GEOTECHNICAL EXPLORATION
PROPOSED PETSUITES
LOT 3B NW MCNARY COURT
LEE'S SUMMIT, MISSOURI

Prepared for:

BETA EQUITY INVESTMENTS, LLC
INDIANAPOLIS, INDIANA

Prepared by:

GEOTECHNOLOGY, INC.
OVERLAND PARK, KANSAS

Date:

JUNE 23, 2020

Geotechnology Project No.:

J036943.01

SAFETY
QUALITY
INTEGRITY
PARTNERSHIP
OPPORTUNITY
RESPONSIVENESS

GEOTECHNOLOGY INC
FROM THE GROUND UP

June 23, 2020

Ms. Shannon Netherton
Beta Equity Investments, LLC
501 Pennsylvania Parkway, Suite 160
Indianapolis, Indiana 46280

Re: Geotechnical Exploration
Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri
Geotechnology Project No. J036943.01

Dear Ms. Netherton:

Presented in this report are the results of the geotechnical exploration conducted for the referenced project. This report includes our project understanding, observed site conditions, conclusions and/or recommendations, and support data as given in the Table of Contents.

It has been our pleasure to provide geotechnical services to you, and we would welcome the opportunity to provide other services during the course of the project. Please contact either of the undersigned if you need further information about this document.

Respectfully submitted,

GEOTECHNOLOGY, INC.

MATTHEW H. McQUALITY
NUMBER E-28930

Matt McQuality, P.E.
Office Leader

June 23, 2020

Joel Weinhold, P.E.
Regional Manager

MHM/JAW:mhm/ljd

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June 23, 2020 | Geotechnology Project No. J036943.01

1.0 EXECUTIVE SUMMARY

The executive summary is provided solely for the purposes of overview, and a number of details are omitted, any one of which could be crucial to the proper application of this report.

- The overall project consists of the construction of a single-story, slab-on-grade structure with a footprint of approximately 14,000 square feet, asphalt pavements and a detention basin.
- The stratigraphy generally consists of fill underlain by medium stiff and stiff, fat clay to the depths explored (5 to 15 feet). The fill includes fat clay and rock fragments, and was encountered in each boring to depths of 3 to 9 feet. Auger refusal on coarse fill was encountered at two of the building borings at depths ranging from 3.5 feet to 7 feet.
- Fill remediation is recommended unless documentation exists that supports the existing fill was placed under moisture and density control. The existing fill may be reused for controlled fill provided the material is placed more than 2 feet below floor slab subgrade and more than 9 inches below pavement subgrade.
- The building may be supported on shallow foundations. Strip and spread footings bearing on firm, native soil and/or compacted fill may be proportioned for net allowable bearing pressures of 2,000 and 2,500 pounds per square feet (psf), respectively.
- Based on the results of the borings, and the general procedures of the 2018 Edition of the International Building Code (IBC), the soil profile at the project site may be defined as Site Class D (Stiff Soil).

2.0 PROJECT DATA

2.1 Authorization

The services documented in this report were provided in general accordance with the scope of services described in Geotechnology's proposal P036943.01 dated June 1, 2020. The project was authorized by a representative of Beta Equity Investments, LLC (Beta).

2.2 Purpose and Scope of Services

The purpose of our services was to develop recommendations for geotechnical aspects of the design and construction of the commercial development as defined in the scope of services of the referenced proposal. Briefly, geotechnical services consisted of drilling eight borings, laboratory testing, engineering analyses and preparation of this report.

2.3 Project Description and Site Location

The overall project includes the construction of a commercial development in Lee's Summit, Missouri. The project site is an approximately 2.13-acre undeveloped tract located at the west end of NW McNary Court approximately 500 feet west of its intersection with NW Commerce Drive. The site is grassed and relatively flat. The site location and general topography of the area as per the 2017 U.S.G.S. maps of the vicinity are shown on Figure 1.

Project details are being finalized. However, we understand the commercial development will include the construction of a single-story, slab-on-grade building with a footprint of approximately 14,000 square feet. Asphalt pavements, which will be subject to relatively lightly loaded automobiles, pick-up trucks and SUVs, will abut the east and south sides of the building. A future detention basin is planned further south of the south pavement area.

Planned grades were not provided. Other than up to 15-foot deep excavations for the detention area, site grading is anticipated to consist of cut and fill amounts of 3 feet or less. Structural loads were not provided. Based on our experience with similar projects, column and wall loads of up to 100 kips and 8 kips per lineal foot, respectively, are anticipated.

Based on review of aerial photographs publicly available on the internet, grading has occurred at the site. The depth of fill placement and/or excavations, however, is unknown. In addition, existing storm sewers occur at the site.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 Field Exploration

The field exploration included drilling eight borings, designated as Borings B-1 through -8, at approximately the locations shown on Figure 2. An engineer from Geotechnology located the borings in the field by measuring distances from site features. Elevations at the boring locations were not determined. A registered land surveyor should establish the boring locations if accurate measurements are required.

The borings were drilled using a track-mounted CME 55 rotary drill rig equipped with 4-inch diameter flight augers. Standard Penetration Tests (SPTs) were performed using an automatic hammer. Split-spoon and Shelby tube samples were obtained at the depths indicated on the boring logs presented in Appendix B. An explanation of the terms and symbols used on the boring logs is also included in Appendix B.

An engineer from Geotechnology provided direction during field exploration, observed drilling and sampling, and prepared logs of the material encountered. The boring logs represent conditions observed at the time of exploration and have been edited by a professional engineer to incorporate results of the laboratory tests.

Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials might be gradual or might occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by Geotechnology in its analyses and should not be used as the basis of design or construction cost estimates without realizing that there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and time where sampling was conducted. The passage of time might result in changes in conditions, interpreted to exist, at or between the locations where sampling was conducted.

3.2 Laboratory Testing

Laboratory testing was performed on the soil samples to estimate engineering and index properties. Moisture content tests were performed on each sample. Atterberg limits tests were performed on selected fine-grained soil samples. Dry unit weight determinations and unconfined compressive strength tests were performed on the Shelby tube samples. Results of the laboratory tests are presented on the boring logs.

4.0 SUBSURFACE CONDITIONS

4.1 Stratigraphy

Below the approximately 2-inch thick root zone, the stratigraphy generally consists of fill underlain by native, fine-grained soils to the depths explored (5 to 15 feet). The fill sampled is generally comprised of fat clay, limestone gravel, shale and shaley clay, and occurs to depths of 3 to 9 feet. At Boring B-7, fill occurs to the 5-foot depth of exploration. Below the fill at Borings B-1 through -4, -6 and -8, native soils comprised of brown and gray, medium stiff and stiff, low and fat clay were encountered.

At Borings B-3 and -5, which were drilled within the building footprint, auger refusal on coarse material initially occurs at approximate depths of 3.5 feet and 5 feet. Each boring was offset 5 feet and redrilled. Boring B-3 was subsequently sampled to the planned depth of 15 feet; however, refusal on coarse material occurs at a depth of approximately 7 feet at the offset location of Boring B-5. The nature of the coarse material was not determined. Based on our experience, auger refusal within fill likely represents a limestone boulder or concrete.

4.2 Groundwater

Groundwater was not observed in the borings during drilling. However, free water trapped in the fill was encountered at approximate depths of 8.5 feet and 6.5 feet in Borings B-2 and -3, respectively. Groundwater levels might not have stabilized, particularly in less permeable fine-grained soil, prior to backfilling. Consequently, the indicated or lack of water levels might not represent present or future levels. Groundwater levels might vary substantially over time due to the effects of seasonal variation in precipitation, recharge or other factors not evident at the time of exploration. Therefore, groundwater levels during construction or at other times in the life of the structure might be higher than the levels indicated on the boring logs. Free water might be trapped in permeable pockets of fill and in utility trenches. Excavations that remain open might collect water.

5.0 DESIGN CONSIDERATIONS AND RECOMMENDATIONS

Geotechnology should be allowed to review final grading and foundation plans to check that our recommendations have been properly implemented. If the structure loads, elevations or locations vary from those discussed, the recommendations herein might require modifications, and/or additional field exploration and related analysis might be required.

Discussion. Fill was encountered to depths of approximately 3 to 9 feet at the boring locations. Fill might extend to greater depths in unexplored locations. Utility trench backfill associated with the existing storm sewer is anticipated in the planned pavement area east of the building footprint. Utility trench backfill associated with an existing storm sewer is also anticipated near the planned trash dumpster area, which is southwest of the building footprint.

The presence of fill and utility trench backfill complicates the project. If fill placement observation and testing records are not available, the fill should be considered uncontrolled and potentially compressible. The risks associated with supporting foundations, floor slabs and pavements on uncontrolled fill include total and differential settlement in excess of tolerable limits. Differential settlement can lead to cosmetic and structural distress, including substantial cracking in walls, floor slabs and pavements.

