March 19, 2014

GLMV Architecture
9229 Ward Parkway, Suite 210
Kansas City, Missouri 64114
Phone: 816-444-4200

Attn: Mr. Kile Morrison
Vice President

Re: Geotechnical Engineering Services Report
VA Medical Center Parking Garage
4801 Linwood Boulevard
Kansas City, Missouri 64128
PSI Project Number 338-882

Dear Mr.Morrison:

Thank you for choosing Professional Service Industries, Inc. (PSI) as your consultant for the referenced VA Medical Center Parking Garage project in Kansas City, Missouri. Per your authorization, PSI has completed a geotechnical engineering study for the referenced project. The results of the study are discussed in the accompanying report, three copies of which are enclosed.

Should there be questions pertaining to this report, please contact our office at (913) 310-1600. PSI would be pleased to continue providing geotechnical services throughout the implementation of the project, and we look forward to working with you and your organization on this and future projects.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

Scott Brown, P.E.
Department Manager
Geotechnical Services

Kelly E. Rotert, P.E., DBIA
Vice President

Distribution: (3 hard copies, 1 copy via email)

Geotechnical Services Report

VA Medical Center Parking Garage

4801 Linwood Boulevard

Kansas City, Missouri 64128

PSI Report Number: 338-882
March 19, 2014

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Engineering • Consulting • Testing

GEOTECHNICAL ENGINEERING SERVICES REPORT

for the

VA MEDICAL CENTER PARKING GARAGE
4801 LINWOOD BOULEVARD
KANSAS CITY, MISSOURI 64128

Prepared for

GLMV ARCHITECTURE
9229 WARD PARKWAY, SUITE 210
KANSAS CITY, MISSOURI 64114

Prepared by

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PSI PROJECT NUMBER 338-882

March 19, 2014

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Engineering • Consulting • Testing

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Principal Consultant

Information To Build On

TABLE OF CONTENTS

Page No.

General Notes
Laboratory Data

PROJECT INFORMATION

Project Authorization

The following table summarizes, in chronological order, the Project Authorization History for the services performed and represented in this report by Professional Service Industries, Inc. (PSI).

PROJECT TITLE: VA MEDICAL CENTER PARKING GARAGE, KANSAS CITY, MO		
Document and Reference Number	**Date**	**Requested/Provided By**
Request for Proposal	8/19/2013	Kile Morrison of GLMV Architecture
PSI Proposal Number: 338103682R	2/5/2014	Scott Brown and Kelly Rotert of PSI
Notice to Proceed	2/6/2014	Kile Morrison of GLMV Architecture

Project Description

PSI understands that the project includes construction of a two to three level above-ground parking garage structure. The existing VA medical center is located at 4801 Linwood Boulevard in Kansas City, Missouri. The proposed parking structure is located west of Building 15 of VA Medical within the perimeter of existing parking lot.

The following table lists the material and information provided for this project:

DESCRIPTION OF MATERIAL	PROVIDER/SOURCE	DATE
Aerial Map	GLMV Architecture	8/19/2013
Site Selection Memo	GLMV Architecture	1/30/2014
Structural Loads	Walter P Moore	2/12/2014
Site Plan	GLMV Architecture	2/5/2014

The following table lists the structural loads and site features that are required for or are the design basis for the conclusions of this report:

STRUCTURAL LOAD/PROPERTY	REQUIREMENT/REPORT BASIS		
BUILDING		**R***	**B***
Maximum Column Loads	700 kips	X	
Settlement Tolerances	1 inch total, ¾ inch differential		X
PAVEMENTS			
Pavement 18-kip ESAL (cycle & duration)	30,000 (light), 60,000 (heavy)		X
GRADING			
Planned grade variations at site	Up to 5 feet		X

*"R" = Requirement indicates specific design information was supplied.
"B" = Report Basis indicates specific design information was not supplied; therefore, this report is based on this parameter.

The geotechnical recommendations presented in this report are based on the available project information, parking garage location, and the subsurface materials described in this report. If the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions within the site to evaluate and provide recommendations for site preparation and grading and for design of foundation and pavement section systems for the proposed construction. PSI's contracted scope of services included drilling6soil test borings at the site to depths of about 20 feet below the ground surface, select laboratory testing, and preparation of this geotechnical report. This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions, and presents recommendations regarding the following:

- Grading procedures for site development.
- Foundation types, depths and allowable bearing capacities.
- Seismic parameters for use in design.
- Pavement section design and pavement subgrade preparation.
- Comments regarding geotechnical factors that will impact construction and performance of the proposed construction.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air on, below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. PSI's scope also did not provide any service to investigate or detect the presence of moisture, mold or other biological contaminants in or around any structure, or any service that was designed or intended to prevent or lower the risk of the occurrence or the amplification of the same. Client should be aware that mold is ubiquitous to the environment with mold amplification occurring when building materials are impacted by moisture.

Drilling, Field and Lab Testing Procedures

Drilling and Sampling Procedures

The soil borings were performed with a truck-mounted rotary head drill rig. Borings were advanced using 3¼-inch inside diameter hollow-stem augers. Representative samples were obtained employing split-spoon sampling procedures in general accordance with ASTM procedures.

Field Tests and Measurements

Penetration Tests and Split-Barrel Sampling of Soils

During the sampling procedure, Standard Penetration Tests (SPT) were performed at regular intervals (2½-foot intervals to 10 feet and 5-foot intervals thereafter) to obtain the standard penetration value (N) of the soil. The results of the standard penetration test indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components. The split-barrel sampler provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain while obtaining the sample.

Rock Coring

To explore the material encountered beyond auger refusal, PSI used a diamond studded core barrel attached to the drill rig. PSI performed the sampling in 5-foot runs. The samples were brought to the surface and a recovery length and RQD values were obtained and documented on the field log.

Water Level Measurements

Water level observations were attempted during and upon completion of the drilling operation using a 100-foot tape measure. The depths of observed water levels in the boreholes are noted on the boring logs presented in the appendix of this report. In the borings where water was unable to be observed during the field activities, in relatively impervious soils, the accurate determination of the groundwater elevation may not be possible even after several days of observation. Seasonal variations, temperature and recent rainfall conditions may influence the levels of the groundwater table and volumes of water will depend on the permeability of the soils.

Laboratory Testing Program

In addition to the field investigation, a supplemental laboratory-testing program was conducted to determine additional engineering characteristics of the foundation materials necessary in analyzing the behavior of the soils as it relates to the construction of the proposed structures. The laboratory testing program is as follows:

Laboratory Determination of Water (Moisture) Content of Soil by Mass

The water content is a significant index property used in establishing a correlation between soil behavior and its index properties. The water content is used in expressing the phase relationship of air, water, and solids in a given volume of material. In fine grained cohesive soils, the behavior of a given soil type often depends on its water content. The water content of a soil along with its liquid and plastic limits as determined by Atterberg Limit testing, is used to express its relative consistency or liquidity index.

Atterberg Limits

The Atterberg Limits are defined by the liquid limit (LL) and plastic limit (PL) states of a given soil. These limits are used to determine the moisture content limits where the soil characteristics changes from behaving more like a fluid on the liquid limit end to where the soil behaves more like individual soil particles on the plastic limit end. The liquid limit is often used to indicate if a soil is a low or high plasticity soil. The plasticity index (PI) is difference between the liquid limit and the plastic limit. The plasticity index is used in conjunction with the liquid limit to assess if the material will behave like a silt or clay. The material can also be classified as an organic material by comparing the liquid limit of the natural material to the liquid limit of the sample after being oven-dried.

SITE AND SUBSURFACE CONDITIONS

Site Location and Description

The proposed parking garage is located within the perimeter of the west parking lot just west of Building 15 of VA Medical Center that is located at 4801 Linwood boulevard in Kansas City, Missouri. The property is bordered by a parking lot to the north, Building 6 to the south, Building 15 to the east, and driveway to the west. At the time of drilling, the site was used as a parking lot with asphalt surface and surface runoff appeared to generally flow from north to south. The site latitude and longitude are approximately 39.0628° and -94.5279°, respectively.

