 3 inches may cause differential settlement below the building slab. Acceptable fill material for below the top 18 inches of the building pad may be GW, GC, GM, SW, SM, SC, ML, MH, CL and CH. The soils encountered on site below the topsoil are classified as acceptable fill material for this application. Material used in the top 18 inches of the building pad should be a low volume change (LVC) material. Acceptable LVC material is any soil type that has a Liquid Limit (LL) of less than 45 and a Plasticity Index (PI) of less than 25. Crushed rock or sand materials are also considered to be LVC material. **The soils encountered on site do not meet the requirements for LVC material.**

Surface Parking Lot Fill – It is recommended that fill consist of cleaner soil materials with a maximum particle size of 3 inches size for the top 3 feet of fill. Material placed below the top 3 feet of fill may contain larger material up to a maximum particle size of 8 inches provided the larger material is not grouped and there is sufficient soil to fill void spaces. Acceptable fill material for the parking lot subgrade may be GW, GC, GM, SW, SM, SC, ML, MH, CH and CL; most site soils are acceptable fill material. Material used in the top 12 inches of the pavement subgrade should be a low volume change (LVC) material as described above. **The soils encountered on site do not meet the requirements for LVC material.**

Lateral Earth Pressures

The following K values are estimated for the determination of lateral soil resistance for retaining structures and below grade walls based on material characteristics. Ka values are appropriate for calculation of lateral pressures behind retaining walls which are unrestrained at the top and will experience some translational or rotational movement i.e. modular retaining walls. Ko values are appropriate for calculating lateral pressures behind retaining walls that are restrained at the top and will experience very little or no movement i.e. basement walls. Kp values are used to calculate the lateral pressure exerted by soil experiencing compression during wall movement. These design values do not include the effects of hydrostatic water or surface surcharges. It is recommended that at least one foot of clean gravel backfill be placed directly adjacent to any retaining or foundation walls to greatly reduce the possibility to develop hydrostatic pressure.

In Situ Site Cohesive Soils (Estimated ϕ of 24°)

K_a = 0.42 (active) K_p = 2.37 (passive) K_o = 0.59 (at rest)

Coefficient of sliding friction = 0.33

Wet density of in place soil, average (γ) = 124 pcf

Clean Granular backfill (Estimated ϕ of 35°)

K_a = 0.27 (active) K_p = 3.69 (passive) K_o = 0.42 (at rest)

Coefficient of sliding friction = 0.47

Wet density of in-place gravel, average (γ) = 120 pcf

Shallow Foundations Bearing on Site Soils

The existing fill and undisturbed soils present at the site exhibit net allowable bearing capacities of 2,500 pounds per square foot (psf) for continuous footings, and 3,000 psf for rectangular footings. These bearing values are based on a minimum factor of safety of three against actual shear failure.

Anticipated settlements for these bearing capacities are 0.25-0.5 inches of total settlement, with a likely differential settlement of 0.25 inches over a horizontal distance of 30 feet. The minimum frost depth for this area is 36 inches. A minimum footing width of 18 inches is recommended. For sliding resistance considerations, an allowable coefficient of friction equal to 0.33 can be used.

The field exploration identified the presence of stiff high plasticity soils (CH) within the depth intervals that corresponds to potential foundation heaving zones. These types of soils are susceptible to volume change with fluctuations in moisture content. At a minimum, its recommended that the existing subgrade moisture condition beneath any footings be maintained at the present conditions, specifically that the clay subgrade soils with a high swell potential not be allowed to either desiccate (dry) or become saturated.

Typical Technical approaches for addressing swelling clay soils include the following

- Over excavate the highly expansive soils to a depth of three feet below the bottom of footing elevation and to an extent of one foot from each edge of the footing. Place and compact low volume change soils such as crushed limestone with fines (MODOT Type-5). Placing and compaction should be per site preparation and engineered fill recommendation in this report. These placements should be verified by KTI.

- Ensure positive drainage away from the structure through good surface drainage and a properly designed/constructed foundation/wall drainage system.

The base of all foundation excavations should be free of water and loose soil/rock prior to placing concrete. Concrete should be placed as soon as possible after excavation to reduce bearing soil disturbance. If the bearing level soils become disturbed the affected soil should be removed prior to placing concrete. Unsuitable soils, soft or otherwise unsuitable bearing soils could be encountered during foundation excavations. If unsuitable soils are encountered the excavations should be extended deeper to suitable soils. Footings could bear directly on these soils at the lower level or a lean concrete backfill could be placed in the excavations to bottom of footing elevation. The footings could also bear on properly compacted backfill extending down to the suitable soils. Over excavation for compacted backfill placement below footings should extend laterally past the footing edges at least 9 inches per foot of over excavation depth below bottom of footing elevation and compacted per this report.

Slab on Grade

The majority of existing material present on site at the anticipated elevation for the slab on grade is considered a high volume change material and does not meet the LVC requirement. The existing soils may be used as subgrade by modifying the parent soil with a 15% of fly ash stabilization. For the purpose of slab design, a modulus of subgrade reaction (k) of 200 pounds/cubic inch is suggested. This value is based on a subgrade consisting of fly ash modified subgrade.

Movement between slabs on grade and walls may occur. To minimize the effects of this movement, we recommend that slip joints be incorporated between all slabs and walls. All slabs should contain crack control and construction joints, which are formed on 15 to 25 foot centers, each way, or as designed by the project structural engineer. A capillary moisture barrier should be placed under the slabs. This barrier should be a minimum of a 6-inch thick layer of clean granular material extending to the limits of the foundation walls. Should additional moisture protection be desired, it should consist of 6-mil polyethylene sheeting placed between the slab and the base course. Appropriate consideration of slab curling for this condition should be undertaken.

Surface Drainage

In order to reduce the problems related to water infiltration, it is recommended that the final grade around the structure perimeters have a positive slope extending at least six feet away from the structure. Backfill of soils around the foundation should be compacted at a minimum of 95 percent of maximum dry density at moisture content between optimum and four percent above optimum in accordance with ASTM D 698.

Subsurface Drainage

Groundwater was encountered at Boring B-1 and B-2. It would be prudent to construct a drain system around the perimeter of below-grade structures or footings. The perimeter drain system should consist of 4-inch PVC or equivalent pipe with at least ¼-inch perforations routed to a sump or by gravity to the exterior. The pipe should be laid with the perforations down and enveloped with gravel. The gravel should be surrounded with Mirafi 140 filter cloth or equivalent.

Excavation Considerations

We believe that the project soils are Type B as classified in the OSHA Excavation Standard Handbook 29 CFR Parts 1926.650 through 1926.652. Type B soils are characterized by cohesive soils above the water table with unconfined compressive strengths greater than 0.5 tons per square foot (tsf) but less than and 1.5 tsf. Type B soils include any fill soils meeting or exceeding the above criteria, as well as undisturbed soils with unconfined compressive strengths of >1.5 tsf which are subject to vibration from traffic. Temporary excavation slopes for Type B soils can be one horizontal to one vertical with a maximum excavation depth of 20 feet.

Excavations deeper than 20 feet may require the use of supplemental shoring and will require the preparation of an excavation design prepared by a registered professional engineer.

Trench Backfill

According to our findings, excavated site materials may be used as backfill for trench excavation. Backfill should not be placed on soft materials or frozen ground. Soil backfill overlying the bedding should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Trench backfill under driveways/parking lots should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at moisture content according to the recommendations presented in the Site Preparation and Engineered Fill section of this report. In common yard areas, the soil backfill should be compacted to a minimum of 90 percent of maximum density (ASTM D 698) using the above moisture parameters. After preparation of the trench bottom, a pipe bed of a minimum of 6" shall be prepared using crushed stone or crushed gravel meeting the following requirements:

Nominal Pipe Size Diameter	AASHTO M43 Size
15" or Less	67, 7, 8 or washed #9
Greater than 15"	57, 6, or 67

Manhole/Inlet Structure Backfill

Soil backfill around structures should be placed in uniform horizontal lifts, with loose thicknesses not exceeding eight inches. The thickness must be appropriate for the method of compaction and the type of equipment used. The geotechnical engineer should approve any off-site material proposed for use as fill. Backfill should be compacted to a minimum of 95 percent of maximum density as defined by Standard Proctor (ASTM D 698) at a moisture content between 0 and 4 percent above optimum moisture (preferred average of plus 2 percent). Another option is to backfill with a Controlled Low Strength Material (CLSM), or flowable fill. The flowable fill should exhibit a minimum unconfined compressive strength of 250 psi after 28 days. Bedding material for manhole/inlet structure should be clean crushed rock conforming to the following gradation:

Sieve Designation	Percent Passing by Weight
1 ½"	100
No. 4	0 – 35
No. 200	0 – 8

PAVEMENT RECOMMENDATIONS

Pavement Subgrade Preparation

Construction scheduling, involving paving and grading by separate contractors, typically results in a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, and/or wetting of the subgrade between grading and paving can result in deterioration of the previously completed subgrade. A non-uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed. Where pavements are planned in cut areas, it is recommended that any soft or loose material encountered be removed and re-compacted as engineered fill to a depth of 12 inches below the subgrade elevation.

Pavement subgrades should be prepared in accordance with the recommendations presented in the SITE PREPARATION and ENGINEERED FILL section of this report. Construction scheduling, involving paving and grading by separate contractors, typically results in a time lapse between the end of grading operations and the commencement of paving. Disturbance, desiccation, and/or wetting of the subgrade between grading and paving can result in deterioration of the previously completed subgrade. A non-uniform subgrade can result in poor pavement performance and local failures relatively soon after pavements are constructed.

We recommend that the pavement subgrade be proof rolled and the moisture content and density of the top 12 inches checked within two days prior to placement of pavement. If any significant event, such as precipitation, occurs after proof rolling, the subgrade should be reviewed by a representative of KTI immediately prior to placing the pavement. The subgrade should be in its finished form at the time of the final review.

The pavement support provided by the soil will depend on the type of soil. The clay soil types available on site have an estimated California Bearing Ratio (CBR) value between 1 and 3 percent and as identified earlier are not recommended directly below paving materials. If the pavement subgrade is constructed from site soils modified by fly ash, lime or if well graded aggregate base is placed, the following options for construction of the parking lot can be considered for the project. It is understood that low to moderate levels of truck traffic may be experienced by the proposed parking lot.