In addition, the fill is fat. These materials have the potential for volume change due to fluctuations in moisture content throughout the life of the structure. Swelling and consequent heaving of floors and pavements can occur when a fat clay subgrade absorbs moisture. Alternatively, shrinkage and consequent loss of subgrade support can occur when a fat clay subgrade desiccates. Options for fill remediation are discussed herein.

5.1 Site Grading

Site Preparation. In general, the site should be stripped of the root zone, existing fill, soft soil, and other deleterious materials. Proofrolling with a tandem axle dump truck loaded to approximately 20,000 pounds per axle (or equivalent proofrolling equipment) can be considered as a means of evaluating the subgrade. Soft areas that develop and areas that exhibit deflection should be overexcavated and backfilled with soil fill or well-graded crushed limestone compacted to the density listed in Table 1.

Existing Fill. The more positive approach for site development is the complete removal and replacement of the existing fill and backfill. Partial removal and replacement of the fill and backfill can be considered in pavement areas only. In exchange for the cost savings associated with remediating only a portion of the fill, the client must recognize that partial remediation will require acceptance of a greater risk for pavement distress compared to full-depth overexcavation and replacement. For such an alternative, fill and backfill in pavement areas could be removed to a depth of 2 feet below planned subgrade. If the client is willing to accept an even greater risk of pavement distress, existing fill and backfill in pavement areas could be proofrolled and soft spots remediated as discussed herein.

Greater depths of removal and replacement may be required based on observation during proofrolling and/or excavation. Open-graded rock occurring at the base of excavations should be covered with filter fabric to reduce the potential for the migration of fines into the voids.

Remediation of Fat Clay. Regardless if records exist documenting that the fill was placed under moisture and density control, fat clay should be remediated to a depth of at least 2 feet below floor slab subgrade. As a measure to improve performance, fat clay could also be remediated to a depth of 9 inches below new pavement sections. The overexcavations may be backfilled with lean clay (liquid limit less than 45 percent) or well-graded crushed limestone with a 2-inch maximum particle size. Chemical remediation of fat clay using lime or fly ash is not advised due to the urban nature of the project and the potential for these caustic materials to become airborne. Additionally, the potential for excess soils where overexcavation is required should be considered in final grading plans if a balanced site is required.

Suitable Fill Materials. On-site materials generated from excavations are expected to include fat clay, shaley clay, shale, limestone and concrete. Fat clay, shaley clay and shale may be used for fill provided the material is moisture conditioned and free of deleterious materials. Due to its expansive nature, however, these materials should be restricted to a depth of 2 feet or more below floor slab subgrade and below a depth of 9 inches or more below the pavement section. Pieces of limestone and concrete larger than 8 inches in dimensions should be hauled off the site and properly disposed.

Imported fill should consist of lean clay (liquid limit value of 45 percent or less) and well-graded crushed limestone with a 2-inch maximum particle size. Limestone screenings are susceptible to changes in moisture content and are not advised in pavement areas.

Fill and Backfill Placement. Fill or backfill should be placed in uniform lifts and compacted. The loose lift thickness should not exceed 8 inches. The fill should be systematically compacted to the level given in Table 1. The soil should be placed at moisture contents compatible with the required unit weight. Depending on the soil moisture at the time of construction, drying or wetting might be required to achieve compaction. Deleterious material should not be included in fill, and the fill should not be placed on soft materials or frozen ground.

Table 1. Compaction Summary

Category	Minimum Compaction[a]
Fine-Grained Soil	95%[b]
Pavement Subgrade	
Crushed Limestone	95%

[a] Measured as a percent of the maximum unit weight as determined by the standard Proctor test (ASTM D 698).

[b] Moisture content within minus 1 to plus 3 percent of the optimum moisture content.

Trench Backfill. Settlement of trench backfill can result in unsightly depressions and localized slab and pavement failures. The magnitude of settlement can be substantially reduced by mechanical compaction of the trench backfill. In floor slab and pavement areas, well-graded crushed rock compacted to the minimum level specified in the Compaction Summary should be used as trench backfill.

Poorly-graded (clean) rock must not be used for trench backfill. Clean rock can collect water which can soften the underlying fine-grained soils, or lead to the migration of fines and loss of subgrade support, or in the presence of fat clay, could lead to heaving. Clean rock in existing utility trenches should be removed and the overexcavation backfilled as discussed herein.

Subgrade Protection. Drainage of the construction areas should be provided to protect foundation, floor slab and pavement subgrades from the detrimental effects of weather during construction. Finished subgrades and foundation excavations should be kept free of standing water. Concrete should be placed in foundation excavations the same day they are completed. Subgrades will be exposed to weather and disturbances from the installation of utilities and normal construction traffic. Disturbance is relatively easy to repair in drier months by reworking of the upper soils. During wetter periods of the year, such as spring and winter, considerable difficulty can be experienced. Construction traffic should be routed away from prepared subgrades.

Collection and Disposal of Site Water. Managing site water is important in the successful performance of foundation and pavement systems. Water from surface runoff, downspouts and subsurface drains should be collected and discharged through a site drainage system. Water should not be allowed to pond next to pavements.

Control of surface runoff should be maintained in compliance with the rules and regulations set forth in the Federal Water Pollution Control Act. Additionally, permits related to site grading activities and control of stormwater during construction activities should be obtained from the applicable governmental jurisdiction(s).

5.2 Temporary Excavations

If site geometry permits, it might be possible to lay slopes back to a stable configuration. The soil type encountered during excavations is anticipated to consist of fill and native, medium stiff and stiff clay. The existing fill classifies as OSHA Type C soil and the native clay classifies as OSHA Type B soil. Temporary slopes in OSHA Type B soil type may be constructed at 1V:1H or flatter. Excavations in and/or terminating in Type C soil and any excavation that extends below the groundwater surface should be sloped at 1V:1.5H or flatter. Benched excavations in OSHA Type C soil and benched excavations below groundwater are not permitted.

The provided soil classification is the professional opinion of Geotechnology. Soil classification relative to temporary slope configuration and worker safety is the responsibility of the contractor. The contractor should be aware that excavation depths and inclinations must comply with local, state or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced and, if not followed, the contractor, or earthwork or utility subcontractors, could be subjected to substantial penalties. Construction site safety is the responsibility of the contractor, who shall also be solely responsible for the means, methods and sequencing of construction operations.

Materials can vary across the excavation, and even if the OSHA criteria are used, there is a potential for slope failure. Temporary slopes left open could undergo sloughing and result in an unstable situation. The contractor should evaluate stability and failure consequences before open cut slopes are made. Minor sloughing of open face slopes can occur. If the slope is expected to remain open for an extended time an impermeable membrane covering the slopes could be considered as a means to reduce the potential for slope degradation and instability.

5.3 Shallow Foundations

Allowable Bearing Pressure. Strip and spread footings may be proportioned for net allowable bearing pressures of 2,000 and 2,500 psf, provided the footings are bearing on firm, native soil or compacted fill as discussed herein. The minimum lateral dimensions for strip and spread footings should be 18 and 24 inches, respectively. As a measure to provide protection from seasonal moisture variations and frost penetration, exterior footings and footings in unheated interior areas should bear at least 36 inches below grade.

Construction Considerations. If soft soil is encountered at footing bearing elevations, footing excavations should be extended through these materials to firm, native soil and the overexcavation backfilled with concrete or lean concrete.

Settlement. Footings, proportioned and constructed as recommended herein, could settle approximately 1 inch. Differential settlement between footings could be approximately 3/4 inch. Estimated values of settlement contained in this report are based on our experience with projects of a similar nature.

Lateral Resistance. Lateral loads may be resisted by available frictional resistance between the base of the footing and the bearing material. Resistance to sliding can be computed assuming an ultimate coefficient of friction of 0.35; however, the maximum resistance should be limited to 500 psf. Ultimate passive resistance, if required, can be computed assuming an equivalent fluid pressure of 300 pounds per cubic foot. Safety factors should be applied to determine the allowable sliding and passive resistances. Passive resistance in the top 36 inches of soil should be neglected due to seasonal variations in moisture and frost penetration.

Uplift Resistance. Uplift loads can be resisted with the dead weight of the footings and the structure, and frictional resistance between the sides of the footings and the soil. An allowable resistance of 350 psf can be used for frictional resistance between the sides of the footings and the soil, provided the footings are earth-formed or compacted backfill is placed around them. Frictional resistance in the top 36 inches of soil should be neglected due to seasonal variations in moisture and frost penetration.