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Subsurface Conditions

The site subsurface conditions were explored with six (6) soil test borings drilled within the proposed parking garage area with depths ranging from 1½ feet to 20 feet below the existing grade.

The boring locations and depths were selected by GLMV Architecture. PSI personnel staked the borings in the field by measuring distances from available surface features. The surface elevations at the borings were interpolated from topographical lines shown on the provided site grading plan.

The following table briefly summarizes the range of results from the field and laboratory testing programs. Please refer to the attached boring logs and laboratory data sheets for more specific information:

VA MEDICAL CENTER PARKING GARAGE-KANSAS CITY, MO	Approximate Layer Thicknesses (ft.)	RANGE OF PROPERTY VALUES						
SOIL STRATA TYPE		Rock Quality Designation, (%)	Standard Penetration, N_{60}	Moisture Content, %	Liquid Limit, %	Plastic Limit, %	Dry Unit Weight, pcf	Unconfined Compressive Strength, Qu (tsf)
Asphalt	1/3	-	-	-	-	-	-	-
Gravel Base	1-1½	-	-	-	-	-	-	-
Possible Fill-Lean Clay	1½-2	-	8-9	24-28	46	22	-	-
Fat Clay	1½-3	-	7-9	24-30	-	-	-	-
Weathered Limestone	5-6	0-25	SSR*	-	-	-	144-157	280-630
Clay Shale	2-3	83-88		-	-	-	-	-
Limestone	5-6	33-100	-	-	-	-	160-165	640-880

*SSR=Split spoon refusal

Auger refusal materials were encountered within the borings at depths ranging from about 1½ feet to 7 feet. Refusal is a designation applied to materials that cannot be further penetrated by the power auger with ordinary effort and is normally indicative of a very hard or very dense material, such as boulders or gravel lenses or the upper surface of bedrock.

Split spoon refusal materials were encountered with the borings. Split spoon refusal materials are defined as materials that cannot be penetrated with a standard split spoon using ordinary effort (greater than 50 blows per 6 inches). These materials were encountered in boring B-6 at an approximate depth of 5 feet.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the Appendix should be reviewed for specific information at individual boring locations. These records include soil/rock descriptions, stratifications, penetration resistances, and locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on these boring logs. The samples that were not altered by laboratory testing will be retained for sixty (60) days from the date of this report and then will be discarded.

Water Level Measurements

Free groundwater was not observed in the borings upon completion, indicating that groundwater at the site at the time of the exploration was either below the terminated depths of the borings, or that the soils encountered are relatively impermeable. Although free water was not encountered at this time, water can be present within the depths explored during other times of the year depending upon climatic and rainfall conditions. However, it should be noted that saturated soils were identified during laboratory analysis at depths as shallow as 3 feet below the ground surface. Additionally, discontinuous zones of perched water may exist within the overburden materials and/or at the contact with bedrock. The water level measurements presented in this report are the levels that were measured at the time of PSI's field activities.

GEOTECHNICAL EVALUATION

Geotechnical Discussion

There are 5 primary geotechnical characteristics at this site, which will affect the selection and performance of the foundations for this structure. The following summarizes those concerns:

1. The shear strength and compressibility of the upper soils/rock will control the behavior of the proposed structure.
2. High plasticity "fat" clays were encountered in the exploration that could require remediation.
3. Existing undocumented fill materials were encountered within the project area.
4. Shallow rock was encountered in the parking garage area that could be difficult to excavate for general grading.
5. Drying of some of the on site soils may be required to achieve proper compaction during grading.

Shear Strength and Compressibility of Soil

The primary geotechnical property controlling the bearing capacity and compressibility of the soils bearing the applied loads is the shear strength of the clay soil. The shear strength of the existing clay soils are estimated to range from 1,000 to 1,800 psf, based on these values and the anticipated load of the parking structure; the proposed structure will be required to be supported on a foundation system that extends to limestone. PSI believes the shear strength of the limestone exceeds 3,500 psf. This shear strength is considered "undrained" or a "total stress" parameter and will be used in conjunction with other physical and geometric parameters to calculate an allowable bearing capacity.

High Plasticity Clay

High plasticity clays are present in the project area that may expand and shrink thereby impacting the proposed construction and long term performance of the structure. Where these soils are within about 18 inches of the parking structure slab elevation, remediation is recommended with new granular structural consisting of AB-3 type material to limit the shrink/swell potential of these types of soils. If limestone is encountered at the proposed slab elevation a minimum of 12 inches of the AB-3 material would be required to limit hard points under the slab and promote drainage. Grading the subgrade to drain and not trap water below the slabs and pavements is recommended to further reduce the potential of distress from these soils.

Existing Undocumented Fill

The presence of undocumented fill introduces a construction risk due to the potential for excessive and/or non-uniform settlement. Fill is defined as follows:

Fill; Man placed soil is called fill, and the process of placing it is termed filling. One of the most common problems of earth construction is the wide variability of the source soil, termed borrow. An essential part of the geotechnical engineering report is to provide guidance for the placement of fill from a borrow source in a manner that achieves the design parameters for the project being constructed. Fill is further classified by the placement process. The following lists various terms applied to fill placement practices:

1. **Uncontrolled Fill**; fill material that consists of soil and/or non-soil materials that has been placed in a manner that does not produce consistent density, uniform moisture content at time of placement, and in general materials of durable physical characteristics is termed an uncontrolled fill.
2. **Undocumented Fill**; fill material composed of soil that has **not** been observed by a geotechnical engineer or qualified technician under the direction of a geotechnical engineer during the actual fill placement process with physical measurements of lift thickness, dry density, moisture content at time of placement, location of tests and fill soils placed, and the methodology of placement with types of placement equipment is termed undocumented fill.
3. **Engineered Fill**; fill material that is placed to have specific shear strength, permeability, consolidation, or other physical parameter(s) specific to the end use of the man placed soil material. Applications include, but are not limited to, retaining wall backfill, pond and landfill liners, embankments, dams, and bridge abutments.

In order to reduce the potential of larger than normal settlement of pavement areas and slabs and to provide uniform support for slabs-on-grade, PSI recommends that proof rolling be performed on the existing undocumented fill soils as recommended in the site preparation section of this report. Areas that do not pass a proofroll should be removed, conditioned, and recompacted or replaced with properly placed and compacted low plasticity structural fill. Based on anticipated loads, foundation elements will need to extend through these materials. Based on the foundation, the presences of these materials should only presents risk associated with the lateral resistance of the foundation elements.

Shallow Rock

Auger refusal material consisting of limestone was encountered as shallow as 1½ feet. Refusal is a designation applied to materials that cannot be further penetrated by the power auger with ordinary effort and is normally indicative. Some of the limestone may be difficult to excavate, especially for the lower level of the parking structure. Excavation machinery equipped with rock chippers may be required in some locations. In addition, intact ledges or boulders of sound and hard rock may be encountered within the limestone layers that could increase the excavation difficulty.

Soil Compaction

Since the surface soils at the site predominantly consist of high moisture content clay soils and high plasticity clays, it may become difficult to achieve the desired compaction of the soils due to high current moisture contents. After stripping activities the surface soils may also not pass a proof roll in their high moisture content state. The soils may need to be scarified and dried to a moisture content that will facilitate compaction in accordance with the structural fill requirements of this report. If scarifying, drying and recompacting of the soils does not stabilize the soils, removing and replacement with new structural fill or treating the soils with class "C" flyash or lime-treatment of the soils clays may need to be performed.

GEOTECHNICAL RECOMMENDATIONS

The following geotechnical related recommendations have been developed on the basis of the subsurface conditions encountered and PSI's understanding of the proposed development. Should changes in the project criteria occur, a review must be made by PSI to determine if modifications to our recommendations will be required.