Asphaltic Cement Concrete Pavements

Full depth recommended flexible pavement sections are presented in Table 1 and recommended flexible pavement sections including aggregate base are presented in Table 2. The pavement profiles presented below for drive lanes and parking stalls assume only passenger vehicle loading. A heavy duty pavement section is presented for emergency vehicles and garbage trucks. Passenger vehicles are defined as two-axle, four-wheel vehicles (cars, trucks, vans and SUVs).

Table 1

Asphaltic Cement Concrete Pavement on Compacted Soil (Minimum)

Material	Parking Stalls	Drive Lanes	Heavy Duty
Surface Course	2-inch	2-inch	2-inch
Base Course	4-inch	6-inch	8-inch

Table 2

Asphaltic Cement Concrete Pavement on Modified Subgrade (Minimum)

Material	Parking Stalls	Drive Lanes	Heavy Duty
Surface Course	1.5-inch	2-inch	2-inch
Base Course	2.5-inch	4-inch	6-inch
Aggregate Base	6-inch	6-inch	6-inch

The asphaltic base course should be compacted to a minimum of 95% of the mixture's Marshall density, when determined in accordance with ASTM D 6926. The surface course should have a minimum Marshall stability of 1500 pounds and be compacted to a minimum of 97% of the mixture's Marshall density, when determined in accordance with ASTM D 6926.

Portland Cement Concrete Pavements

Based on the soil types encountered in the proposed parking lot and previous experience with materials of this type, an effective resilient modulus of 100 pci was estimated for design of ridged pavements on unimproved subgrades. If a stabilized subgrade is used, a resilient modulus of 200-pci is suggested.

Portland cement concrete (PCC) pavements are recommended for drive approaches, loading dock aprons, trash dumpster pads and approaches, loading/unloading areas, and other areas where heavy wheel loads will be concentrated. We recommend that the concrete pavements in areas receiving heavy truck traffic have a minimum thickness of 8 inches. If PCC pavements are considered for passenger vehicle areas, we recommend a minimum thickness of 5 inches.

It is also recommended that a 4-inch leveling and drainage course of clean, crushed rock be placed below all PCC pavements and that appropriate sub drainage or connection to a suitable gravity outfall be provided to remove water from the drainage layer.

The mixture should be designed to develop a minimum compressive strength of 4000 psi at 28 days with a 4-inch maximum slump and 5 to 7 percent entrained air. Where Portland cement concrete is used, load transfer devices should be installed at all construction joints or post-placement sawed joints.

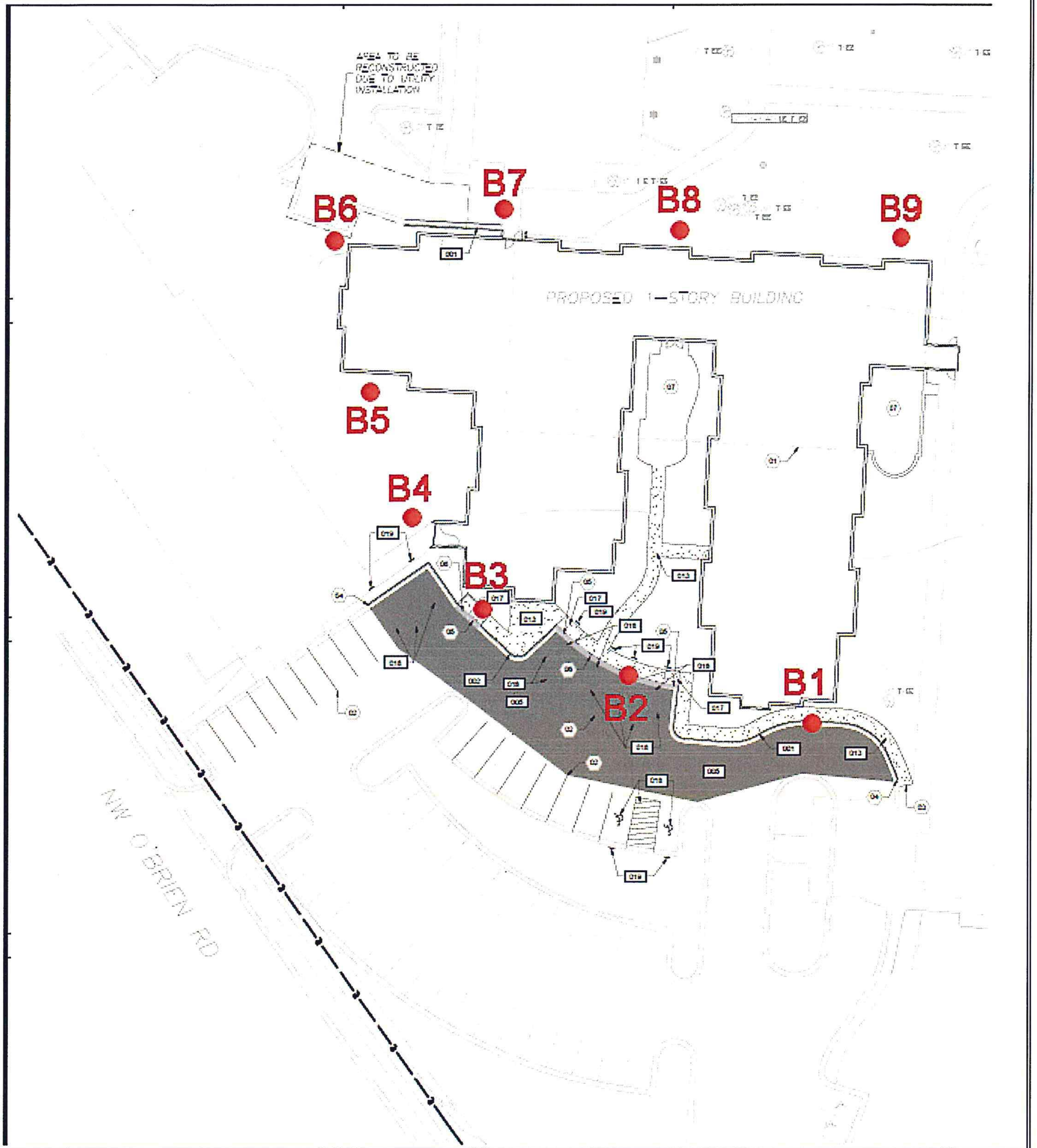
REMARKS

It is recommended that the geotechnical engineer be retained to review the plans and specifications for the project so that an evaluation and comments can be provided regarding the proper incorporation of information from this geotechnical report into the final construction documents. We further recommend that the geotechnical engineer be retained during construction phases for earthwork, pavement, and foundations to provide observation and testing to aid in determining that design intent has been accomplished.

The findings, recommendations, and suggestions contained in this report are our opinions based on data acquired to date and are assumed to be representative of conditions at locations between borings. Due to the fact that the area at the borings is very small relative to the overall site, and for other reasons, we make no statement warranting the conditions below our borings or at other locations throughout the site. In addition, we do not warrant that the general strata logged at the borings are necessarily typical of the remaining areas of the site.

Reports shall not be reproduced except in full, without written approval of KTI. Information in this report applies only to the referenced project in its present configuration and location and shall not be used for any other project or location.

BORING LOCATION DIAGRAM



Boring Location Diagram
JKV Village Assisted Living 400 Unit
Lee's Summit, Missouri

KRUGER TECHNOLOGIES, INC.

Drawn: TMA	**Date:** 10/02/2018	**Project No: 218178G**

APPENDIX I

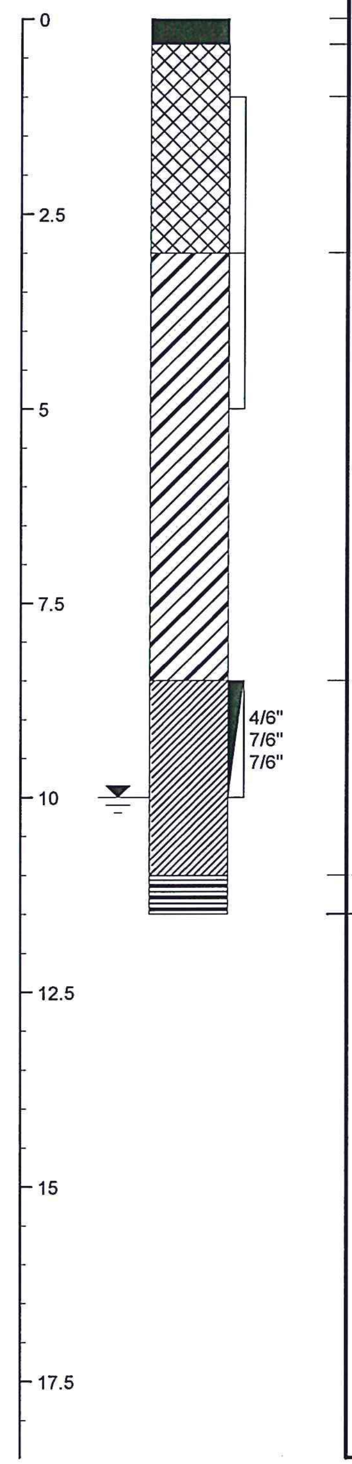
Boring Logs

LOG OF TEST BORING
BORING B-1

PROJECT: JKV Village Assisted Living 400 Unit
CLIENT: John Knox Village
PROJECT NO.: 218178G **START:** 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water 10 **caving**

DATE: 10/9/2018
ELEVATION:
FINISH: 9/27/18

LOGGER: TMA
DATE CHECKED:

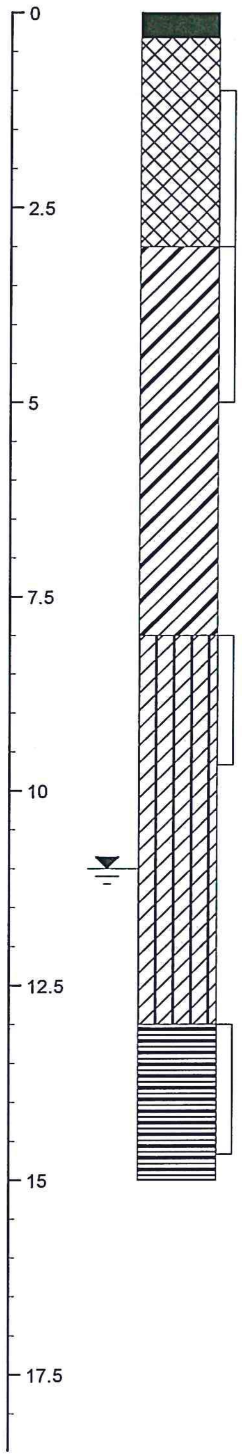


ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
		ACC	Asphalt				
		FILL	Fill, lean clay, dark gray, moist				
		FILL	Fill, fat clay, stiff, gray, moist	1, ST	99.9	23.6	
		CL-CH	Lean to fat clay, stiff, olive gray, moist	2, ST	101.2	24.3	5186
	4/6" 7/6" 7/6"	CH	Fat clay, stiff, reddish brown, moist	1, SS			
		W	Weathered limestone, very stiff to hard				
			Drilling discontinued at auger refusal at 11.5 feet				

Notes:

LOG OF TEST BORING
BORING B-2

PROJECT: JKV Village Assisted Living 400 Unit
DATE: 10/9/2018
CLIENT: John Knox Village
ELEVATION:
PROJECT NO.: 218178G
START: 9/27/18
FINISH: 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
LOGGER: TMA
DEPTH TO - water 11 **caving**
DATE CHECKED:



ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
		ACC	Asphalt				
		FILL	Fill, lean clay, dark gray, moist				
		FILL	Fill, fat clay, stiff, gray & brown, moist	1, ST	94.7	29.8	
		CL-CH	Lean to fat clay, stiff, gray & red mix, moist	2, ST	101.0	23.7	
		CL	Lean clay, stiff, brown, moist	3, ST			
		W	Highly weathered shale, very stiff, gray, moist to dry	4, ST	104.2	22.0	
			Drilling discontinued at 11.5 feet				

Notes:

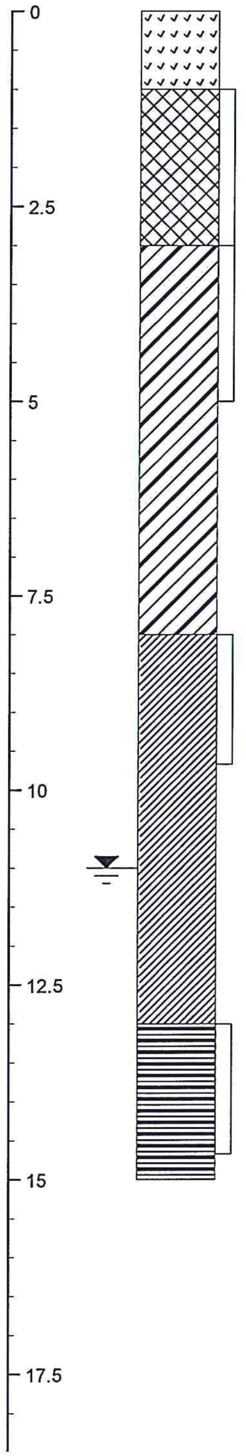
LOG OF TEST BORING

BORING B-3

PROJECT: JKV Village Assisted Living 400 Unit
CLIENT: John Knox Village
PROJECT NO.: 218178G **START:** 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water 11 **caving**

DATE: 10/9/2018
ELEVATION:
FINISH: 9/27/18

LOGGER: TMA
DATE CHECKED:

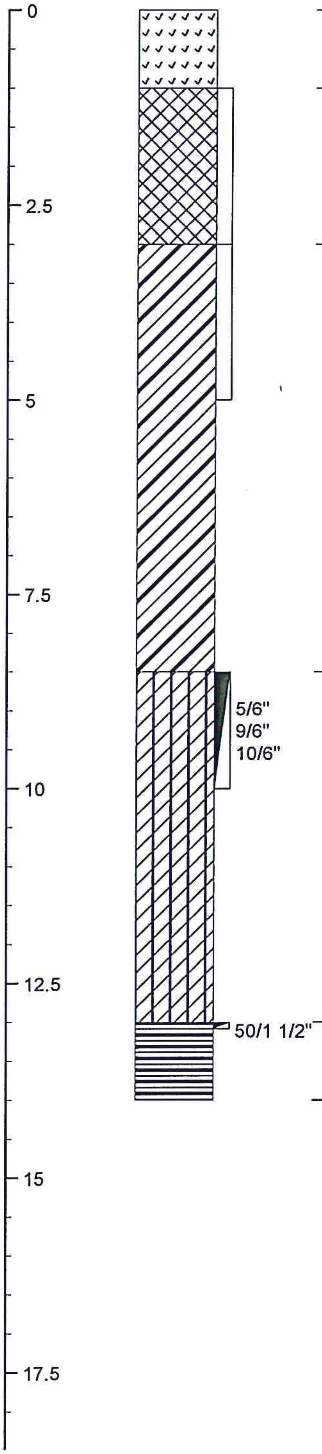


ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
		T	Topsoil				
		FILL	Fill, lean clay, stiff, gray, moist	1, ST	97.1	30.6	
		CL-CH	Lean to fat clay, stiff, gray & brown mix, moist	2, ST	95.6	25.9	2472
		CH	Fat clay, stiff, red, moist	3, ST	92.5	29.5	2128
		W	Highly weathered sandstone, very stiff to hard, reddish brown, moist to dry	4, ST	99.4	25.1	
			Drilling discontinued at 15.0 feet				

Notes:

LOG OF TEST BORING
BORING B-4

PROJECT: JKV Village Assisted Living 400 Unit
DATE: 10/9/2018
CLIENT: John Knox Village
ELEVATION:
PROJECT NO.: 218178G
START: 9/27/18
FINISH: 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
LOGGER: TMA
DEPTH TO - water
caving
DATE CHECKED:

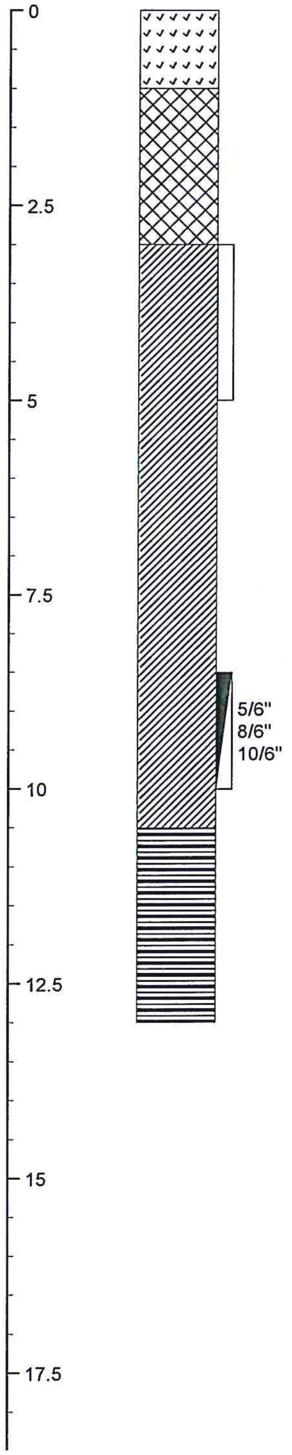


ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
		T	Topsoil				
		FILL	Fill, lean to fat clay, very stiff, gray, moist	1, ST	98.6	25.9	
		CL-CH	Lean to fat clay, stiff, gray, moist	2, ST	109.2	17.0	24611
	5/6" 9/6" 10/6"	CL	Lean clay, stiff, dark gray, moist	1, SS			
	50/1 1/2"	W	Highly weathered sandstone, very stiff to hard, reddish brown, moist to dry	2, SS			
			Drilling discontinued at auger refusal at 14.0 feet				

Notes:

LOG OF TEST BORING
BORING B-5

PROJECT: JKV Village Assisted Living 400 Unit
DATE: 10/9/2018
CLIENT: John Knox Village
ELEVATION:
PROJECT NO.: 218178G
START: 9/27/18
FINISH: 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
LOGGER: TMA
DEPTH TO - water
caving
DATE CHECKED:



ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
		T	Topsoil				
		FILL	Fill, clayey gravel, stiff, moist				
		CH	Fat clay, stiff, gray, moist	1, ST	104.3	19.7	11505
	5/6" 8/6" 10/6"	CH	Fat clay, stiff, dark brown, moist	1, SS			
		W	Highly weathered shale, very stiff to hard				
			Drilling discontinued at auger refusal at 13.0 feet				

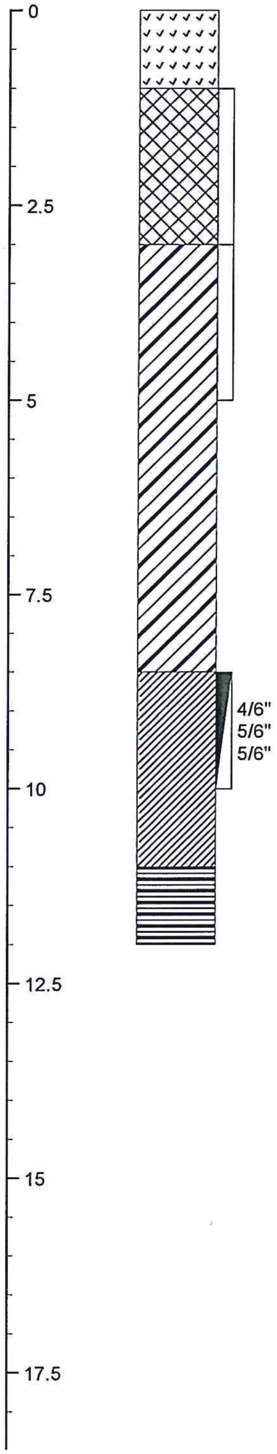
Notes:

Sheet 1 of 1

LOG OF TEST BORING

BORING B-6

PROJECT: JKV Village Assisted Living 400 Unit **DATE:** 10/9/2018
CLIENT: John Knox Village **ELEVATION:**
PROJECT NO.: 218178G **START:** 9/27/18 **FINISH:** 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers **LOGGER:** TMA
DEPTH TO - water **caving** **DATE CHECKED:**



ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
		T	Topsoil				
		FILL	Fill, fat clay, stiff, brown, moist	1, ST	87.2	34.2	
		CL-CH	Lean to fat clay, very stiff, grayish brown, moist	2, ST	99.7	24.6	3893
	4/6" 5/6" 5/6"	CH	Fat clay, stiff, dark brown, moist	1, SS			
		W	Highly weathered limestone, very stiff to hard				
			Drilling discontinued at auger refusal at 12.0 feet				