5.4 Floor Slabs

The existing fill should be remediated as previously discussed. Floor slabs can be designed using a vertical subgrade modulus of 100 pounds per cubic inch (pci). Floor slabs should be underlain by a 4- to 6-inch layer of compacted well-graded crushed rock. A 15-mil or thicker plastic vapor barrier can be placed below the floor in interior finished areas to reduce the potential for moisture permeation through the slab and for mold growth within the building. Floor slabs should be structurally separated from walls, columns, footings and penetrations to allow independent movement of the floor. Alternatively, floor slabs that are not structurally independent should be designed to allow for differential movements that normally occur between the floor slabs, columns and foundation walls.

5.5 Pavement Considerations

Pavement design and analysis were beyond the scope of our services. Standard asphaltic concrete and Portland cement concrete (PCC) pavement design for a given service life requires evaluation of the soil by CBR tests or other methods, estimates of daily traffic volumes and axle weights, drainage requirements, and the desired level of maintenance.

Based on the results of the laboratory tests and our local experience, asphaltic pavement sections may be designed assuming a CBR value of 2, which is typical for fat clay soils in the Kansas City region. Where heavy wheel loads are concentrated, particularly at approaches to trash dumpsters, concrete pavement should be used. The concrete pavement may be designed assuming a vertical subgrade modulus of 75 pci where concrete is placed on a clay subgrade and 100 pci where 6 inches of a granular subbase is used.

Regardless of which pavement sections are selected, the soil subgrade should be stable and compacted as specified in Table 1 to a depth of at least 8 inches. In addition, pavement subgrades comprised of fat clay could be remediated as discussed herein. Pavement service life can decrease substantially if the pavement is constructed on a poor subgrade, if it has poor surface or subsurface drainage, and/or if the pavement is not maintained. Periodic maintenance, such as filling cracks and sealing, is required for a pavement section to achieve its design life.

The soil subgrade should be sloped to provide drainage. Asphaltic concrete should be checked during placement to verify density and total thickness.

If pavements are not constructed immediately after grading, the subgrade should be shaped to prevent ponding. Minor ponding, of even short duration, can cause softening of a soil subgrade to a substantial depth. If there is substantial lapse of time between grading and paving, or if the subgrade is disturbed by construction activities, the subgrade should be proofrolled. Soft spots observed during initial construction or proofrolling should be removed and replaced with compacted soil of the same type present in the subgrade, possibly combined with a geotextile or geogrid. The rock base course and soil subgrade should be compacted to the levels given in Table 1.

Depending on when the pavement is constructed, the subgrade might not support construction equipment such as rock trucks or asphalt trucks, which have substantially heavier axle loads than those vehicles that the pavement section is expected to support. Such conditions will be more apparent during wetter periods of the year. Overexcavation of soft subgrade and placement of additional base course and/or geogrid could be required to construct pavements during these periods.

Minimum Recommended Pavement Thicknesses. Parking lot traffic consisting primarily of personal vehicles (SUVs, automobiles and pick-up trucks) is anticipated. The following pavement sections for parking lots are recommended.

Table 2. Recommended Full-Depth Asphaltic Concrete Pavement Sections

Material	Drive Lanes	Parking Stalls
Asphalt Surface Course	2 inches	2 inches
Asphalt Base Course	6 inches	4 inches
Compacted Pavement Subgrade	8 inches	

Areas subjected to heavy wheel loads and/or turning traffic should be constructed with thicker asphaltic concrete pavement or PCC pavement. These recommended minimum pavement sections follow.

Table 3. Recommended Pavement Sections for Areas Subject to Heavy Traffic

Pavement Type	Material	Pavement Section
Rigid	Portland Cement Concrete	6 inches
	Well-Graded Crushed Stone (GW)	6 inches
	Compacted Pavement Subgrade	8 inches
Flexible	Asphalt Surface Course	2 inches
	Asphalt Base Course	8 inches
	Compacted Pavement Subgrade	8 inches

The pavement sections provided in this report represent minimum recommended thicknesses and, as such, regular maintenance should be anticipated. Pavements should be sloped to provide drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. Maintenance of pavements should include sealing of cracks and joints and preservation of surface drainage.

5.6 Seismicity

Per the general procedures of the 2018 edition of the IBC, the soil profile at the project site can be defined as Class D (Stiff Soil). Based on the computer program *U.S. Seismic Design Maps Web Application* prepared by the United States Geological Survey (USGS), the mapped maximum considered earthquake spectral response acceleration is approximately 9.9 percent gravity (0.099 g) at short periods (S_S) and 6.8 percent gravity (0.068 g) at 1-second periods (S_1).

5.7 Slopes

Slope stability analysis of the existing and/or proposed slopes is beyond the scope of services. Stability of a slope depends on many factors, including the slope geometry, slope height, soil type, and surface pressures, if any. In general, permanent cut and fill slopes, constructed at 1 vertical (V) on 3 horizontal (H), have been observed to perform satisfactorily. Therefore, it is our opinion that, as a minimum, slopes should be constructed at 1V:3H or flatter.

Cut slopes may be designed similar to fill slopes. However, the potential for sloughing and/or general slope failure increases with an increase in the steepness and depth of cut, particularly if low strength soil or rock and/or if groundwater occurs in or near the base of the slope.

6.0 RECOMMENDED ADDITIONAL SERVICES

The conclusions and recommendations given in this report are based on: Geotechnology's understanding of the proposed design and construction, as outlined in this report; site observations, interpretation of the exploration data, and our experience. Since the intent of the design recommendations is best understood by Geotechnology, we recommend that Geotechnology be included in the final design and construction process, and be retained to review the project plans and specifications to confirm that the recommendations given in this report have been correctly implemented. We recommend that Geotechnology be retained to participate in prebid and preconstruction conferences to reduce the risk of misinterpretation of the conclusions and recommendations in this report relative to the proposed construction of the subject project.

Since actual subsurface conditions between boring locations may vary from those encountered in the borings, our design recommendations are subject to adjustment in the field based on the subsurface conditions encountered during construction. Therefore, we recommend that Geotechnology be retained to provide construction observation services as a continuation of the design process to confirm the recommendations in this report and to revise them accordingly to accommodate differing subsurface conditions. Construction observation is intended to enhance compliance with project plans and specifications. It is not insurance, nor does it constitute a warranty or guarantee of any type. Regardless of construction observation, contractors, suppliers, and others are solely responsible for the quality of their work and for adhering to plans and specifications.

7.0 LIMITATIONS OF REPORT

This report has been prepared on behalf of, and for the exclusive use of the client for specific application to the named project as described herein. If this report is provided to other parties, it should be provided in its entirety with all supplementary information. In addition, the client should make it clear that the information is provided for factual data only, and not as a warranty of subsurface conditions presented in this report.

Geotechnology has attempted to conduct the services reported herein in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing in the same locality and under similar conditions. The recommendations and conclusions contained in this report are professional opinions. The report is not a bidding document and should not be used for that purpose.

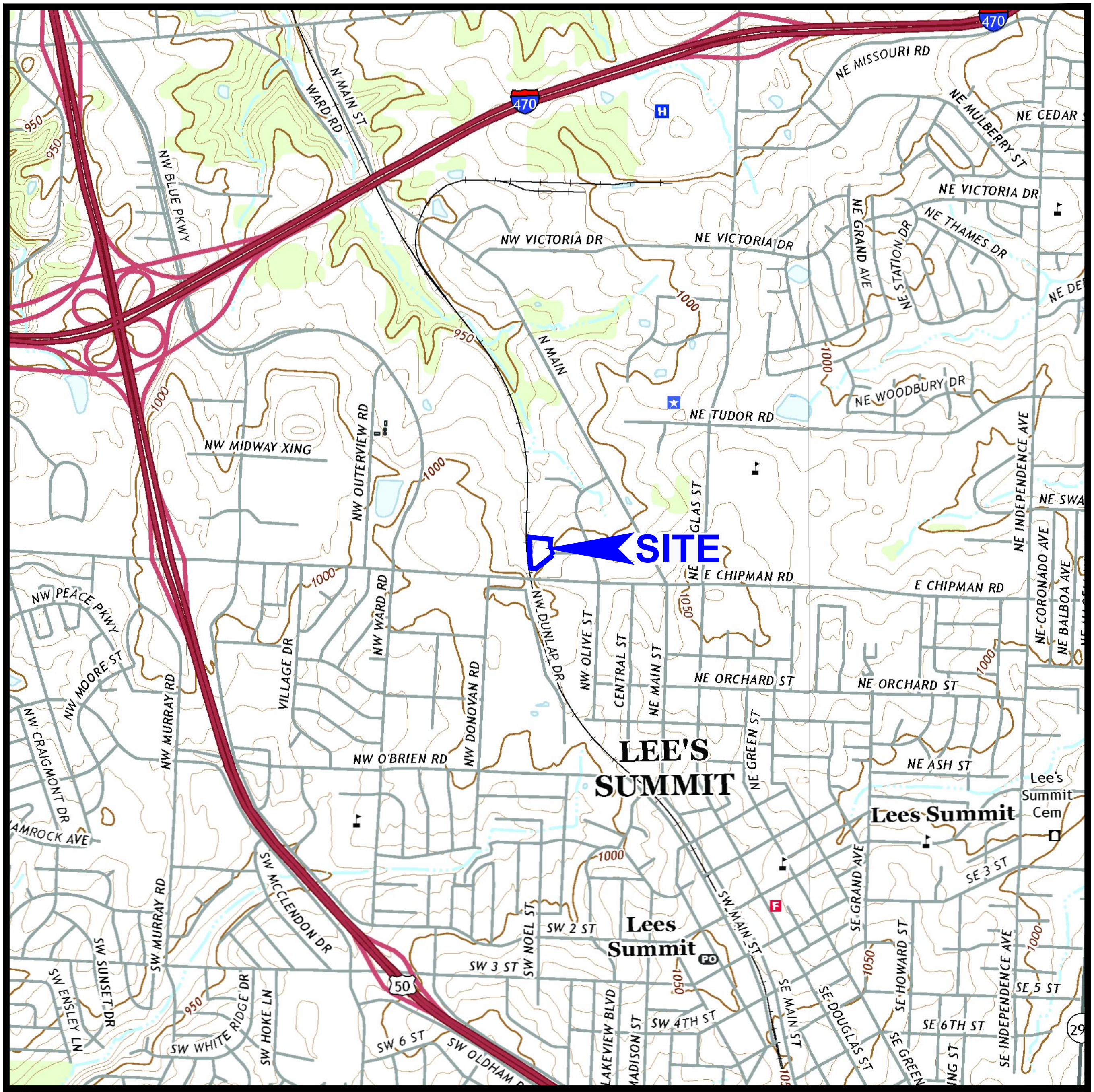
Our scope of service for this phase of the project did not include any environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements in this report or on the boring logs regarding odors noted or unusual or suspicious items or conditions observed are strictly for the information of our client. Our scope of service did not include an assessment of the effects of flooding and erosion of creeks or rivers adjacent to or on the project site.