Site Preparation

PSI recommends that existing asphalt, roots, soft, organic, frozen, or unsuitable soils in the construction areas be stripped from the site and either wasted or stockpiled for later use in non-structural areas. A representative of the geotechnical engineer should evaluate and document the required depth of removal at the time of construction.

Highly plasticity fat clays should be removed where they are present within a depth of two (2) feet beneath proposed slabs and one (1) foot beneath proposed pavements. This material should be replaced with a dense positively-drained graded crushed stone. A representative of PSI's geotechnical engineer should observe the subgrade soils, perform plasticity index tests, and estimate the approximate extent of the exposed fat clays. The geotechnical engineer's representative should observe the remediation procedures for compliance with the project plans and specifications.

After stripping to the proposed subgrade level, as required, the soil in the parking structure area should be proof-rolled with a loaded tandem axle dump truck or similar heavy rubber tired vehicle (typically with an axial load greater than nine (9) tons). Soils that are observed to rut or deflect excessively (typically greater than one (1) inch) under the moving load should be undercut and replaced with properly compacted low plasticity fill material. The proof-rolling and undercutting activities should be witnessed by a representative of the geotechnical engineer and should be performed during a period of dry weather. Care should be taken during construction activities not to allow excessive drying or wetting of exposed soils. The subgrade soils should be scarified and compacted to at least 95% of the materials' standard or Proctor maximum dry density, in general accordance with ASTM procedures, to a depth of at least twelve (12) inches below the surface.

New fill to be placed to reestablish grades should be placed in maximum loose lifts of eight (8) inches and compacted to at least 95% of the materials' standard Proctor maximum dry density, and within a range of the optimum moisture content as designated in the table below, as determined in general accordance with ASTM procedures. Each lift of compacted-engineered fill should be tested and documented by a representative of the geotechnical engineer prior to placement of subsequent lifts.

The fill placed should be tested and documented by a geotechnical technician and directed by a geotechnical engineer to evaluate the placement of fill material. It should be noted that the geotechnical engineer of record can only certify the testing that is performed and the work observed by that engineer or staff in direct report to that engineer. The fill should be evaluated in accordance with the following table:

MATERIAL TESTED	PROCTOR TYPE	MIN % DRY DENSITY	PLACEMENT MOISTURE CONTENT RANGE	FREQUENCY OF TESTING *[1]
Structural Lean Clay Fill* (Cohesive)	Standard	95%	-1 to +3 %	1 per 2,500 ft^2 of fill placed / lift
Structural Fill (Granular)*	Standard	95%	-2 to +2 %	1 per 2,500 ft^2 of fill placed / lift
Random Fill (non load bearing)	Standard	90%	-3 to +3 %	1 per 6,000 ft^2 of fill placed / lift
Utility Trench Backfill	Standard	95%	-1 to +3 %	1 per 150 lineal foot / lift

*Structural Fill is defined as fill beneath or supporting any improvements on site
*[1] Minimum 3 per lift.

The test frequency for the laboratory reference should be one laboratory Proctor or Relative Density test for each material used on the site. If the borrow or source of fill material changes, a new reference moisture/density test should be performed.

Tested fill materials that do not achieve either the required dry density or moisture content range shall be recorded, the location noted, and reported to the Contractor and Owner. A re-test of that area should be performed after the Contractor performs remedial measures.

Deep Foundation Recommendations

Based on the anticipated loads of the parking garage, PSI recommends that the structure be supported on deep foundation system consisting of drilled piers.

As a result of the field explorations, shallow auger refusal materials were encountered within portion of the proposed parking structure area. These materials may be removed during the grading process for the parking structure depending on the design elevation of the structure. However, large sections of weathered rock may still be encountered between the borings that could cause problems in augering using standard soil excavation techniques. Depending on the size of the excavation machines and augers, refusal may be shallower than those stated in this report and should not be used as an exact depth in pricing of the drill pier installation. The table below presents the parameters for use in the design of the allowable capacity of the drilled piers. The parameters should be used for designing with or without a rock socket.

SOIL TYPE	APPROXIMATE DEPTHS (FT)	ALLOWABLE BEARING CAPACITY (PSF)	ALLOWABLE SKIN FRICTION (PSF)
Fat Clay	937-929	NA	600
Weathered limestone	931-924	10,000	2,000
Clay Shale	928-925	10,000	4,000
Limestone at surface (RQD 30-60%)	925-below	50,000	NA
Limestone with 3-foot socket (RQD >60 %)	925-below	100,000	5,000

The side friction between the piers and the rock can be calculated by taking 5% of compression strength of the weaker material. Because the compressive strength of the limestone bedrock in this area typically far exceeds the strength of the concrete the compressive strength of the concrete governs the maximum allowable skin friction.

When uplift is a concern for a deep foundation, then the pier design is typically controlled by the uplift forces applied to the sides of the foundation. Uplift capacity is equal to the allowable skin friction and the weight of the pier. The effective weight of the pier concrete (at 145 pcf) should be included in the uplift calculations.

To facilitate pier construction, concrete should be on site and ready for placement as the pier excavation is completed. The foundation excavation should be cleaned of loose or disturbed materials and any free water before placing reinforcing steel and concrete.

Loose materials on the bearing surface must be removed prior to concrete placement. To reduce the lateral movement of the pier, the contractor must place the pier concrete in intimate contact with undisturbed natural soil. The contractor must fill voids or enlargements in the pier shaft excavation with concrete at the time of concrete placement.

Concrete slumps ranging from four to seven-inches are recommended for drilled pier construction. Concrete with slumps in this range will usually fill irregularities along the side and bottom of the hole. Concrete should be placed into the drilled hole through a centering chute at the surface to prevent contact with the sides of the hole and reinforcing steel. This procedure will reduce the potential side flow and segregation. The sequence of operations should be scheduled so that each pier is drilled, reinforcing steel is placed, and concrete is placed in a continuous, rapid, and orderly manner to reduce the time the excavation is open.

The lateral loads on the piers can be calculated with the parameters given in the following table. These parameters are for analytical programs such as L-Pile or COM624P which will analyze both the applied load verse strain resistance of the soil and the deflection of the structural element. In general, the upper 5-feet below grade of the pier is ignored in the lateral capacity for exterior piles and for areas exposed to footings.

TYPICAL SOIL TYPE	SHEAR STRENGTH (PSF)	*INTIAL MODULUS, E (KSI)	STATIC LATERAL MODULUS, K (PCI)	CYCLIC LATERAL MODULUS, K (PCI)	STRAIN FACTOR, E_{50}
Fat Clay	1,200	-	330	130	0.0082
Weathered Limestone	8,000	-	2,700	1,200	0.0028
Clay Shale	4,000	-	1,300	550	0.0042
Limestone (RQD >60 %)	30,000	11,000	2,700	1,000	0.0005

*Based on Elastic Modulus-Compressive Strength Groupings for Intact Igneous Rock Material (Deere & Miller, 1966) "

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance of the foundation system if not engaged to also provide construction observation and testing for this project.

Based on the known subsurface conditions and site geology, laboratory testing and past experience, PSI anticipates that properly designed and constructed footings supported on the recommended materials should experience total settlements of less than ½-inch.

Earthquake and Seismic Design Consideration

The 2009 International Building Code requires a site class for the calculation of earthquake design forces. This class is a function of soil type (i.e., depth of soil and strata types). Based on the depth to rock and the estimated shear strength of the soil at the boring locations, Site Class "C" is recommended. The USGS-NEHRP probabilistic ground motion values near latitude 39.0268° and longitude -94.5279° are as follows:

Period (Seconds)	2% Probability of Event in 50 years (%g)	Site Coefficient F_a	Site Coefficient F_v
PGA	5.7	---	---
0.2 (S_s)	12.7	1.2	---
1.0 (S_1)	5.9	---	1.7

The Site Coefficients, F_a and F_v were interpolated from IBC 2009 Tables 1613.5.3(1) and 1613.5.3(2) as a function of the site classifications and the mapped spectral response acceleration at the short (S_s) and 1 second (S_1) periods.