Notes:

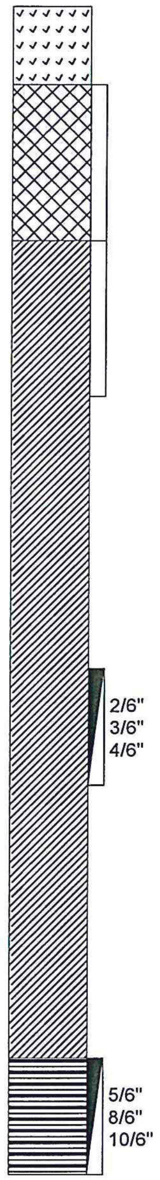
KTI

LOG OF TEST BORING

BORING B-7

PROJECT: JKV Village Assisted Living 400 Unit
CLIENT: John Knox Village
PROJECT NO.: 218178G **START:** 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water **caving**

DATE: 10/9/2018
ELEVATION:
FINISH: 9/27/18
LOGGER: TMA
DATE CHECKED:



ELEVATION/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	Description	Sample # & Type	Density pcf	Moist- ure, %	Qu, psf
0		T	Topsoil				
2.5		FILL	Fill, lean to fat clay, stiff, dark gray, moist	1, ST	99.9	23.7	
5 7.5		CH	Fat clay, stiff, gray, moist	2, ST	93.2	28.0	
10 12.5	2/6" 3/6" 4/6"	CH	Fat clay, medium stiff, dark grayish brown, moist	1, SS			
15	5/6" 8/6" 10/6"	W	Highly weathered shale, stiff, gray, moist	2, SS			
17.5			Drilling discontinued at refusal at 15.0 feet				

Notes:

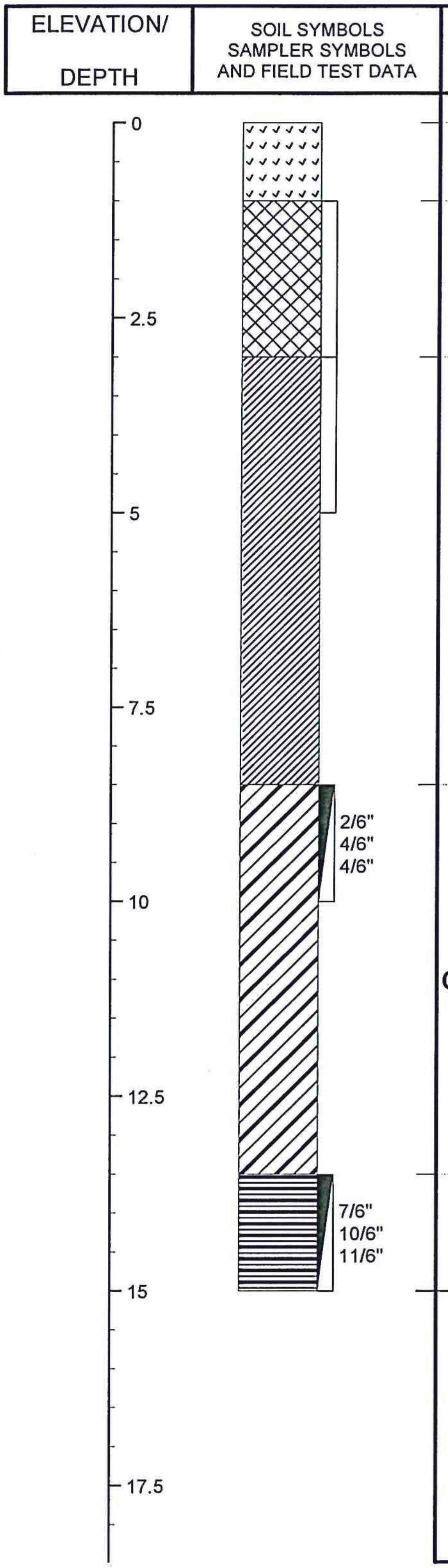
KTI

LOG OF TEST BORING

BORING B-8

PROJECT: JKV Village Assisted Living 400 Unit
CLIENT: John Knox Village
PROJECT NO.: 218178G
START: 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water
caving

DATE: 10/9/2018
ELEVATION:
FINISH: 9/27/18
LOGGER: TMA
DATE CHECKED:



USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
T	Topsoil				
FILL	Fill, lean to fat clay, stiff, gray & black, moist	1, ST	98.6	23.5	
CH	Fat clay, stiff, gray, moist	2, ST	98.4	25.3	5728
CL-CH	Lean to fat clay, medium stiff, grayish brown, moist	1, SS			
W	Highly weathered shale, very stiff, gray, moist	2, SS			
	Drilling discontinued at 15.0 feet				

Notes:

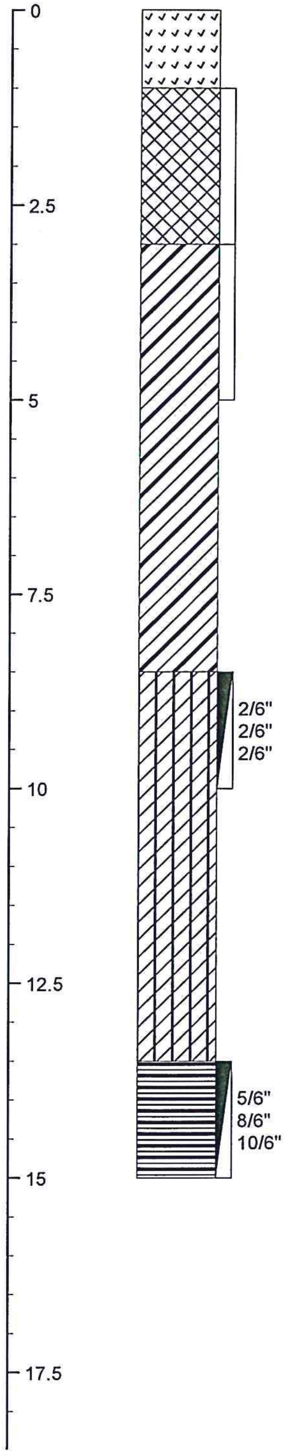
KTI

LOG OF TEST BORING

BORING B-9

PROJECT: JKV Village Assisted Living 400 Unit
CLIENT: John Knox Village
PROJECT NO.: 218178G **START:** 9/27/18
BORING LOCATION: See Boring Location Plan
METHOD OF DRILLING: 4" Continuous Flight Augers
DEPTH TO - water **caving**

DATE: 10/9/2018
ELEVATION:
FINISH: 9/27/18
LOGGER: TMA
DATE CHECKED:



USCS	Description	Sample # & Type	Density pcf	Moist-ure, %	Qu, psf
T	Topsoil				
FILL	Fill, fat clay, stiff, dark gray, moist	1, ST	94.6	26.4	
CL-CH	Lean to fat clay, stiff, gray, moist	2, ST	99.6	24.0	4421
CL-CH	Lean to fat clay, soft, grayish brown, moist	1, SS			
W	Highly weathered shale, stiff, gray, moist	2, SS			
	Drilling discontinued at 15.0 feet				

Notes:

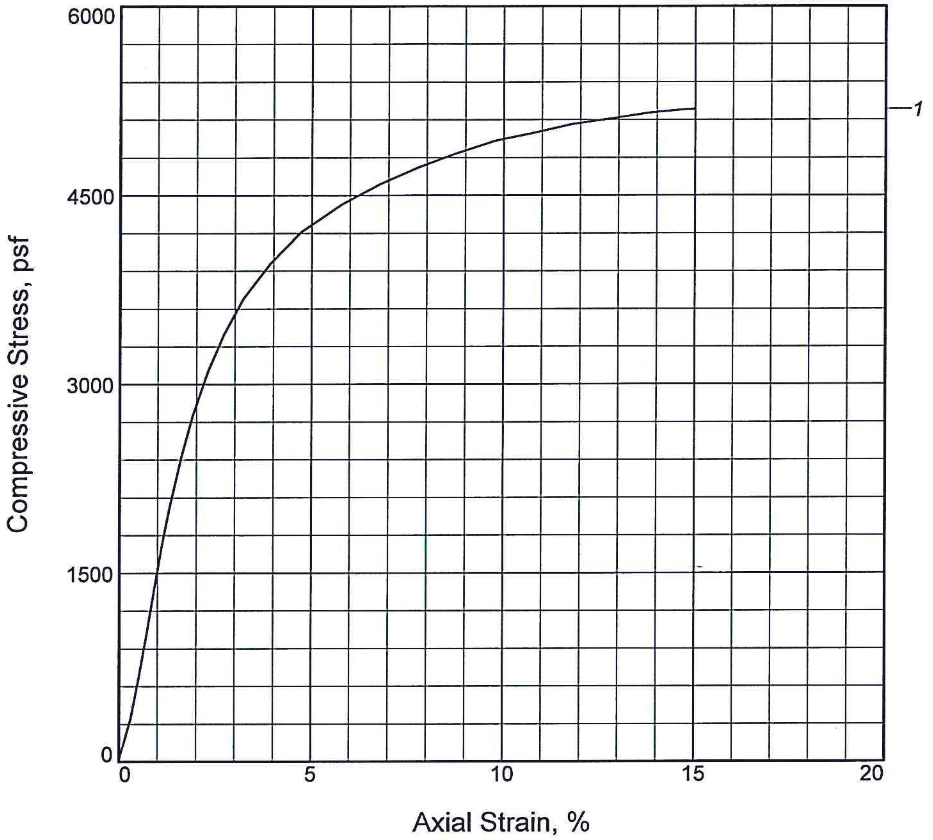
APPENDIX II

Laboratory Results

SUMMARY OF LABORATORY TEST RESULTS

Boring	Depth (Ft)	Sample No./Type	Natural Moisture %	Natural Dry Density (pcf)	Unconfined Compressive Strength (psf)	Atterberg Limits		Soil Type
						Liquid Limit %	Plasticity Index %	
B-1	1.0-3.0	ST-1	23.6	99.9		62	41	CH
B-1	3.0-5.0	ST-2	24.3	101.2	5186	50	28	CL-CH
B-2	1.0-3.0	ST-1	29.8	94.7				
B-2	3.0-5.0	ST-2	23.7	101.0	5330			
B-2	13.0-15.0	ST-4	22.0	104.2				
B-3	1.0-3.0	ST-1	30.6	97.1				
B-3	3.0-5.0	ST-2	25.9	95.6	2472			
B-3	8.0-10.0	ST-3	29.5	92.5	2128			
B-3	13.0-15.0	ST-4	25.1	99.4				
B-4	1.0-3.0	ST-1	25.9	98.6				
B-4	3.0-5.0	ST-2	17.0	109.2	24611			
B-5	3.0-5.0	ST-1	19.7	104.3	11505	55	35	CH
B-6	1.0-3.0	ST-1	34.2	87.2				
B-6	3.0-5.0	ST-2	24.6	99.7	3893			
B-7	1.0-3.0	ST-1	23.7	99.9				
B-7	3.0-5.0	ST-2	28.0	93.2				
B-8	1.0-3.0	ST-1	23.5	98.6				
B-8	3.0-5.0	ST-2	25.3	98.4	5728			
B-9	1.0-3.0	ST-1	26.4	94.6		77	57	CH
B-9	3.0-5.0	ST-2	24.0	99.6	4421			