The analyses, conclusions, and recommendations contained in this report are based on the data obtained from the subsurface exploration. The field exploration methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Consequently, subsurface conditions may vary gradually, abruptly, and/or nonlinearly between sample locations and/or intervals.

The conclusions or recommendations presented in this report should not be used without Geotechnology's review and assessment if the nature, design, or location of the facilities is changed, if there is a substantial lapse in time between the submittal of this report and the start of work at the site, or if there is a substantial interruption or delay during work at the site. If changes are contemplated or delays occur, Geotechnology must be allowed to review them to assess their impact on the findings, conclusions, and/or design recommendations given in this report. Geotechnology will not be responsible for any claims, damages, or liability associated with any other party's interpretations of the subsurface data or with reuse of the subsurface data or engineering analyses in this report.

The recommendations included in this report have been based in part on assumptions about variations in site stratigraphy that may be evaluated further during earthwork and foundation construction. Geotechnology should be retained to perform construction observation and continue its geotechnical engineering service using observational methods. Geotechnology cannot assume liability for the adequacy of its recommendations when they are used in the field without Geotechnology being retained to observe construction.

A copy of "Important Information about This Geotechnical-Engineering Report" that is published by the Geotechnical Business Council (GBC) of the Geoprofessional Business Association (GBA) is included in Appendix A for your review. The publication discusses some other limitations, as well as ways to manage risk associated with subsurface conditions.



NOTES

1. Plan adapted from a 7.5 minute U.S.G.S. map for Lee's Summit and Lake Jacomo, Missouri quadrangles, last revised in 2017.

0 2,000 4,000

SCALE IN FEET

N

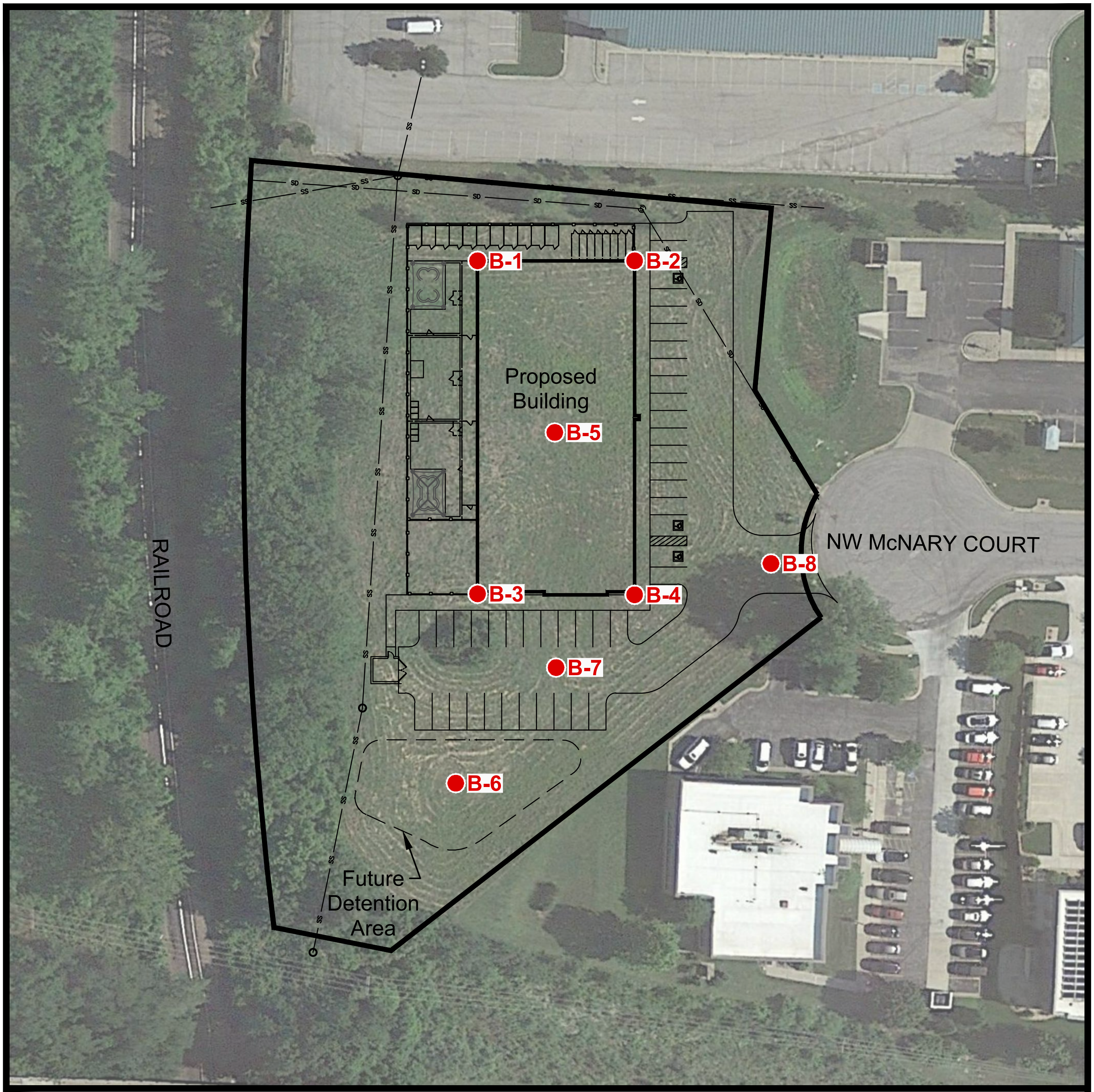
Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 6-12-20	Date: 6-17-20	Date: 6-23-20

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

SITE LOCATION AND TOPOGRAPHY

Project Number J036943.01	FIGURE 1



NOTES

1. Plan adapted from an July 25, 2019 aerial photograph courtesy of Google Earth and from a drawing titled "Concept Plan #5" dated April 6, 2020 and prepared by Premier Design Group.