Parking Slab Recommendations

In limestone rock cut areas, the slab should be underlain by 12 inches of compacted AB-3 type material. Areas that encounter existing fat clay or shale soils should be remediated as indicated above so that the slab is supported on a minimum of 18 inches of properly compacted AB-3 type material or extending to the rock surface elevations, whichever is shallower. Proof-rolling, as discussed earlier in this report, should be accomplished to identify soft or unstable soils that should be removed from the floor slab area prior to fill placement and/or floor slab construction. These soils should be replaced with properly compacted structural fill as described earlier in this report.

The soil surface shall be graded to drain away from the building without low spots that can trap water prior to placing the granular drainage layer. The slabs should have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage.

For subgrade prepared as recommended and properly compacted fill, a modulus of subgrade reaction, *k* value, of 140 pounds per cubic inch (pci) may be used in the grade slab design based on correlation to values typically resulting from a 1 ft. x 1 ft. plate load test. However, depending on how the slab load is applied, the value will have to be geometrically modified. Where slab loading is distributed over more than a 1 foot by 1 foot area, the value k should be adjusted for larger areas using the following expression for cohesive and cohesionless soil:

Modulus of Subgrade Reaction, $k_s = (\frac{k}{B})$ for cohesive soil and

$$k_s = k\,(\frac{B+1}{2B})^2 \text{ for cohesionless soil}$$

Where: k_s = coefficient of vertical subgrade reaction for loaded area,
k = coefficient of vertical subgrade reaction for 1 square foot area, and
B = effective width of area loaded, in feet

The precautions listed below should be followed for construction of slab-on-grade pads. These details will not reduce the amount of movement, but are intended to reduce potential damage should some settlement of the supporting subgrade take place. Some increase in moisture content is inevitable as a result of development and associated landscaping. However, extreme moisture content increases can be largely controlled by proper and responsible site drainage, building maintenance and irrigation practices.

- Cracking of slab-on-grade concrete is normal and should be expected. Cracking can occur not only as a result of heaving or compression of the supporting soil and/or bedrock material, but also as a result of concrete curing stresses. The occurrence of concrete shrinkage crack, and problems associated with concrete curing may be reduced and/or controlled by limiting the slump of the concrete, proper concrete placement, finishing, and curing, and by the placement of crack control joints at frequent intervals, particularly where re-entrant slab corners occur. The American Concrete Institute (ACI) recommends a maximum panel size (in feet) equal to approximately three times the thickness of the slab (in inches) in both directions. For example, joints are recommended at a maximum spacing of twelve (12) feet based on having a four-inch slab. PSI also recommends that the slab be independent of the foundation walls. Using fiber reinforcement in the concrete can also control shrinkage cracking.
- Areas supporting slabs should be properly moisture conditioned and compacted. Backfill in all interior and exterior water and sewer line trenches should be carefully compacted to reduce the shear stress in the concrete extending over these areas.

Exterior slabs should be isolated from the building. These slabs should be reinforced to function as independent units. Movement of these slabs should not be transmitted to the building foundation or superstructure.

Utilities Trenching

Excavation for utility trenches shall be performed in accordance with OSHA regulations as stated in 29 CFR Part 1926. It should be noted that utility trench excavations have the potential to degrade the properties of the adjacent fill materials. Utility trench walls that are allowed to move laterally can lead to reduced bearing capacity and increased settlement of adjacent structural elements and overlying slabs.

Backfill for utility trenches is as important as the original subgrade preparation or structural fill placed to support either a foundation or slab. Therefore, it is imperative that the backfill for utility trenches be placed to meet the project specifications for the structural fill of this project. PSI recommends that flowable fill or lean mix concrete be utilized for utility trench backfill. If on-site soils are placed as trench backfill, the backfill for the utility trenches should be placed in four (4) to six (6) inch loose lifts and compacted to a minimum of 95% of the maximum dry density achieved by the standard Proctor test. The backfill soil should be moisture conditioned to be within 2% of the optimum moisture content as determined by the standard Proctor test. Up to four (4) inches of bedding material placed directly under the pipes or conduits placed in the utility trench can be compacted to the 90% compaction criteria with respect to the standard Proctor. Compaction testing should be performed for every 200 cubic yards of backfill place or each lift within 200 linear feet of trench, whichever is less. Backfill of utility trenches should not be performed with water standing in the trench. If granular material is used for the backfill of the utility trench, the granular material should have a gradation that will filter protect the backfill material from the adjacent soils. If this gradation is not available, a geosynthetic non-woven filter fabric should be used to reduce the potential for the migration of fines into the backfill material. Granular backfill material shall be compacted to meet the above compaction criteria. The clean granular backfill material should be compacted to achieve a relative density greater than 75% or as specified by the geotechnical engineer for the specific material used.

Pavement Recommendations

PSI's scope of services did not include extensive sampling and CBR testing of existing subgrade or potential sources of imported fill for the specific purpose of detailed pavement analysis. Instead, this report is based on pavement-related design parameters that are considered to be typical for the area soils types.

Pavement sections can be grade supported on a minimum of twelve (12) inches of properly compacted low plasticity structural fill. Class "C" flyash or lime-treatment of the onsite high plastic clays can also be performed. The crushed stone base can be included in the 12 inches of remediation recommended in the areas of undocumented fill and fat clay. Proof-rolling, as discussed earlier in this report, should be accomplished to identify soft or unstable soils that should be removed from the pavement area prior to fill placement and/or pavement construction. These soils should be replaced with properly compacted structural fill as described earlier in this report.

Pavement sections were evaluated using Pavement Assessment Software (PAS), which is based on the 1993 AASHTO Design equations, a reliability of 80%, an annual growth rate of 2%, and a 20 year equivalent 18-kip single axle load (ESAL) of 30,000 for light duty pavements and 60,000 for heavy duty pavements. Flexible Pavements were evaluated based on an initial serviceability of 4.2 and a terminal service of 2.0. Rigid Pavements were evaluated based on an initial serviceability of 4.5, a terminal service of 2.0, an unreinforced concrete mix with a 28-day modulus of rupture of 650 pounds per square inch (psi) (approximately 4,000 psi compressive strength), are assumed to be edge supported, and dowel and mesh reinforced.

In large areas of pavement, or where pavements are subject to significant traffic, a more detailed analysis of the subgrade and traffic conditions should be made. The results of such a study will provide information necessary to design an economical and serviceable pavement.

The recommended thicknesses presented below are considered typical and minimum for the assumed parameters. The client, the owner, and the project principals should be aware that thinner pavement sections might result in increased maintenance costs and lower than anticipated pavement life. The pavement subgrade should be prepared as discussed below.

The PSI recommendation is based on the subgrade soils being prepared to achieve a minimum CBR of three (3). On this basis, it is possible to use a locally typical "standard" pavement section consisting of the following:

RECOMMENDED THICKNESSES (INCHES)		
PAVEMENT MATERIALS *	**LIGHT DUTY**	**HEAVY DUTY**
Asphaltic Surface Course	1½	1½
Asphaltic Binder Course	2	3½
Crushed stone (3/4-inch minus)	6	6
Or		
Portland Cement Concrete	5	6
Crushed stone (3/4-inch minus)	4	4

*Pavement materials should conform to local and state guidelines, if applicable.

Asphalt Pavement

The granular base course should be built at least two (2) feet wider than the pavement on each side to support the tracks of the slipform paver. This extra width is structurally beneficial for wheel loads applied at the pavement edge. The asphalt base course should be compacted to a minimum of 95% Marshall density according to ASTM D1559.

Asphaltic surface mixture should have a minimum stability of 1,800 pounds and the surface course should be compacted to a minimum of 97% Marshall density according to ASTM D1559. Asphalt mixes should comply with APWA or MODOT specifications.