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	5186			
Undrained shear strength, psf	2593			
Failure strain, %	15.0			
Strain rate, in./min.	0.050			
Water content, %	24.3			
Wet density, pcf	125.8			
Dry density, pcf	101.2			
Saturation, %	97.6			
Void ratio	0.6776			
Specimen diameter, in.	2.86			
Specimen height, in.	5.59			
Height/diameter ratio	1.95			

Description: Fat clay, stiff, olive gray, moist

LL = 50	**PL =** 22	**PI =** 28	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G
Date Sampled: 9/27/18
Remarks:

Figure _______

Client: John Knox Village

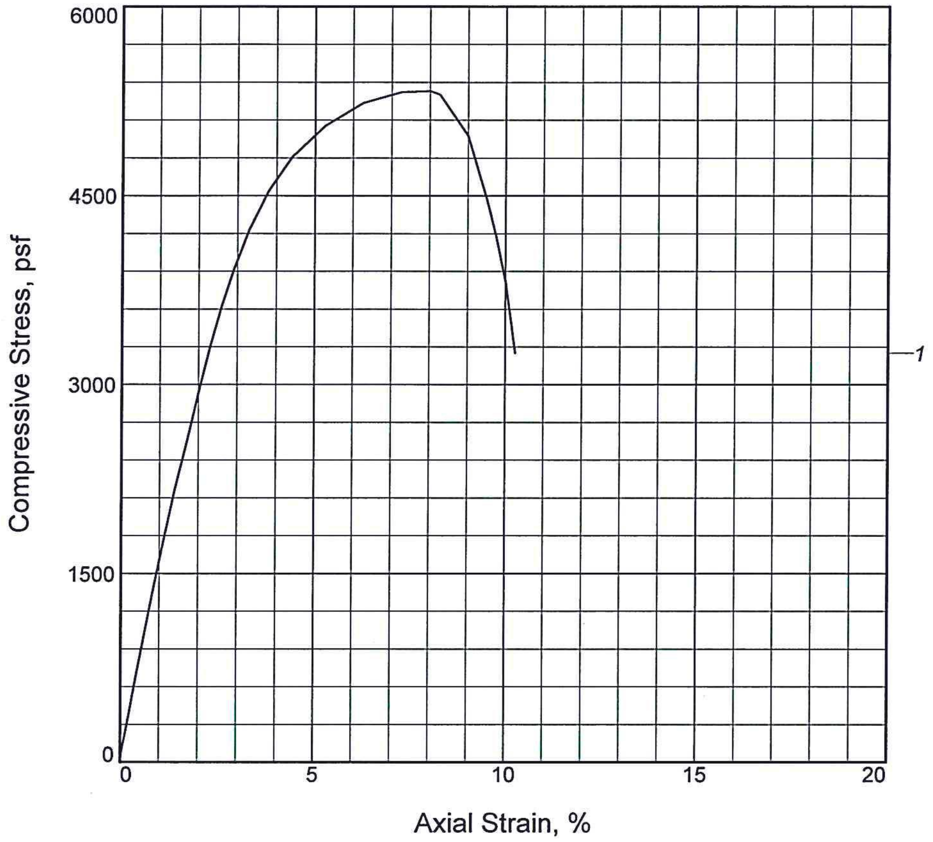
Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-1 **Depth:** 3
Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	5330			
Undrained shear strength, psf	2665			
Failure strain, %	8.0			
Strain rate, in./min.	0.050			
Water content, %	23.7			
Wet density, pcf	124.9			
Dry density, pcf	101.0			
Saturation, %	94.4			
Void ratio	0.6819			
Specimen diameter, in.	2.84			
Specimen height, in.	5.64			
Height/diameter ratio	1.99			

Description: Lean to fat clay, stiff, gray & red mix, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G
Date Sampled: 9/27/18
Remarks:

Figure _______

Client: John Knox Village

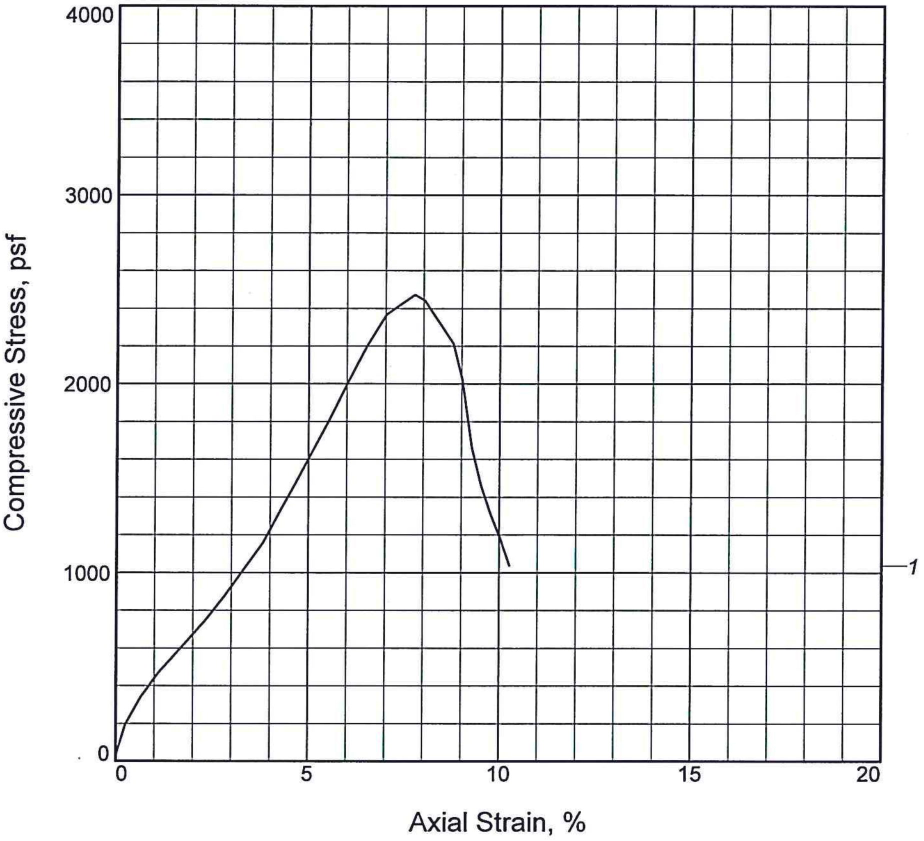
Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-2 **Depth:** 3
Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2472			
Undrained shear strength, psf	1236			
Failure strain, %	7.8			
Strain rate, in./min.	0.050			
Water content, %	25.9			
Wet density, pcf	120.4			
Dry density, pcf	95.6			
Saturation, %	90.7			
Void ratio	0.7758			
Specimen diameter, in.	2.79			
Specimen height, in.	5.63			
Height/diameter ratio	2.02			

Description: Lean to fat clay, stiff, gray & brown mix, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G

Date Sampled: 9/27/18

Remarks:

Figure _______

Client: John Knox Village

Project: JKV Village Assisted Living 400 Unit

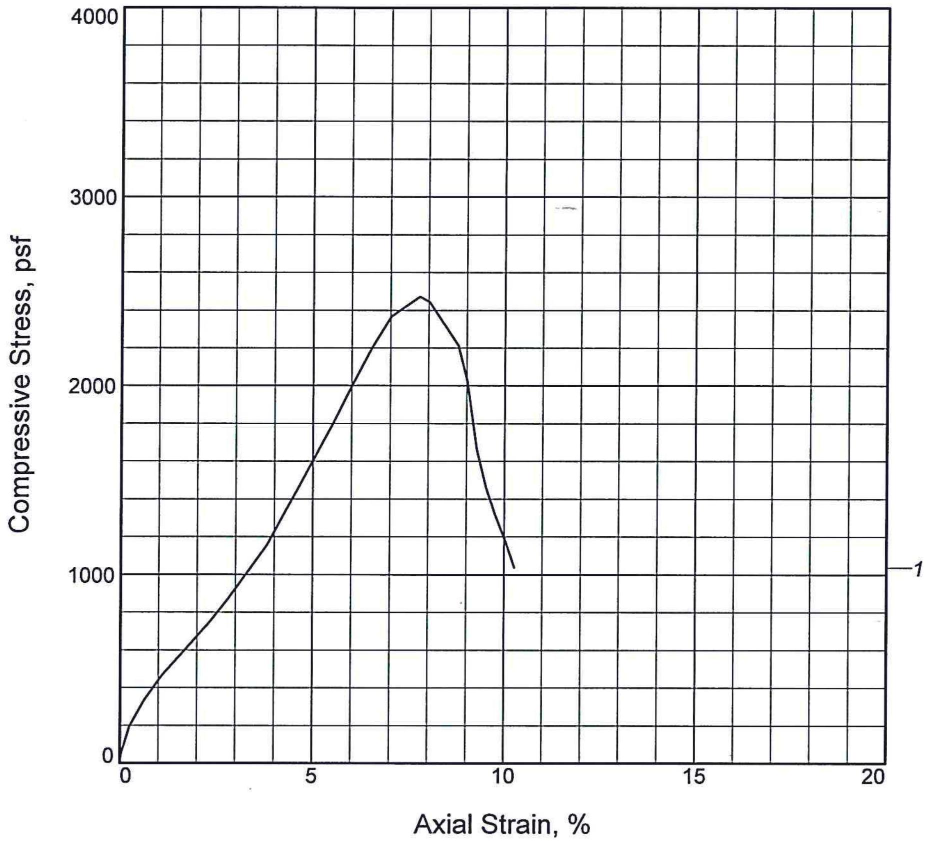
Source of Sample: B-3 **Depth:** 3

Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2472			
Undrained shear strength, psf	1236			
Failure strain, %	7.8			
Strain rate, in./min.	0.050			
Water content, %	25.9			
Wet density, pcf	120.4			
Dry density, pcf	95.6			
Saturation, %	90.7			
Void ratio	0.7758			
Specimen diameter, in.	2.79			
Specimen height, in.	5.63			
Height/diameter ratio	2.02			