2. Borings were located in the field with reference to site features and are shown approximate only.

LEGEND

● Boring Location

0 200 400

SCALE IN FEET

N

Drawn By: WAH	Ck'd By: MHM	App'vd By: JAW
Date: 6-12-20	Date: 6-17-20	Date: 6-23-20

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

AERIAL PHOTOGRAPH OF SITE AND BORING LOCATIONS

Project Number
J036943.01

FIGURE 2

APPENDIX A

Important Information about This Geotechnical-Engineering Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GBC GEOTECHNICAL
BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org

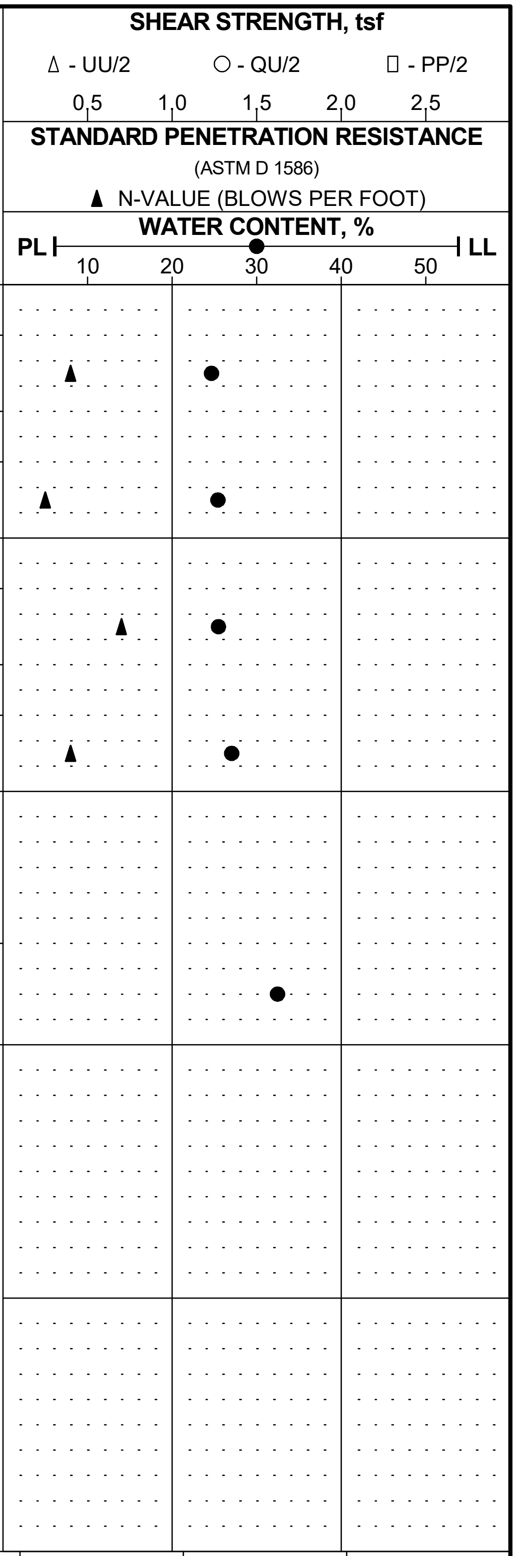
APPENDIX B

Logs of Borings B-1 through -8
Boring Log: Terms and Symbols

Surface Elevation ______ Completion Date: 6/8/20

Datum ______

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - dark brown, fat clay	▩		
			2-3-5	SS1
	some organics		3-2-3	SS2
5				
	some shale		3-4-10	SS3
	rough drilling to 8 feet			
	CLAY - dark brown, lean, medium stiff - CL	▨	4-3-5	SS4
10				
	CLAY - gray and brown, fat, medium stiff - CH	▨		
				ST5
15	Boring terminated at 15 feet.			
20				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ Date: 6/10/20	Check by: MHM Date: 6/17/20	App'vd by: JAW Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-1

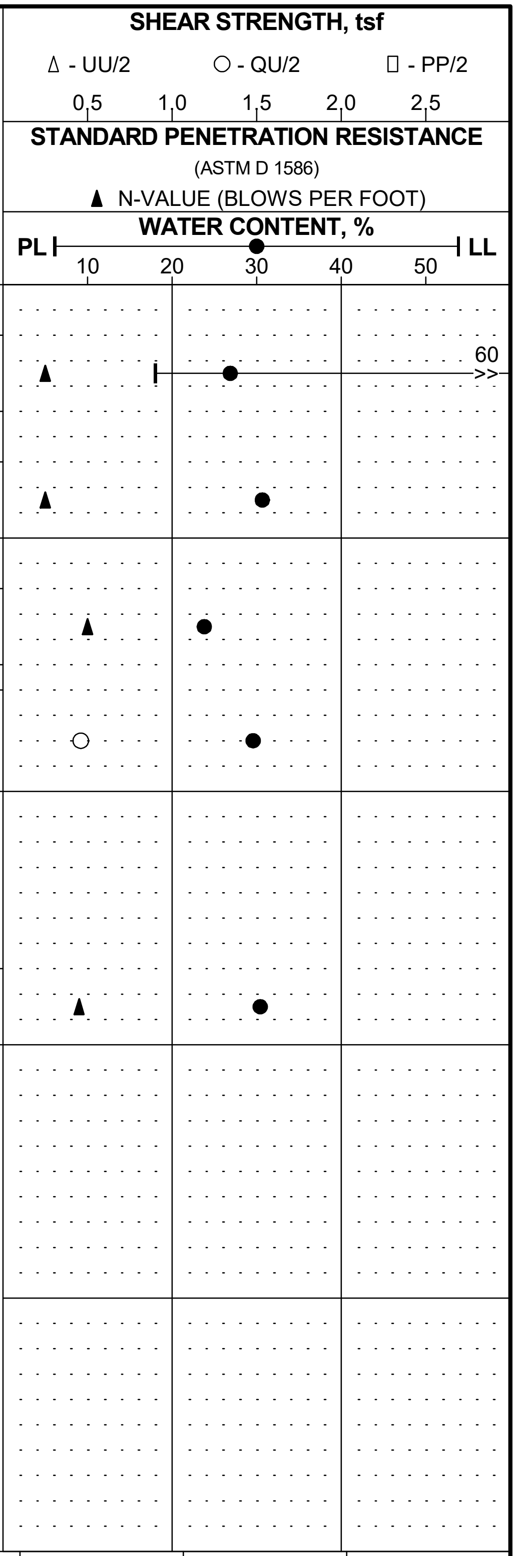
Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: **6/8/20**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - gray and brown to dark brown, fat clay	▩		
		▩	2-2-3	SS1
		▩	2-2-3	SS2
5		▩		
		▩	3-4-6	SS3
	CLAY - brown to mottled gray and brown, fat, medium stiff to stiff - CH ∇	▨	93	ST4
10		▨		
		▨	3-3-6	SS5
15	Boring terminated at 15 feet.			
20				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 8.5 FEET ∇

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ Date: 6/10/20	Check by: MHM Date: 6/17/20	App'vd by: JAW Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-2

Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: **6/8/20**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - brown to dark brown, fat clay	▨		
	poor sample recovery	▨	3-2-3	SS1
		▨	5-2-9	SS2
5	asphalt fragments	▨		
	concrete fragments ∇	▨	2-3-5	SS3
	CLAY - dark brown, lean, stiff - CL	▨	96	ST4
10		▨		
	CLAY - mottled brown and gray, fat, stiff - CH	▨		
		▨	3-3-6	SS5
15	Boring terminated at 15 feet.			
20				

SHEAR STRENGTH, tsf

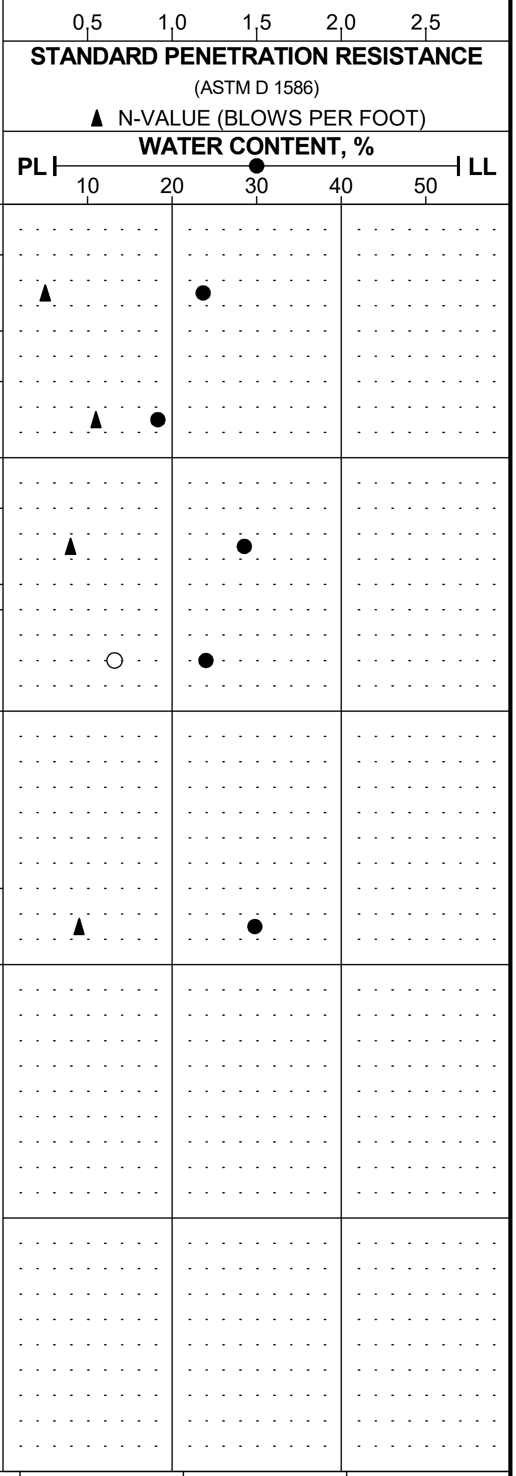
∆ - UU/2 ○ - QU/2 ▯ - PP/2

STANDARD PENETRATION RESISTANCE

(ASTM D 1586)

▲ N-VALUE (BLOWS PER FOOT)

WATER CONTENT, %



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

ENCOUNTERED AT 6.5 FEET ∇

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS: Auger refusal on coarse fill initially occurs at a depth of approximately 3.5 feet. The boring was offset 5 feet to the north and completed.