Asphaltic concrete mix designs and Marshall characteristics should be reviewed to determine if they are consistent with the recommendations given in this report.

Concrete Pavement

Because the pavement at this site will be subjected to freeze-thaw cycles, PSI recommends that an air entrainment admixture be added to the concrete mix to achieve air content in the range of 5% to 7% to provide freeze-thaw durability in the concrete. PSI recommends that a Concrete with a 28-day specified compressive strength of 4,000 psi should be used. A mixture with a maximum slump of four (4) inches is acceptable. If a water reducing admixture is specified, the slump can be higher. It is recommended that admixtures be submitted to the owner in advance of use in the concrete.

Pavement for any dumpster areas or areas subject to consistent heavy loads should be constructed of Portland cement concrete with load transfer devices installed where construction joints are required. A thickened edge is recommended on the outside of slabs subjected to wheel loads. This thickened edge usually takes the form of an integral curb. Fill material should be compacted behind the curb or the edge of the outside slabs should be thickened. The following are recommended to enhance the quality of the pavement.

- Moisten subgrade just prior to placement of concrete.
- Cure fresh concrete with a liquid membrane-forming curing compound.
- Keep automobile traffic off the slab for three (3) days and truck traffic off the slab for seven (7) days, unless tests are made to determine that the concrete has gained adequate strength (i.e., usually 70% of design strength).

Pavement Subgrade Preparation

Prior to paving, the prepared subgrade should be proof-rolled using a loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of nine (9) tons per single axle. Localized soft areas identified should be repaired prior to paving. Moisture content of the subgrade should be maintained between –2% and +3% of the optimum at the time of paving. It may require rework when the subgrade is either desiccated or wet.

Construction traffic should be minimized to prevent unnecessary disturbance of the pavement subgrade. Disturbed areas, as verified by PSI, should be removed and replaced with properly compacted material.

The edges of compacted fill should extend a minimum two (2) feet beyond the edges of the pavement, or a distance equal to the depth of fill beneath the pavement, whichever is greater. The measurement should be taken from the outside edge of the pavement to the toe of the excavation prior to sloping.

Pavement Drainage & Maintenance

PSI recommends pavements be sloped to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade, cause premature deterioration of the pavements, and may require removal and replacement. PSI recommends the subgrade be sloped to drain prior to placing the crushed stone base. Consideration should be given to the use of interceptor drains to collect and remove water collecting in the crushed stone base. The interceptor drains could be incorporated with the storm drains of other utilities located in the pavement areas.

Periodic maintenance of the pavement should be anticipated. This should include sealing of cracks and joints and by maintaining proper surface drainage to avoid ponding of water on or near the pavement areas. Underdrains, sub-drains and underslab drains presented in this report will not prevent moisture vapor that can cause mold growth.

CONSTRUCTION CONSIDERATIONS

PSI should be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI cannot accept responsibility for conditions that deviate from those described in this report, nor for the performance of the foundation system if not engaged to also provide construction observation and testing for this project.

Moisture Sensitive Soils/Weather Related Concerns

The upper fine-grained soils encountered at this site are expected to be sensitive to disturbances caused by construction traffic and to changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. In addition, soils that become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather.

Drainage and Groundwater Considerations

PSI recommends that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

Excavations

In Federal Register, Volume 54, Number 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, Subpart P". This document was issued to better enhance the safety of workers entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavation or footing excavations, be constructed in accordance with the new OSHA guidelines. It is PSI's understanding that these regulations are being strictly enforced and if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations.

PSI is providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

GEOTECHNICAL RISK

The concept of risk is an important aspect of the geotechnical evaluation. The primary reason for this is that the analytical methods used to develop geotechnical recommendations do not comprise an exact science. The analytical tools which geotechnical engineers use are generally empirical and must be used in conjunction with engineering judgment and experience. Therefore, the solutions and recommendations presented in the geotechnical evaluation should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soils and the proposed structure will perform as planned. The engineering recommendations presented in the preceding section constitutes PSI's professional estimate of those measures that are necessary for the proposed structure to perform according to the proposed design based on the information generated and referenced during this evaluation, and PSI's experience in working with these conditions.

REPORT LIMITATIONS

The recommendations submitted are based on the available subsurface information obtained by PSI and design details furnished by GLMV Architecture. If there are revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. This report has been prepared for the exclusive use of GLMV Architecture for the specific application to the proposed VA Medical Center Parking Garage located at 4801 Linwood Boulevard in Kansas City, Missouri.

Appendix

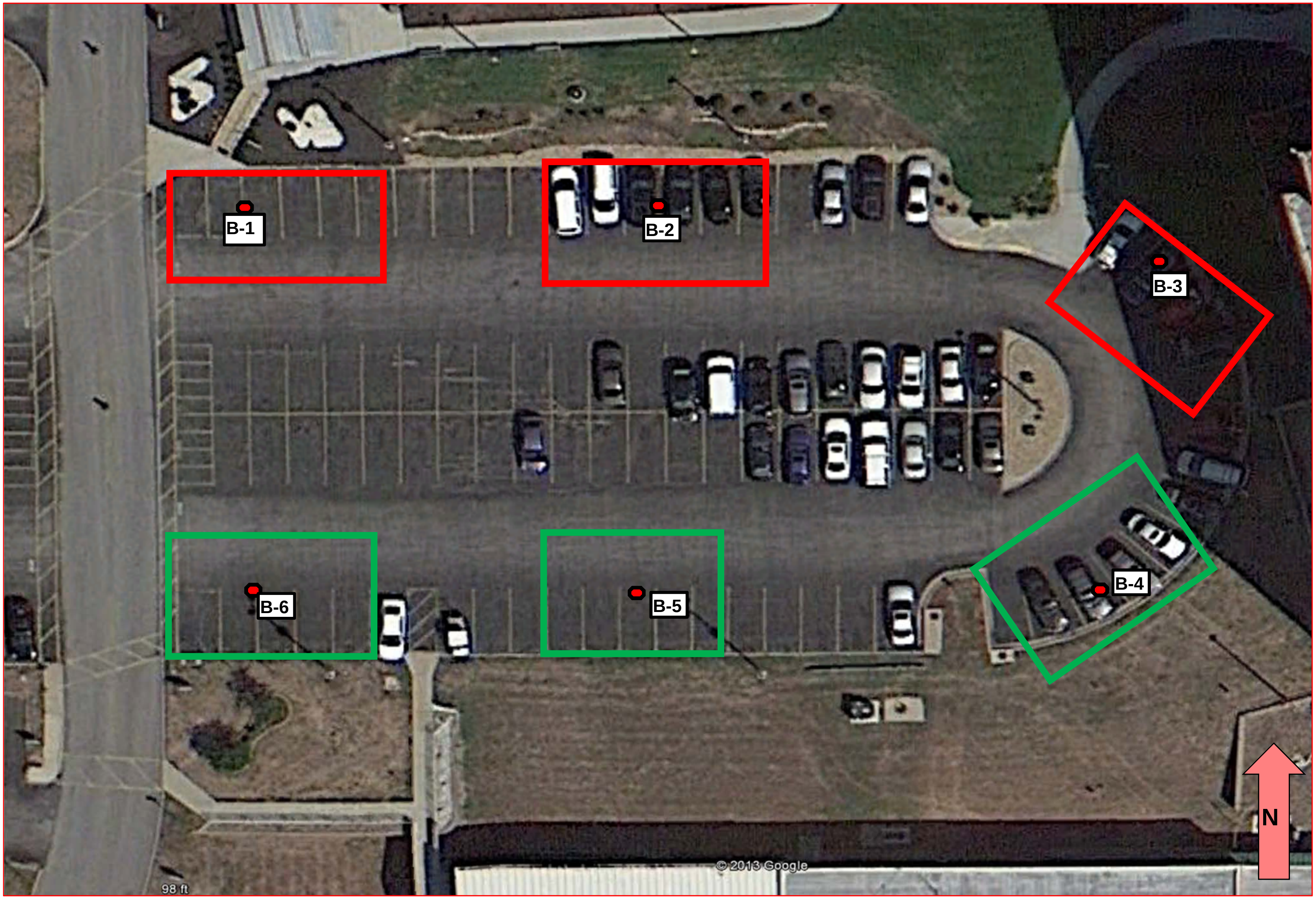
Site Vicinity Map

Professional Service Industries, Inc.