Description: Lean to fat clay, stiff, gray & brown mix, moist

LL =	PL =	PI =	Assumed GS= 2.72	Type: ST

Project No.: 218178G
Date Sampled: 9/27/18
Remarks:

Figure ________

Client: John Knox Village

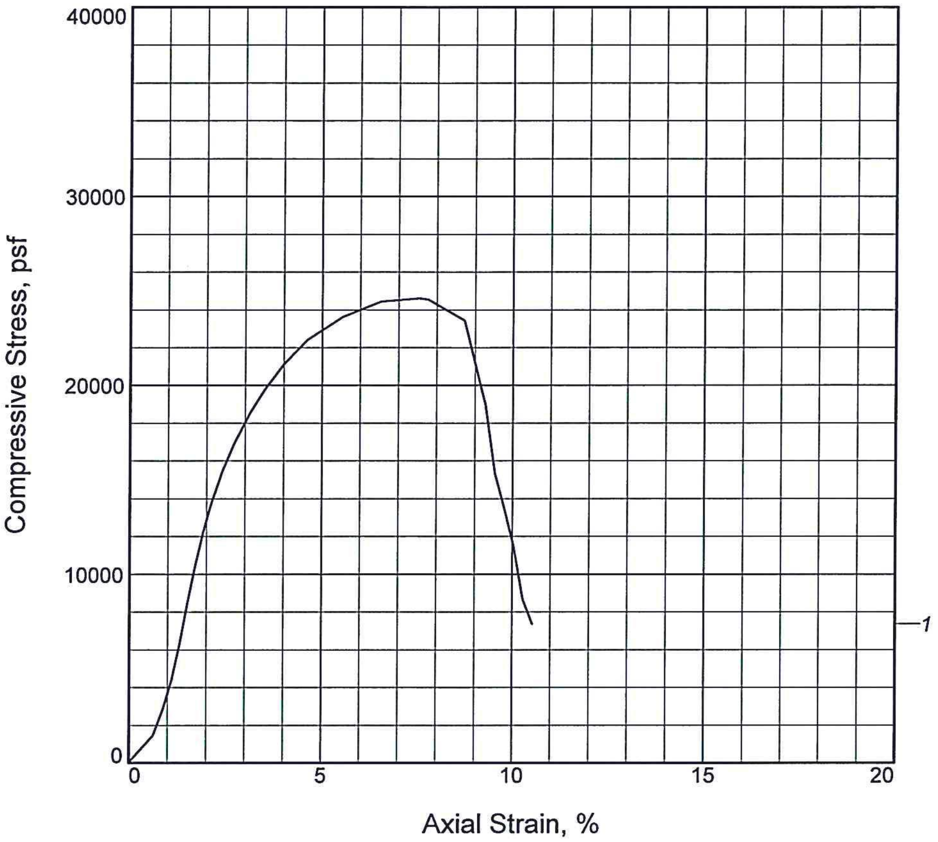
Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-3 **Depth:** 3
Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	24611			
Undrained shear strength, psf	12306			
Failure strain, %	7.5			
Strain rate, in./min.	0.500			
Water content, %	17.0			
Wet density, pcf	127.7			
Dry density, pcf	109.2			
Saturation, %	83.2			
Void ratio	0.5553			
Specimen diameter, in.	2.89			
Specimen height, in.	5.71			
Height/diameter ratio	1.98			

Description: Lean to fat clay, stiff, gray, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G

Date Sampled: 9/27/18

Remarks:

Figure _______

Client: John Knox Village

Project: JKV Village Assisted Living 400 Unit

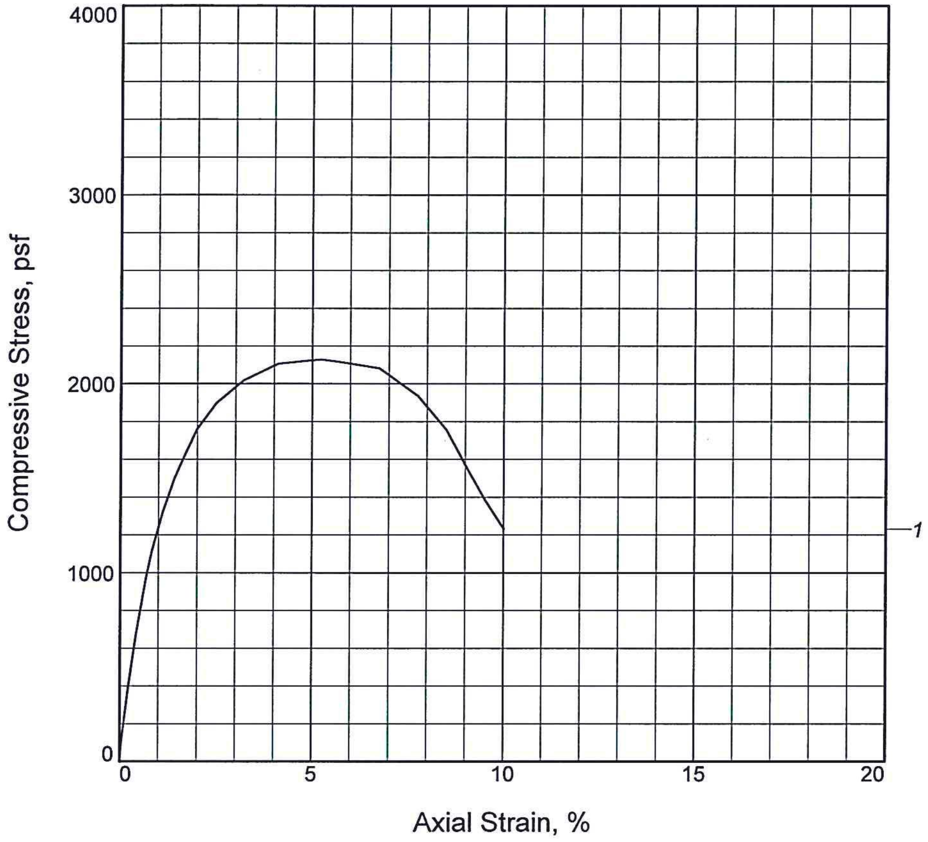
Source of Sample: B-4 **Depth:** 3

Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	2128			
Undrained shear strength, psf	1064			
Failure strain, %	5.3			
Strain rate, in./min.	0.050			
Water content, %	29.5			
Wet density, pcf	119.8			
Dry density, pcf	92.5			
Saturation, %	96.0			
Void ratio	0.8349			
Specimen diameter, in.	2.84			
Specimen height, in.	5.61			
Height/diameter ratio	1.98			

Description: Fat clay, stiff, red, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G
Date Sampled: 9/27/18
Remarks:

Figure ________

Client: John Knox Village

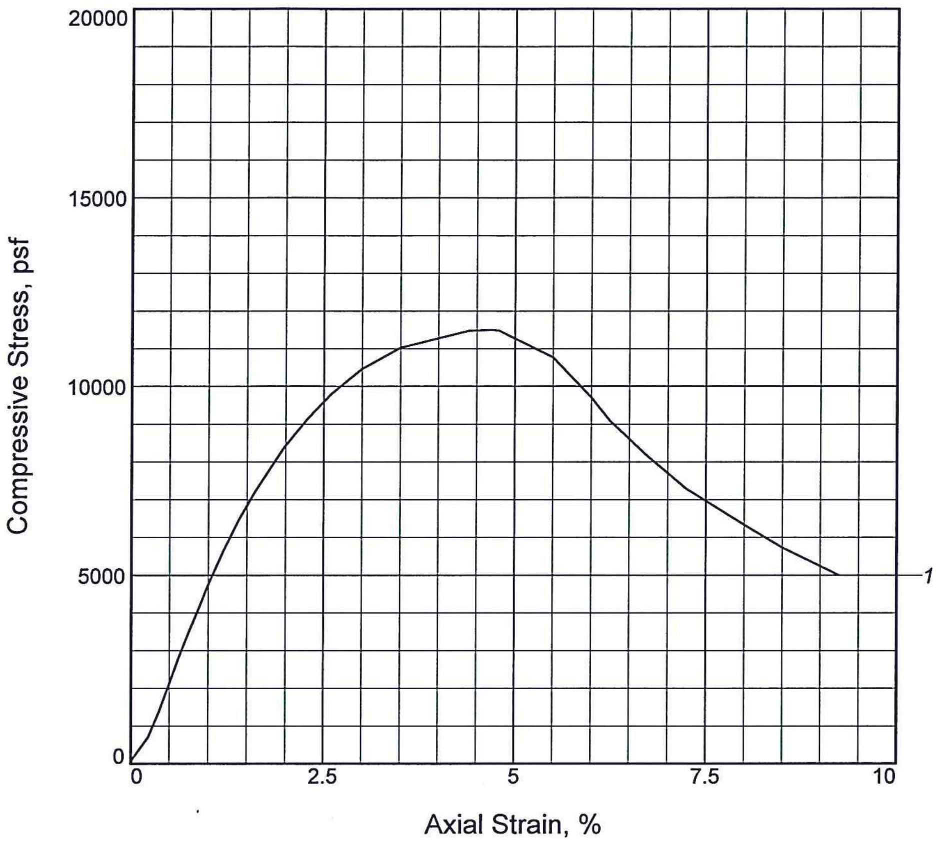
Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-3 **Depth:** 8
Sample Number: 3