Drawn by: RFJ Date: 6/10/20	Check by: MHM Date: 6/17/20	App'vd by: JAW Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-3

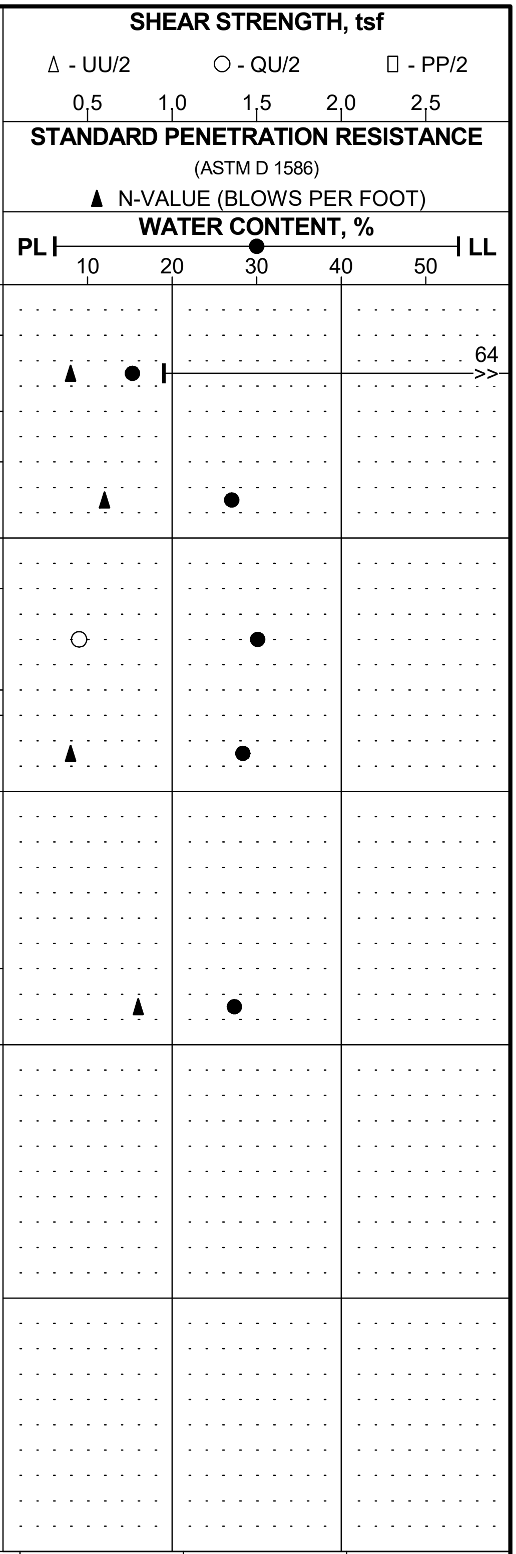
Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: **6/8/20**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - brown, fat clay, trace limestone gravel			
			2-3-5	SS1
			3-5-7	SS2
	CLAY - brown, lean, stiff - CL			
5	CLAY - brown, fat, medium stiff - CH			
			93	ST3
	trace gravel			
			4-3-5	SS4
10				
	shaley, very stiff			
			4-6-10	SS5
15	Boring terminated at 15 feet.			
20				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ	Check by: MHM	App'vd by: JAW
Date: 6/10/20	Date: 6/17/20	Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-4

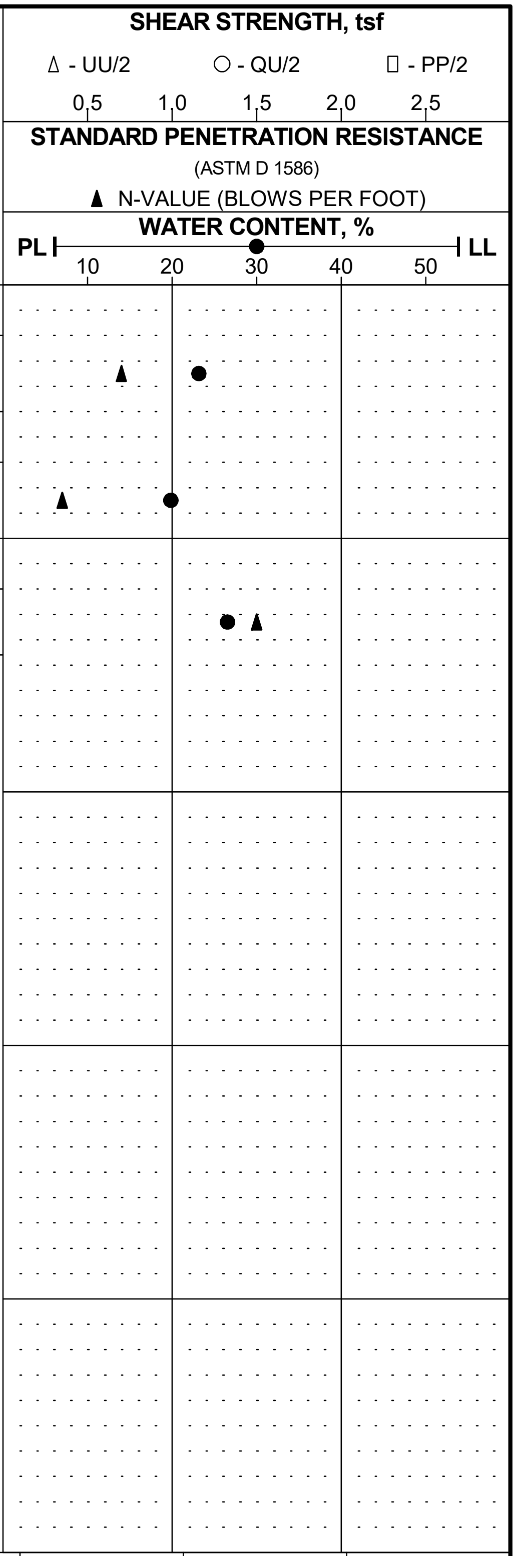
Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: **6/9/20**

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - brown, fat clay	▨		
		▨	2-4-10	SS1
	rough drilling to 2.8 feet	▨		
	some limestone fragments	▨	5-3-4	SS2
5		▨		
		▨	3-5-25/3"	SS3
	Auger refusal and sampler refusal at 7.3 feet.			
10				
15				
20				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS: Auger refusal on coarse fill initially occurs at a depth of approximately 5 feet. The boring was offset 5 feet west and redrilled.

Drawn by: RFJ Date: 6/10/20	Check by: MHM Date: 6/17/20	App'vd by: JAW Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-5

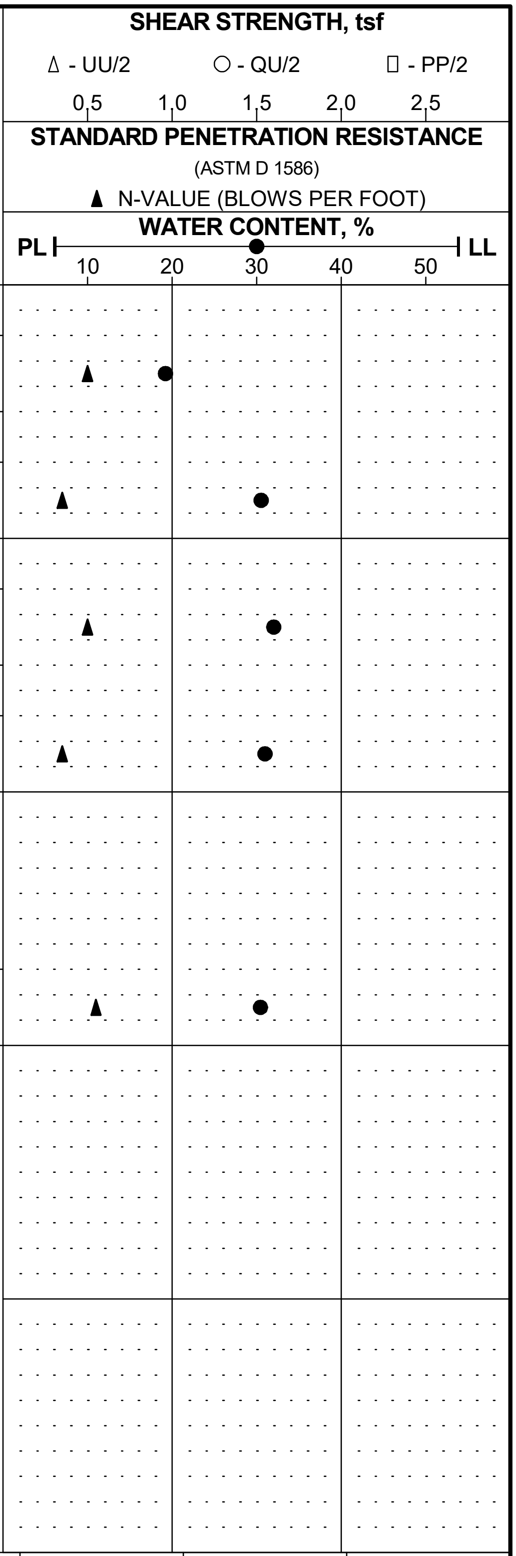
Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: 6/9/20