Site Vicinity Plan KCVA Medical Center Inpatient Parking Garage E. 35th Street and Emanuel Cleaveer Blvd. Kansas City, Missourui	PSI Project No.:	338-882	
	Aerial Year:	2012	Drawn By:
	Drawing Date:	2/28/14	SDB

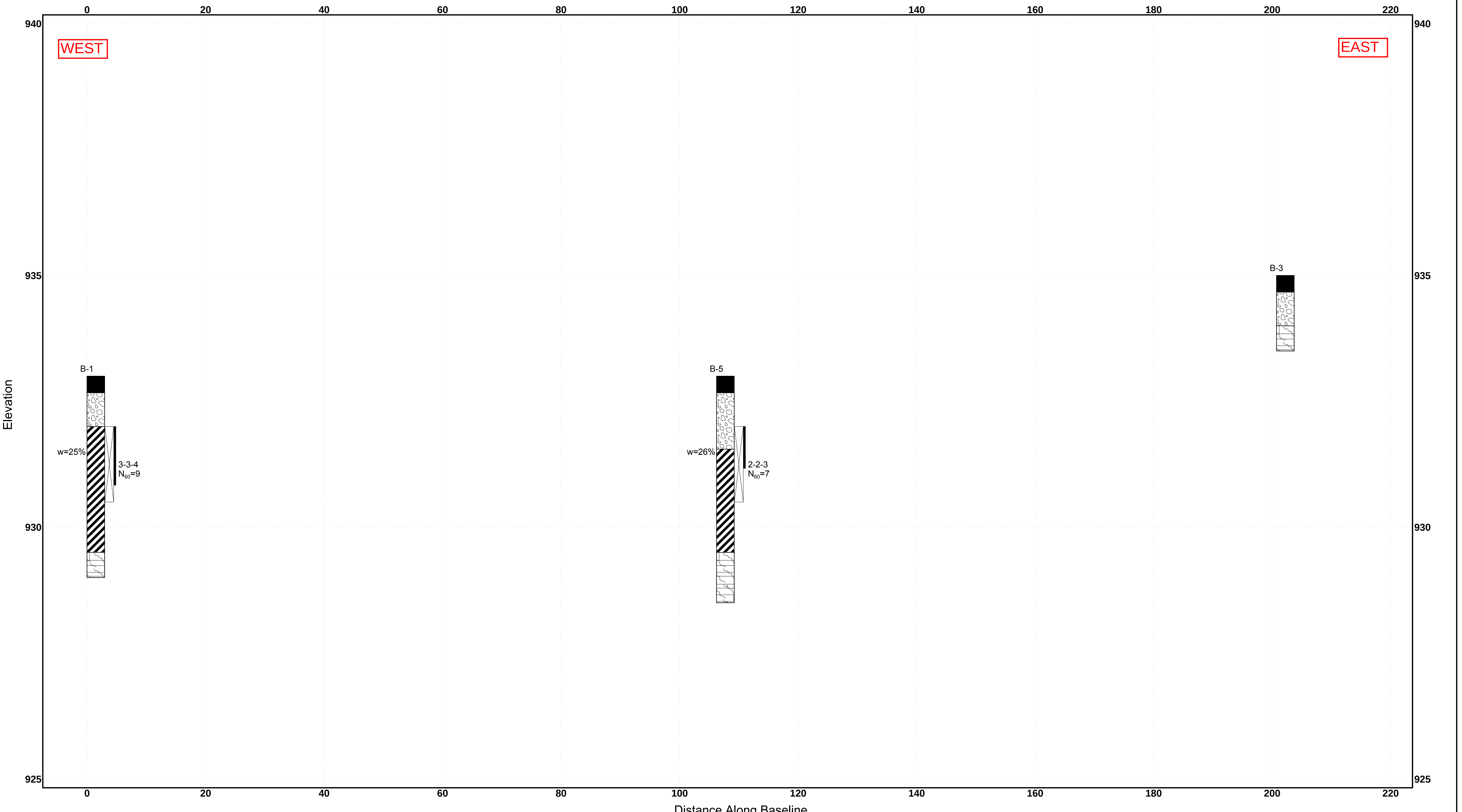
Boring Location Plan

Professional Service Industries, Inc.



Boring Location Diagram KCVA Medical Center Inpatient Parking Garage E. 35th Street and Emanuel Cleaveer Blvd. Kansas City, Missorui	PSI Project No.:	338-882
	Date: 2/28/2014	Drawn By: SDB

Boring Logs

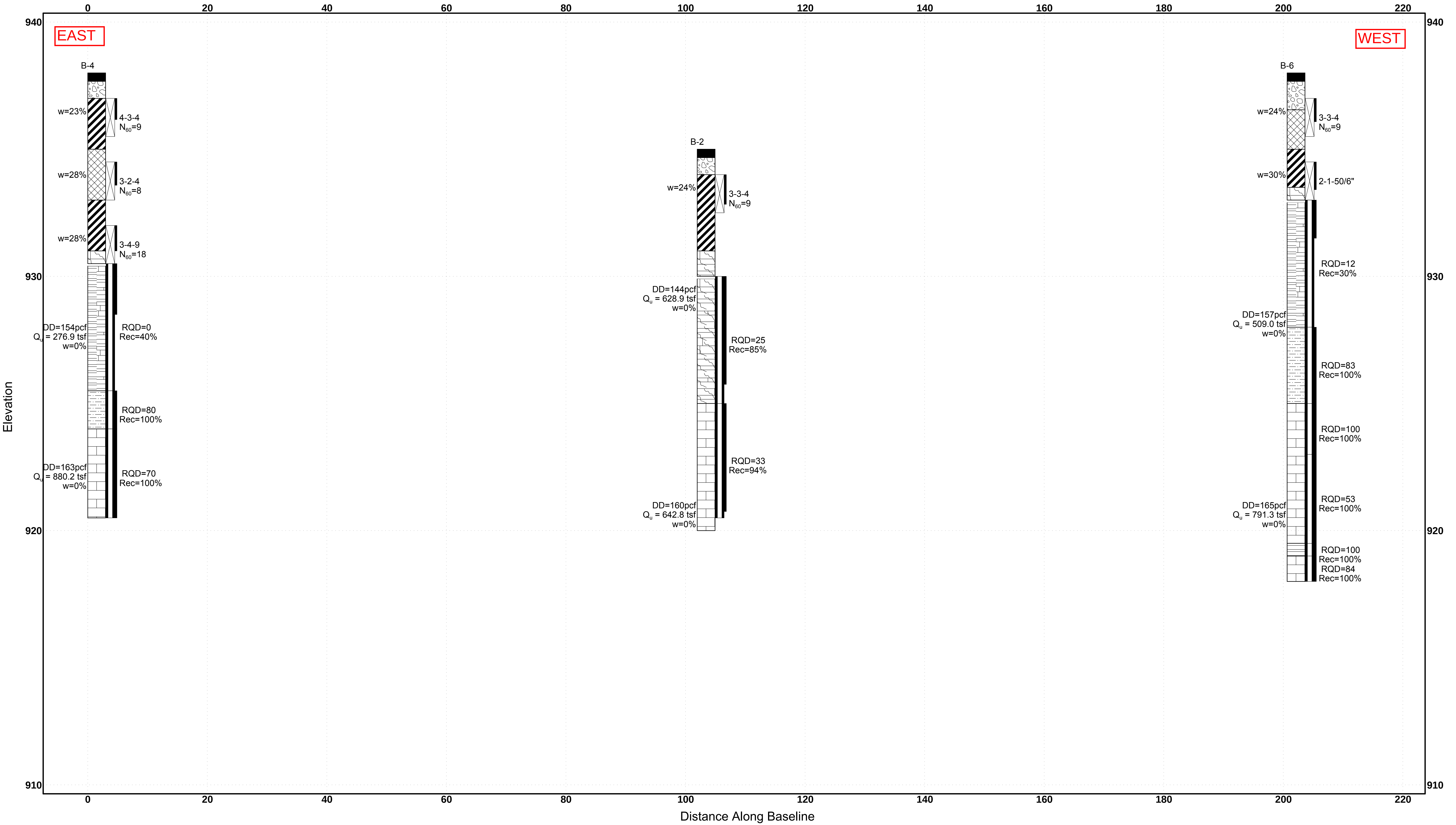


Professional Service Industries, Inc.
1211 W. Cambridge Circle Drive
Kansas City, KS 66103