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	11505			
Undrained shear strength, psf	5752			
Failure strain, %	4.7			
Strain rate, in./min.	0.050			
Water content, %	19.7			
Wet density, pcf	124.8			
Dry density, pcf	104.3			
Saturation, %	85.2			
Void ratio	0.6280			
Specimen diameter, in.	2.89			
Specimen height, in.	5.63			
Height/diameter ratio	1.95			

Description: Fat clay, stiff, gray, moist

LL = 55	**PL =** 20	**PI =** 35	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G
Date Sampled: 9/27/18
Remarks:

Figure _______

Client: John Knox Village

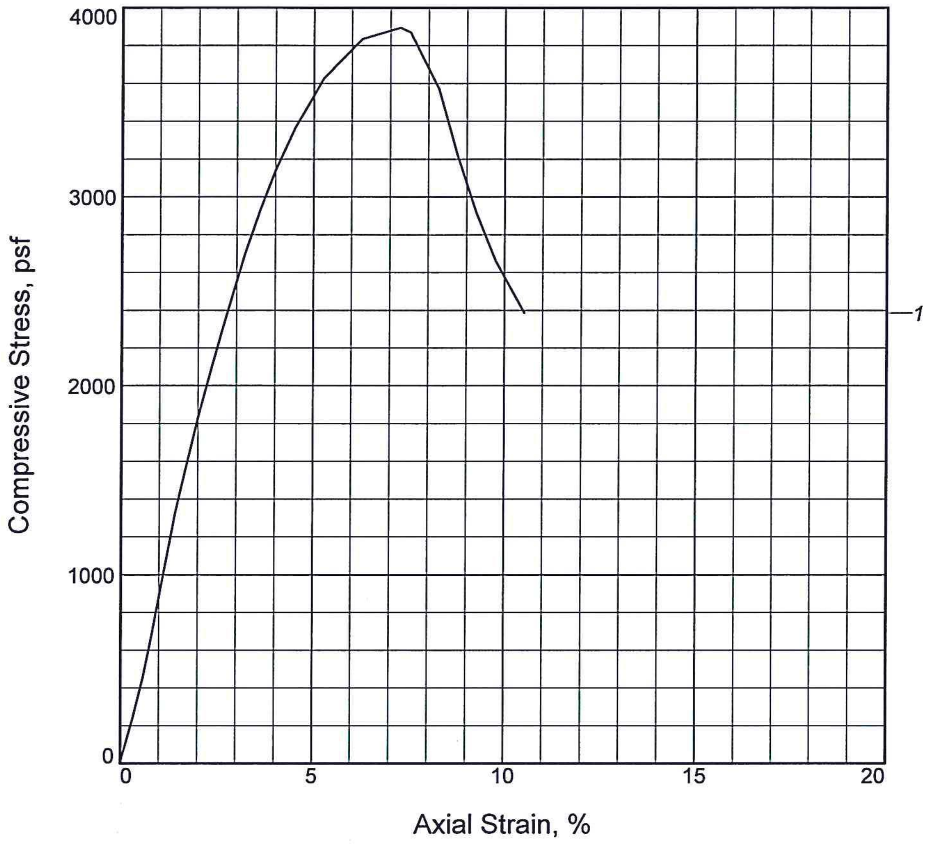
Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-5 **Depth:** 3
Sample Number: 1

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	3893			
Undrained shear strength, psf	1947			
Failure strain, %	7.3			
Strain rate, in./min.	0.050			
Water content, %	24.6			
Wet density, pcf	124.3			
Dry density, pcf	99.7			
Saturation, %	95.4			
Void ratio	0.7025			
Specimen diameter, in.	2.85			
Specimen height, in.	5.61			
Height/diameter ratio	1.97			

Description: Lean to fat clay, very stiff, grayish brown, moist

LL = | **PL =** | **PI =** | **Assumed GS=** 2.72 | **Type:** ST

Project No.: 218178G

Date Sampled: 9/27/18

Remarks:

Figure _______

Client: John Knox Village

Project: JKV Village Assisted Living 400 Unit

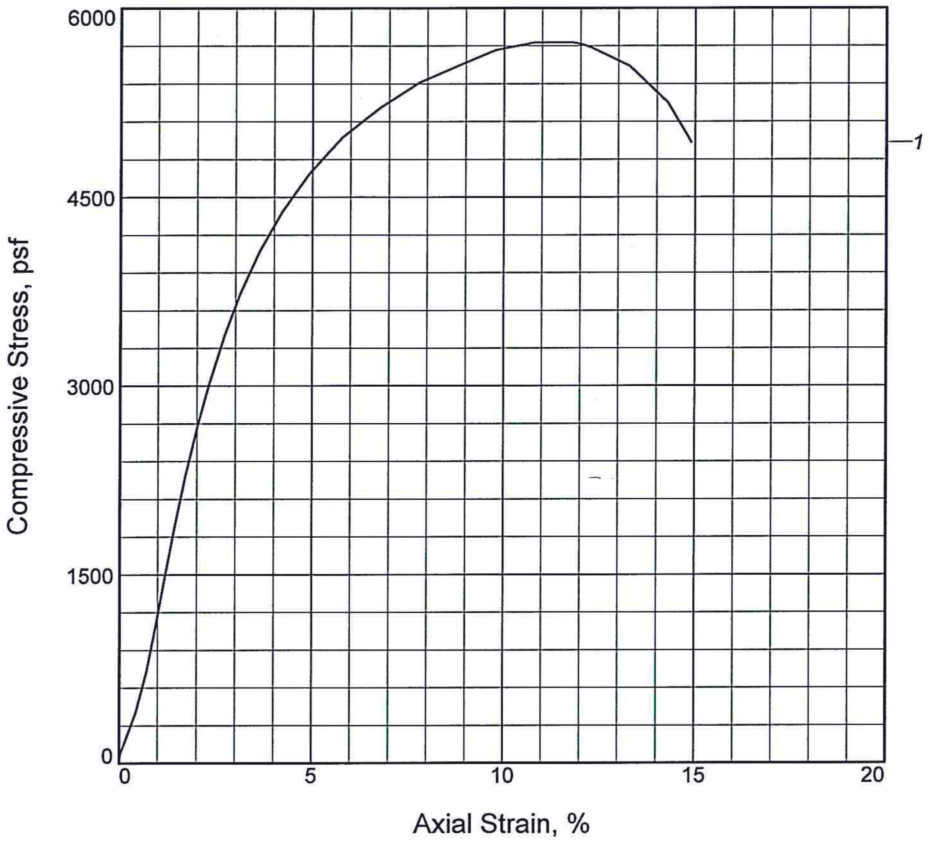
Source of Sample: B-6 **Depth:** 3

Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	5728			
Undrained shear strength, psf	2864			
Failure strain, %	10.8			
Strain rate, in./min.	0.050			
Water content, %	25.3			
Wet density, pcf	123.4			
Dry density, pcf	98.4			
Saturation, %	95.0			
Void ratio	0.7248			
Specimen diameter, in.	2.89			
Specimen height, in.	5.60			
Height/diameter ratio	1.94			

Description: Fat clay, stiff, gray, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G

Date Sampled: 9/27/18

Remarks:

Figure _______

Client: John Knox Village

Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-8 **Depth:** 3

Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
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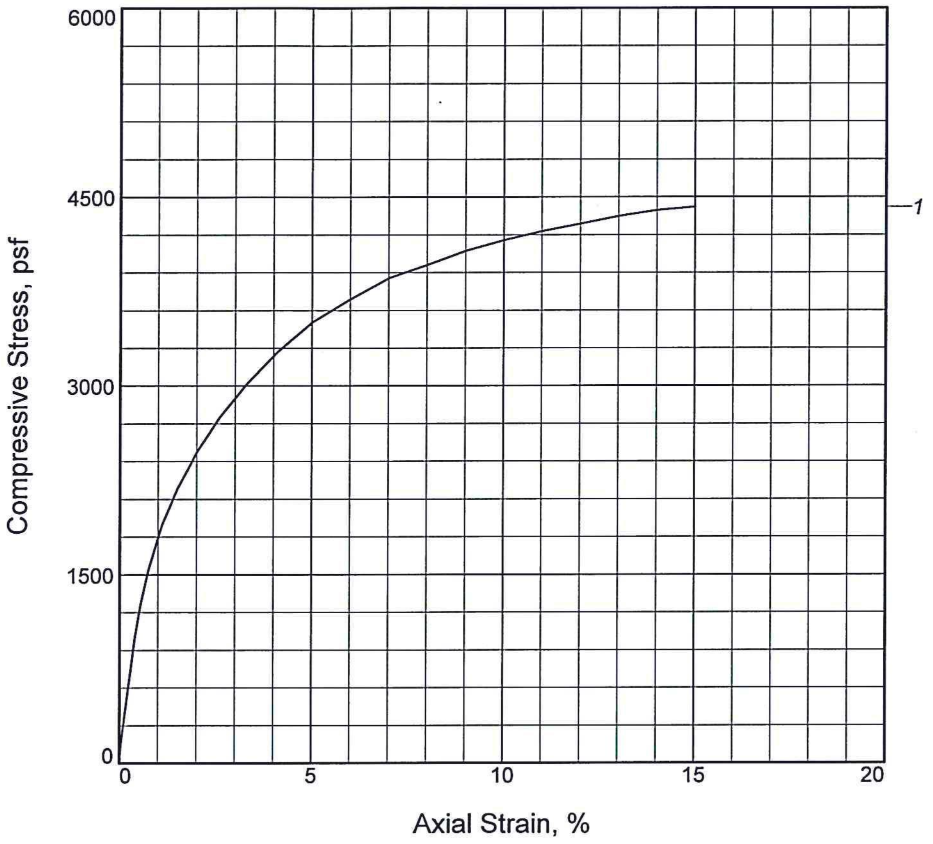
Tested By: TMA **Checked By:** OJK

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	4421			
Undrained shear strength, psf	2211			
Failure strain, %	15.0			
Strain rate, in./min.	0.050			
Water content, %	24.0			
Wet density, pcf	123.6			
Dry density, pcf	99.6			
Saturation, %	92.8			
Void ratio	0.7043			
Specimen diameter, in.	2.83			
Specimen height, in.	5.60			
Height/diameter ratio	1.98			

Description: Lean to fat clay, stiff, gray, moist

LL =	**PL =**	**PI =**	**Assumed GS=** 2.72	**Type:** ST

Project No.: 218178G
Date Sampled: 9/27/18
Remarks:

Figure _______

Client: John Knox Village

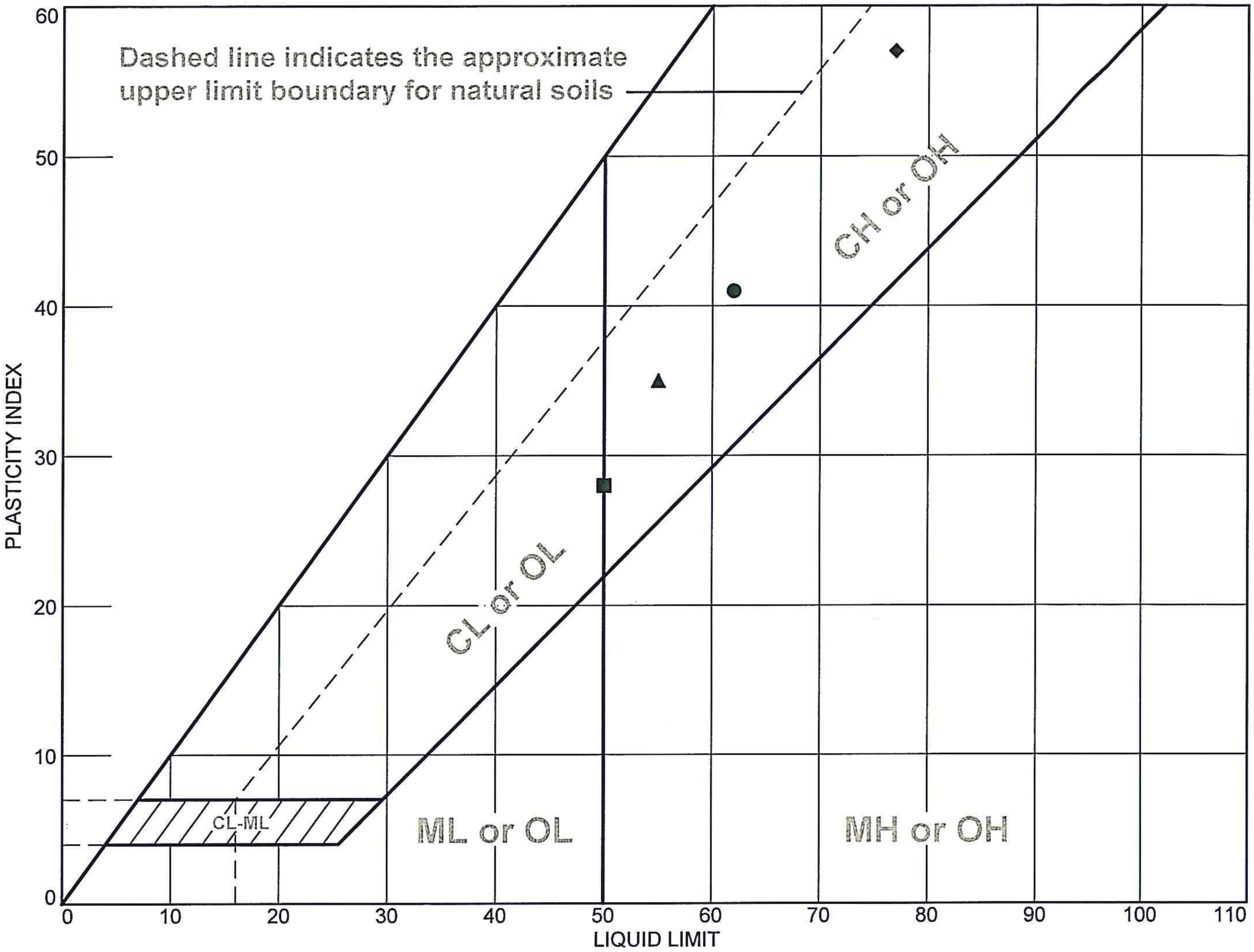
Project: JKV Village Assisted Living 400 Unit

Source of Sample: B-9 **Depth:** 3
Sample Number: 2

UNCONFINED COMPRESSION TEST
KRUGER TECHNOLOGIES, INC.
LENEXA, KS

Tested By: TMA **Checked By:** OJK

LIQUID AND PLASTIC LIMITS TEST REPORT ASTM D 4318



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Fill, lean to fat clay, stiff, gray, moist	62	21	41			CH
■	Fat clay, stiff, olive gray, moist	50	22	28			CL-CH
▲	Fat clay, stiff, gray, moist	55	20	35			CH
◆	Fill, lean to fat clay, stiff, dark gray, moist	77	20	57			CH

Project No. 218178G **Client:** John Knox Village

Project: JKV Village Assisted Living 400 Unit

● **Source of Sample:** B-1 **Depth:** 1 **Sample Number:** 1
■ **Source of Sample:** B-1 **Depth:** 3 **Sample Number:** 2
▲ **Source of Sample:** B-5 **Depth:** 3 **Sample Number:** 1
◆ **Source of Sample:** B-9 **Depth:** 1 **Sample Number:** 1

KRUGER TECHNOLOGIES, INC.

LENEXA, KS

Remarks:

Figure

GLOSSARY OF GEOTECHNICAL TERMS

ALLUVIUM	Sediments deposited by streams, including riverbeds and floodplains.
ARGILLACEOUS	Rocks composed of or having a notable portion of fine silt and/or clay in their composition.
ATTERBERG LIMITS	Water contents, in percentage of dry weight of soil, that correspond to the boundaries between the states of consistency, i.e. the boundary between the liquid and plastic states (liquid limit) and the boundary between the plastic and solid states (plastic limit).
BEDROCK-IN-PLACE	Continuous rock mass which essentially has not moved from its original depositional position.
CALCAREOUS	Containing calcium carbonate determined by effervescence when tested with dilute hydrochloric acid.
CHANNEL SANDSTONE	Sandstone that has been deposited in a streambed or other channel eroded into the underlying beds.
COLLUVIAL	Rock debris of various sizes loose from in-place bedrock mass, often shifted down gradient in conjunction with soil.
CROSS-BEDDING	Stratification which is inclined to the original horizontal surface upon which the sediment accumulated.
FISSILE BEDDING	Term applied to bedding which consists of laminae less than 2 millimeters in thickness.
FORMATION	A distinctive body of rock that serves as a convenient unit for study and mapping.
FOSSIL DETRITUS	The accumulation of broken, fragmented fossil debris.
FOSSILIFEROUS	Containing organic remains.
GLACIAL ERRATIC	A transported rock fragment different from the bedrock on which it lies, either free or as part of a sediment.
GLACIAL TILL	Nonsorted, nonstratified sediment carried or deposited by a glacier.
GLACIOFLUVIAL	Primarily deposited by streams from glaciers.
GROUP	A lithostratigraphic unit consisting of two or more formations.
JOINT	A fracture in a rock along which no appreciable displacement has occurred.
LIMESTONE	A sedimentary rock composed mostly of calcium carbonate ($CaCO_3$).

LOESS	A homogenous, nonstratified, unindurated deposit consisting predominantly of silt, with subordinate amounts of very fine sand and/or clay.
MICA	A mineral group, consisting of phyllosilicates, with sheetlike structures.
MEMBER	A specially developed part of a varied formation is called a member, if it has considerable geographic extent.
NODULE	A small, irregular, knobby, or rounded rock that is generally harder than the surrounding rock.
PERMEABILITY	The capacity of a material to transmit a fluid.
RECOVERY	The percentage of bedrock core recovered from a core run length.
RELIEF	The difference in elevation between the high and low points of a land surface.
RESIDUAL SOIL	Soil formed in place by the disintegration and decomposition of rocks and the consequent weathering of the mineral materials.
ROCK QUALITY DESIGNATION (RQD)	Refers to percentage of core sample recovered in unbroken lengths of 4 inches or more.
SANDSTONE	Sedimentary rock composed mostly of sand sized particles, usually cemented by calcite, silica, or iron oxide.
SERIES	A time-stratigraphic unit ranked next below a system.
SHALE	A fine-grained plastic sedimentary rock formed by consolidation of clay and mud.
STRATIGRAPHY	Branch of geology that treats the formation, compositions, sequence, and correlation of the stratified rocks as parts of the earth's crust.
SYSTEM	Designates rocks formed during a fundamental chronological unit, a period.
UNCONFORMITY	A surface of erosion or nondeposition, usually the former, which separates younger strata from older rocks.
WEATHERING	The physical and chemical disintegration and decomposition of rocks and minerals.

General Notes

Laboratory Test Symbols	
Symbol	**Definition**
LL	Liquid Limit (ASTM D4318)
PL	Plastic Limit (ASTM D4318)
PI	Plasticity Index (LL minus PL)
Qu	Unconfined Compressive Strength, Pounds per Square Foot (psf)
Qp	Pocket Penetrometer Reading, Tons per Square Foot (TSF)
RQD	Rock Quality Designation % (Sum of rock core pieces >4 inches/length of core run)

Common Soil Classification Symbols

Clay	
Symbol	**Soil Type**
CL	Low plasticity clay
CL-ML	Low plasticity clay and silt
CL/CH	Medium plasticity clay
CH	High plasticity clay

Silt	
Symbol	**Soil Type**
ML	Low plasticity silt
MH	High plasticity silt

Sand	
Symbol	**Soil Type**
SW	Well graded sand
SP	Poorly graded sand
SM	Silty sand
SC	Clayey sand

Gravel	
Symbol	**Soil Type**
GW	Well graded gravel
GP	Poorly graded gravel
GM	Silty gravel
GC	Clayey gravel

Descriptive Terminology

Cohesionless Soils

Relative Density Term	"N" Value
Very Loose	0 - 4
Loose	5 - 9
Medium Dense	10 - 29
Dense	30 – 49
Very Dense	50 or more

Cohesive Soils

Consistency Term	"N" Value
Very soft	0 – 2
Soft	3 – 4
Medium	5 – 8
Stiff	9 – 15
Very Stiff	16 - 30
Hard	> 30

Relative Proportions and Sizes

Term	Range
Trace	< 5%
A Little	5 – 15%
Some	15 – 30%
With	30 – 50%

Material	Size
Boulder	> 12"
Cobble	3" – 12"
Gravel	4.75 - 76.2 mm
Sand	0.075 – 4.75 mm
Silt and Clay	< 0.075 mm