DEPTH IN FEET	DESCRIPTION OF MATERIAL	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - brown to dark brown, fat clay, rock fragments		
		3-4-6	SS1
		4-3-4	SS2
5			
	CLAY - dark brown, lean, stiff - CL	3-4-6	SS3
	CLAY - grayish brown to brown, fat, medium stiff - CH	2-3-4	SS4
10			
	shaley, stiff	3-4-7	SS5
15	Boring terminated at 15 feet.		
20			



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM
WASHBORING FROM ___ FEET
DJT DRILLER RFJ LOGGER
CME 55 DRILL RIG
HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ	Check by: MHM	App'vd by: JAW
Date: 6/10/20	Date: 6/17/20	Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-6

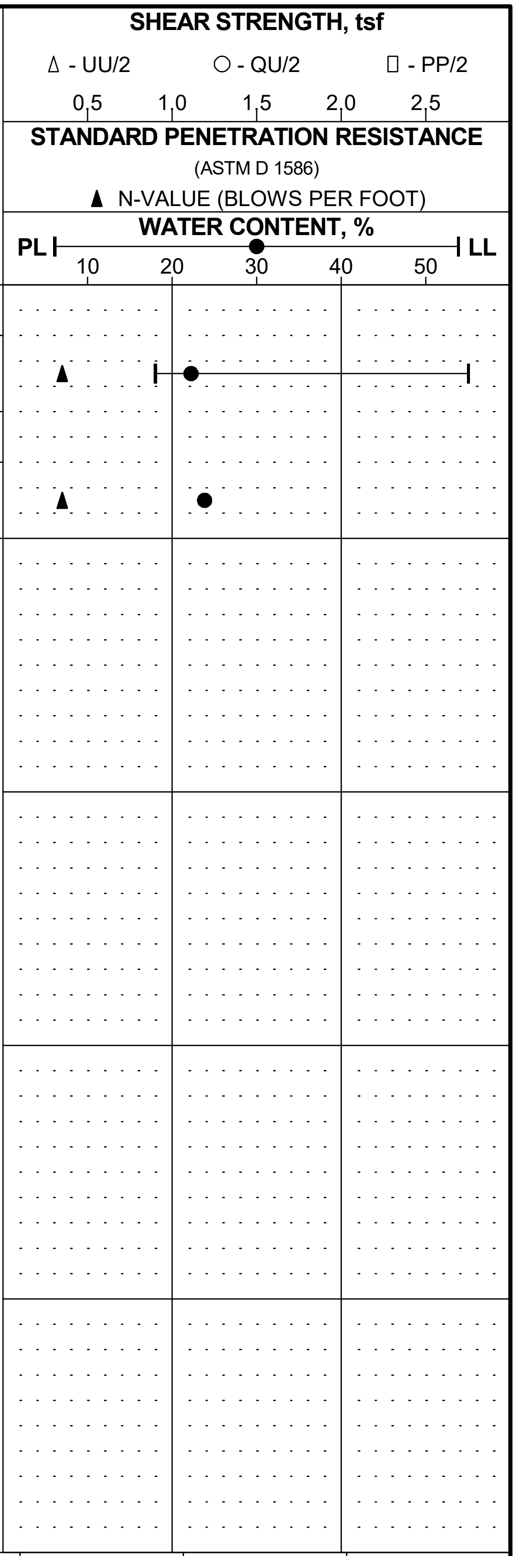
Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: 6/9/20

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - brown and gray, fat clay, trace shale and organics	▨	2-3-4 2-3-4	SS1 SS2
5	Boring terminated at 5 feet.			
10				
15				
20				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ Date: 6/10/20	Check by: MHM Date: 6/17/20	App'vd by: JAW Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-7

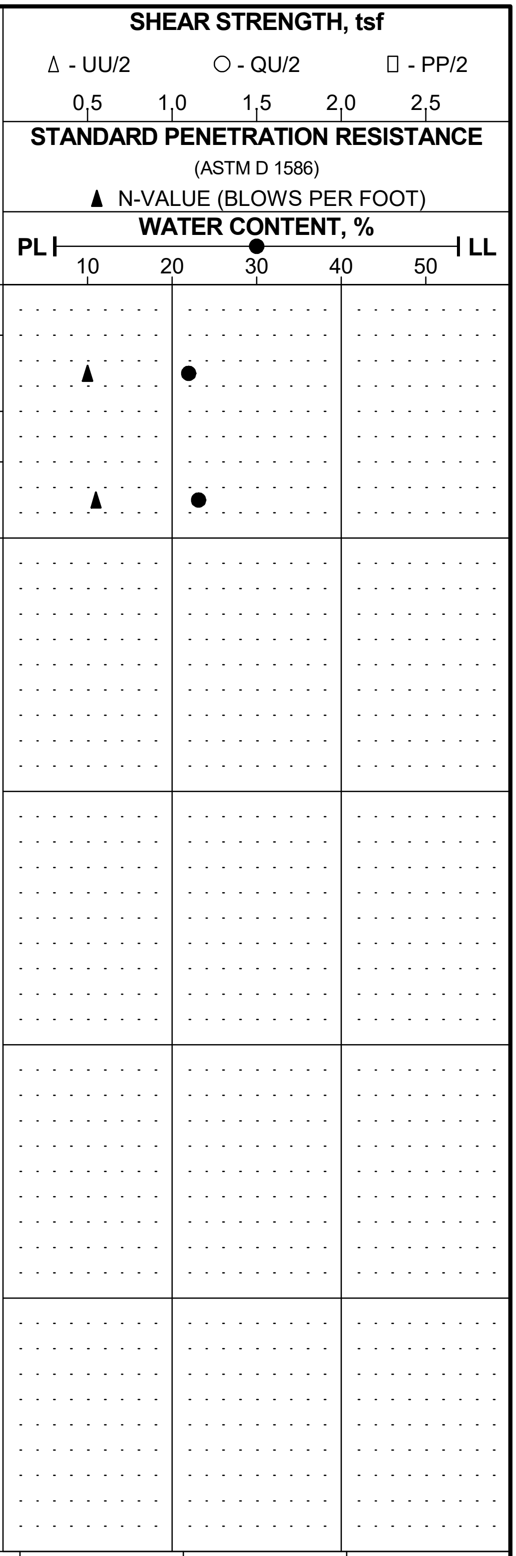
Project No. J036943.01

Surface Elevation ______

Datum ______

Completion Date: 6/9/20

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GRAPHIC LOG	DRY UNIT WEIGHT (pcf) SPT BLOW COUNTS CORE RECOVERY/RQD	SAMPLES
	FILL - dark brown, lean clay, trace limestone gravel	▨	3-4-6	SS1
	CLAY - brown and dark brown, fat, stiff - CH	▨	3-4-7	SS2
5	Boring terminated at 5 feet.			
10				
15				
20				



NOTE: STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. GRAPHIC LOG FOR ILLUSTRATION PURPOSES ONLY.