Profile

VA Medical Center
PSI Project Number: 338-882

4801 Linwood Boulevard
Kansas City, Missouri



Professional Service Industries, Inc.
1211 W. Cambridge Circle Drive
Kansas City, KS 66103

Profile

VA Medical Center
PSI Project Number: 338-882

4801 Linwood Boulevard
Kansas City, Missouri

BORING B-1

DATE STARTED:	3/16/14	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	3/16/14	**DRILLER:** DJK **LOGGED BY:**	JRB
COMPLETION DEPTH	4.0 ft	**DRILL RIG:**	CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	933 ft	**SAMPLING METHOD:**	SS
LATITUDE:	39.0628°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-94.5279°	**EFFICIENCY**	81%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AR

Water

While Drilling	not observed
Upon Completion	not observed
Delay	N/A

BORING LOCATION:
See boring location Plan

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA (N in blows/ft ◎; × Moisture; PL; LL; 0–25–50) / STRENGTH, tsf (▲ Qu; ✳ Qp; 0–2.0–4.0)	Additional Remarks
	0					**ASPHALT- 3 to 4-inches**					
						GRAVEL BASE					
				1	14	**HIGH PLASTICITY CLAY** brown, reddish brown Reddish brown	CH	3-3-4 N_{60}=9	25		
930											
						WEATHERED LIMESTONE Auger refusal at 4 feet					

Professional Service Industries, Inc.
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Telephone: (913) 310-1600

PROJECT NO.: 338-882
PROJECT: VA Medical Center
LOCATION: 4801 Linwood Boulevard
Kansas City, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

DATE STARTED: 3/16/14	**DRILL COMPANY:** PSI, Inc.		
DATE COMPLETED: 3/16/14	**DRILLER:** DJK **LOGGED BY:** JRB		
COMPLETION DEPTH 15.0 ft	**DRILL RIG:** CME-55		
BENCHMARK: N/A	**DRILLING METHOD:** Hollow Stem Auger		
ELEVATION: 935 ft	**SAMPLING METHOD:** SS		
LATITUDE: 39.0628°	**HAMMER TYPE:** Automatic		
LONGITUDE: -94.5279°	**EFFICIENCY** 81%		
STATION: N/A **OFFSET:** N/A	**REVIEWED BY:** AR		

BORING B-2

Water		
▽ While Drilling	not observed	
▼ Upon Completion	not observed	
▽ Delay	N/A	

BORING LOCATION: See boring location Plan

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**ASPHALT- 3 to 4-inches**				
				GRAVEL BASE				
		1	14	**HIGH PLASTICITY CLAY** brown, reddish brown Brown. grey brown	CH	3-3-4 N_{60}=9	24	
				WEATHERED LIMESTONE				
930	5	2	51	Auger refusal at 5 feet, Started Coring **WEATHERED LIMESTONE**		RQD=25 Rec=85%	0	>>DD = 144 pcf Q_u = 628.9 tsf
925	10	3	51	**LIMESTONE**		RQD=33 Rec=94%	0	>>DD = 160 pcf Q_u = 642.8 tsf
920	15			Boring terminated at 15 feet				

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (0, 25, 50). STRENGTH, tsf: ▲ Qu; ✳ Qp (0, 2.0, 4.0)

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PROJECT: VA Medical Center
LOCATION: 4801 Linwood Boulevard, Kansas City, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-3

DATE STARTED:	3/16/14	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	3/16/14	**DRILLER:** DJK	**LOGGED BY:** JRB
COMPLETION DEPTH	1.5 ft	**DRILL RIG:**	CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	935 ft	**SAMPLING METHOD:**	SS
LATITUDE:	39.0628°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-94.5279°	**EFFICIENCY**	81%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AR

Water

While Drilling	not observed
Upon Completion	not observed
Delay	N/A

BORING LOCATION:
See boring location Plan

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA N in blows/ft ◎ × Moisture ◪ PL ✚ LL 0 25 50 / STRENGTH, tsf ▲ Qu ✳ Qp 0 2.0 4.0	Additional Remarks
	0					**ASPHALT- 3 to 4-inches**					
						GRAVEL BASE					
						WEATHERED LIMESTONE					
						Auger refusal at 1½ feet					

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Kansas City, Missouri

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BORING B-4

- **DATE STARTED:** 3/16/14
- **DATE COMPLETED:** 3/16/14
- **COMPLETION DEPTH** 17.5 ft
- **BENCHMARK:** N/A
- **ELEVATION:** 938 ft
- **LATITUDE:** 39.0628°
- **LONGITUDE:** -94.5279°
- **STATION:** N/A **OFFSET:** N/A
- **DRILL COMPANY:** PSI, Inc.
- **DRILLER:** DJK **LOGGED BY:** JRB
- **DRILL RIG:** CME-55
- **DRILLING METHOD:** Hollow Stem Auger
- **SAMPLING METHOD:** SS
- **HAMMER TYPE:** Automatic
- **EFFICIENCY** 81%
- **REVIEWED BY:** AR
- **REMARKS:** N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Water	
While Drilling	not observed
Upon Completion	not observed
Delay	N/A

BORING LOCATION: See boring location Plan

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**ASPHALT- 3 to 4-inches**				
				GRAVEL BASE				
		1	10	**HIGH PLASTICITY CLAY**-brown, reddish brown	CH	4-3-4 N_{60}=9	23	
935		2	11	**POSSIBLE FILL-LOW PLASTICITY CLAY**-grey, brown, dark grey	CL	3-2-4 N_{60}=8	28	
	5	3	12	**HIGH PLASTICITY CLAY**-brown, grey brown	CH	3-4-9 N_{60}=18	28	
				WEATHERED LIMESTONE				
930				Auger refusal at 7½ feet, Started Coring **LIMESTONE AND WEATHERED SHALE**				
	10	4	24			RQD=0 Rec=40%	0	DD = 154 pcf Q_u = 276.9 tsf
925		5	18	**CLAY SHALE**		RQD=80 Rec=100%		
				LIMESTONE				
	15	6	42			RQD=70 Rec=100%	0	DD = 163 pcf Q_u = 880.2 tsf
				Boring terminated at 17½ feet				

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (0, 25, 50). STRENGTH, tsf: ▲ Qu; ✳ Qp (0, 2.0, 4.0)

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PROJECT NO.: 338-882
PROJECT: VA Medical Center
LOCATION: 4801 Linwood Boulevard, Kansas City, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-5

DATE STARTED:	3/16/14	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	3/16/14	**DRILLER:** DJK	**LOGGED BY:** JRB
COMPLETION DEPTH	4.5 ft	**DRILL RIG:**	CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	933 ft	**SAMPLING METHOD:**	SS
LATITUDE:	39.0628°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-94.5279°	**EFFICIENCY**	81%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AR