GROUNDWATER DATA

X FREE WATER NOT ENCOUNTERED DURING DRILLING

DRILLING DATA

4" AUGER ___ HOLLOW STEM

WASHBORING FROM ___ FEET

DJT DRILLER RFJ LOGGER

CME 55 DRILL RIG

HAMMER TYPE Auto

REMARKS:

Drawn by: RFJ Date: 6/10/20	Check by: MHM Date: 6/17/20	App'vd by: JAW Date: 6/23/30

GEOTECHNOLOGY INC
FROM THE GROUND UP

Proposed PetSuites
Lot 3B NW McNary Court
Lee's Summit, Missouri

LOG OF BORING: B-8

Project No. J036943.01

BORING LOG: TERMS AND SYMBOLS

GENERAL NOTES

1. *Information on each boring log is a compilation of subsurface conditions based on soil or rock classifications obtained from the field as well as from laboratory testing of samples. The strata lines on the logs may be approximate or the transition between the strata may be gradual rather than distinct. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.*
2. *Relative composition and Unified Soil Classification designations are based on visual estimates and are approximate only. If laboratory tests were performed to classify the soil, the unified designation is show in parenthesis.*
3. *Value given in Unit Dry Weight/SPT Column is either a unit dry weight in pounds per cubic foot, if adjacent to a ST sample designation, or blows per 6-inch increment if adjacent to a SS sample designation.*

ABBREVIATIONS

UU/2	*Shear Strength from Unconsolidated – Undrained Triaxial Test (ASTM D2850)*
QU/2	*Shear Strength from Unconfined Compression Test (ASTM D2166)*
SV	*Shear Strength from Field Vane (ASTM D2573)*
PL	*Plastic Limit (ASTM D4318)*
LL	*Liquid Limit (ASTM D4318)*

LEGEND

CS	Continuous Sampler
GB	Grab Sample Taken From Auger Cuttings or Wash Water Return
NX 100 42	NX Rock Core with Percent Recovery/R.Q.D. Given In Adjacent Column
PST	Three Inch Diameter Piston Tube Sample
SS	Split Spoon Sample (Standard Penetration Test)
ST	Three Inch Diameter Shelby Tube Sample
*	Sample Not Recovered
SV	Field Vane Test

SPLIT – BARREL SAMPLER DRIVING RECORD

Blow per Foot (N-Value)	*Description*
25	*25 blows drove sampler 12 inches after initial 6 inches of seating.*
75/10"	*75 blows drove sampler 10 inches after initial 6 inches of seating.*
50/S3"	*50 blows drove sampler 3 inches during initial 6 inch seating interval.*

NOTES:
1. *To avoid damage to sampling tools, driving is limited to 50 blows during any six inch interval.*
2. *N-Value (Blow Count) is the standard penetration resistance based on the total number of blows, using a 140-lb hammer with 30-inch free fall, required to drive a split spoon the last two of three, 6-inch drive increments. (Example: 4/7/9, N = 7 + 9 = 16). Values are shown as a summation on grid plot and may be shown as 4/7/9 in Unit Dry Weight – SPT column.*

RELATIVE COMPOSITION

Trace	*0-10 %*
With/Some	*11-35 %*
Soil modifier such As silty, clayey, sandy, etc.	*> 35 %*

DENSITY OF GRANULAR SOILS

Descriptive Term:	***N—Value***
Very Loose	*0 - 4*
Loose	*5 - 10*
Medium Dense	*11 - 30*
Dense	*31 - 50*
Very Dense	*> 50*

STRENGTH OF COHESIVE SOILS

Consistency	***Undrained Shear Strength Tons Per Sq. Ft.***	***Field Test***	***Approximate N-Value Range***
Very Soft	*less than 0.12*	*Thumb will penetrate soil more than 1"*	*0 - 1*
Soft	*0.13 to 0.25*	*Thumb will penetrate soil about 1"*	*2 - 4*
Medium Stiff	*0.26 to 0.50*	*Thumb will penetrate soil about ¼"*	*5 – 8*
Stiff	*0.51 to 1.00*	*Thumb hardly indents soil*	*9 – 15*
Very Stiff	*1.01 to 2.00*	*Thumb will not indent soil, but readily indented with thumbnail*	*16 – 30*
Hard	*greater than 2.00*	*Thumbnail will not indent soil*	*> 30*

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

	12"		3"		¾"		4		10		40		200		
BOULDERS		COBBLES		GRAVEL COARSE		GRAVEL FINE		SAND COARSE		SAND MEDIUM		SAND FINE		SILT	CLAY
	300		76.2		19.1		4.76		2.00		0.42		0.074	0.002	

SOIL GRAIN SIZE IN MILLIMETERS

SOIL STRUCTURE

Calcareous *– Having appreciable quantities of carbonate.*

Fissured *– Containing shrinkage or relief cracks, often filled with sand or silt; usually more or less vertical.*

Slickensided *– Having planes of weakness that appear slick and glossy. The degree of slickensidedness depends upon the spacing of slickensides and the ease of breaking along those planes.*

Layer *-- Inclusion greater than 3 inches thick.*

Seam *– Inclusion 1/8 inch to 3 inches thick extending through the sample*

Parting *– Inclusion less than 1/8 inch thick.*

Pocket *– Inclusion of material of different texture that is smaller than the diameter of the sample.*

Interlayered *– Soil samples composed of alternating layers of different soil types.*

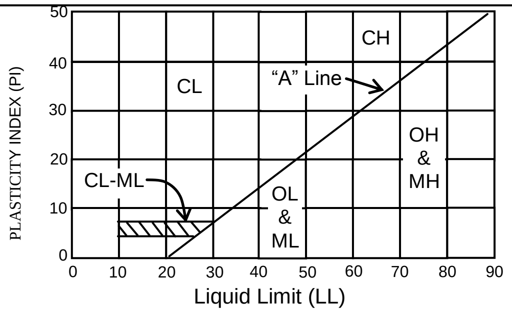
Intermixed *– Soil samples composed of pockets of different soil types and a layered or laminated structure is not evident.*

Laminated *– Soil sample composed of alternating partings or seams of different soil type.*

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOL	DESCRIPTION
Coarse-Grained Soils (More than 50% Larger than No 200 Sieve Size)	Gravel and Gravelly Soils	Clean Gravels Little or no Fines	GW	Well-Graded Gravel, Gravel-Sand Mixture
			GP	Poorly –Graded Gravel, Gravel-Sand Mixture
		Gravels with Appreciable Fines	GM	Silty Gravel, Gravel-Sand-Silt Mixture
			GC	Clayey-Gravel, Gravel-Sand-Clay Mixture
	Sand and Sandy Soils	Clean Sands Little or no Fines	SW	Well-Graded Sand, Gravelly Sand
			SP	Poorly Graded Sand, Gravelly Sand
		Sands with Appreciable Fines	SM	Silty Sand, Sand-Silt Mixture
			SC	Clayey Sand, Sand-Clay Mixture
Fine-Grained Soils (More than 50% Smaller than No 200 Sieve Size)	Silts and Clays	Liquid Limit Less Than 50	ML	Silt, Clayey Silt, Silty or Clayey Very Fine Sand, Slight Plasticity
			CL	Clay, Sandy Clay, Silty Clay, Low to Medium Plasticity
			OL	Organic Silts, or Silty Clays of Low Plasticity
	Silts and Clays	Liquid Limit More Than 50	MH	Silt, Fine Sandy or Silt Soil with High Plasticity
			CH	Clay, High Plasticity
			OH	Organic Clay of Medium to High Plasticity
	Highly Organic Soils		PT	Peat, Humus, Swamp Soil

PLASTICITY CHART



RELATIVE PLASTICITY

Nonplastic	Cannot Roll Into Ball
Trace Plasticity	Barely Roll Into Ball
Medium Plastic	Can be Rolled Into Ball
Highly Plastic	No Rupture by Kneading

VISUAL DESCRIPTION CRITERIA*

TABLE 1: CRITERIA FOR DESCRIBING ANGULARITY OF COARSE-GRAINED PARTICLES

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

TABLE 2: CRITERIA FOR DESCRIBING PARTICLE SHAPE

Description	Criteria
Flat	Particles with width/thickness X3
Elongated	Particles with length/width X3
Flat and Elongated	Particles meet criteria for both flat and elongated

TABLE 3: CRITERIA FOR DESCRIBING MOISTURE CONDITION

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below the water table

TABLE 4: CRITERIA FOR DESCRIBING REACTION WITH HCL

Description	Criteria
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming rapidly

TABLE 6: CRITERIA FOR DESCRIBING CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

*NOTES: 1. Tables adapted from ASTM D2488 "Description and identification of Soils" (Visual-Manual Procedure)
2. Tables 5, 7 and 11 incorporated into other information on this plate.

TABLE 8: CRITERIA FOR DESCRIBING DRY STRENGTH

Description	Criteria
None	The dry specimen crumbles into powder with mere pressure of handling
Low	The dry specimen crumbles into powder with some finger pressure
Medium	The dry specimen breaks into pieces or crumbles with considerable finger pressure
High	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
Very High	The dry specimen cannot be broken between the thumb and a hard surface

TABLE 9: CRITERIA FOR DESCRIBING DILATANCY

Description	Criteria
None	No visible change in the specimen
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

TABLE 10: CRITERIA FOR DESCRIBING TOUGHNESS

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness
High	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness

TABLE 12: IDENTIFICATION OF INORGANIC FINE-GRAINED SOILS FROM MANUAL TESTS

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	None to low	Slow to rapid	Low or thread cannot be formed
CL	Medium to high	None to slow	Medium
MH	Low to medium	None to slow	Low to medium
CH	High to very high	none	High