Water

▽ While Drilling	not observed
▼ Upon Completion	not observed
▽ Delay	N/A

BORING LOCATION:
See boring location Plan

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Graphic Log	Sample Type	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	STANDARD PENETRATION TEST DATA (N in blows/ft ◎; × Moisture; ◪ PL; ✚ LL; 0–25–50) / STRENGTH, tsf (▲ Qu; ✳ Qp; 0–2.0–4.0)	Additional Remarks
	0					**ASPHALT- 3 to 4-inches**					
						GRAVEL BASE					
				1	10	**HIGH PLASTICITY CLAY** brown, greyish brown	CH	2-2-3 N_{60}=7	26	◎ ×	
930						**WEATHERED LIMESTONE**					
						Auger refusal at 4½ feet					

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PROJECT: VA Medical Center
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Kansas City, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

BORING B-6

DATE STARTED:	3/16/14	**DRILL COMPANY:**	PSI, Inc.
DATE COMPLETED:	3/16/14	**DRILLER:** DJK	**LOGGED BY:** JRB
COMPLETION DEPTH	20.0 ft	**DRILL RIG:**	CME-55
BENCHMARK:	N/A	**DRILLING METHOD:**	Hollow Stem Auger
ELEVATION:	938 ft	**SAMPLING METHOD:**	SS
LATITUDE:	39.0628°	**HAMMER TYPE:**	Automatic
LONGITUDE:	-94.5279°	**EFFICIENCY**	81%
STATION: N/A	**OFFSET:** N/A	**REVIEWED BY:**	AR

Water

While Drilling	not observed
Upon Completion	not observed
Delay	N/A

BORING LOCATION: See boring location Plan

REMARKS: N_{60} denotes the normalization to 60% efficiency as described in ASTM D4633.

Elevation (feet)	Depth, (feet)	Sample No.	Recovery (inches)	MATERIAL DESCRIPTION	USCS Classification	SPT Blows per 6-inch (SS)	Moisture, %	Additional Remarks
	0			**ASPHALT- 3 to 4-inches**				
				GRAVEL BASE				
		1	11	**POSSIBLE FILL-LOW PLASTICITY CLAY**-brown, reddish brown	CL	3-3-4 N_{60}=9	24	LL = 46 PL = 22
935		2	13	**HIGH PLASTICITY CLAY**brown, grey brown	CH	2-1-50/6"	30	
				WEATHERED LIMESTONE				
	5	3	18	Auger refusal at 7½ feet, Started Coring **WEATHERED LIMESTONE AND WEATHERED SHALE**		RQD=12 Rec=30%	0	DD = 157 pcf Q_u = 509.0 tsf
930	10	4	36	**CLAY SHALE**		RQD=83 Rec=100%		
925		5	24	**LIMESTONE**		RQD=100 Rec=100%		
	15	6	42			RQD=53 Rec=100%	0	DD = 165 pcf Q_u = 791.3 tsf
920		7	6	**SHALE**		RQD=100 Rec=100%		
		8	12	**LIMESTONE**		RQD=84 Rec=100%		
	20			Boring terminated at 20 feet				

STANDARD PENETRATION TEST DATA: N in blows/ft ◎; × Moisture; PL; LL (0, 25, 50). STRENGTH, tsf: ▲ Qu; ✳ Qp (0, 2.0, 4.0)

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PROJECT: VA Medical Center
LOCATION: 4801 Linwood Boulevard, Kansas City, Missouri

The stratification lines represent approximate boundaries. The transition may be gradual.

General Notes

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System (USCS), AASHTO 1988 and ASTM designations D2487 and D-2488 are used to identify the encountered materials unless otherwise noted. Coarse-grained soils are defined as having more than 50% of their dry weight retained on a #200 sieve (0.075mm); they are described as: boulders, cobbles, gravel or sand. Fine-grained soils have less than 50% of their dry weight retained on a #200 sieve; they are defined as silts or clay depending on their Atterberg Limit attributes. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size.

DRILLING AND SAMPLING SYMBOLS

- SFA: Solid Flight Auger - typically 4" diameter flights, except where noted.
- HSA: Hollow Stem Auger - typically 3¼" or 4¼ I.D. openings, except where noted.
- M.R.: Mud Rotary - Uses a rotary head with Bentonite or Polymer Slurry
- R.C.: Diamond Bit Core Sampler
- H.A.: Hand Auger
- P.A.: Power Auger - Handheld motorized auger
- SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
- ST: Shelby Tube - 3" O.D., except where noted.
- BS: Bulk Sample
- PM: Pressuremeter
- CPT-U: Cone Penetrometer Testing with Pore-Pressure Readings

SOIL PROPERTY SYMBOLS

- N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2-inch O.D. Split-Spoon.
- N_{60}: A "N" penetration value corrected to an equivalent 60% hammer energy transfer efficiency (ETR)
- Q_u: Unconfined compressive strength, TSF
- Q_p: Pocket penetrometer value, unconfined compressive strength, TSF
- w%: Moisture/water content, %
- LL: Liquid Limit, %
- PL: Plastic Limit, %
- PI: Plasticity Index = (LL-PL),%
- DD: Dry unit weight, pcf
- ▼,▽,▼: Apparent groundwater level at time noted

RELATIVE DENSITY OF COARSE-GRAINED SOILS

Relative Density	N - Blows/foot
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	50 - 80
Extremely Dense	80+

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

GRAIN-SIZE TERMINOLOGY

Component	Size Range
Boulders:	Over 300 mm (>12 in.)
Cobbles:	75 mm to 300 mm (3 in. to 12 in.)
Coarse-Grained Gravel:	19 mm to 75 mm (¾ in. to 3 in.)
Fine-Grained Gravel:	4.75 mm to 19 mm (No.4 to ¾ in.)
Coarse-Grained Sand:	2 mm to 4.75 mm (No.10 to No.4)
Medium-Grained Sand:	0.42 mm to 2 mm (No.40 to No.10)
Fine-Grained Sand:	0.075 mm to 0.42 mm (No. 200 to No.40)
Silt:	0.005 mm to 0.075 mm
Clay:	<0.005 mm

PARTICLE SHAPE

Description	Criteria
Flat:	Particles with width/thickness ratio > 3
Elongated:	Particles with length/width ratio > 3
Flat & Elongated:	Particles meet criteria for both flat and elongated

RELATIVE PROPORTIONS OF FINES

Descriptive Term	% Dry Weight
Trace:	< 5%
With:	5% to 12%
Modifier:	>12%

GENERAL NOTES

(Continued)

CONSISTENCY OF FINE-GRAINED SOILS

Q_U - TSF	N - Blows/foot	Consistency
0 - 0.25	0 - 2	Very Soft
0.25 - 0.50	2 - 4	Soft
0.50 - 1.00	4 - 8	Firm (Medium Stiff)
1.00 - 2.00	8 - 15	Stiff
2.00 - 4.00	15 - 30	Very Stiff
4.00 - 8.00	30 - 50	Hard
8.00+	50+	Very Hard

MOISTURE CONDITION DESCRIPTION

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 water table

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term	% Dry Weight
Trace:	< 15%
With:	15% to 30%
Modifier:	>30%

STRUCTURE DESCRIPTION

Description	Criteria
Stratified:	Alternating layers of varying material or color with layers at least ¼-inch (6 mm) thick
Laminated:	Alternating layers of varying material or color with layers less than ¼-inch (6 mm) thick
Fissured:	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided:	Fracture planes appear polished or glossy, sometimes striated

Description	Criteria
Blocky:	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed:	Inclusion of small pockets of different soils
Layer:	Inclusion greater than 3 inches thick (75 mm)
Seam:	Inclusion 1/8-inch to 3 inches (3 to 75 mm) thick extending through the sample
Parting:	Inclusion less than 1/8-inch (3 mm) thick

SCALE OF RELATIVE ROCK HARDNESS

Q_U - TSF	Consistency
2.5 - 10	Extremely Soft
10 - 50	Very Soft
50 - 250	Soft
250 - 525	Medium Hard
525 - 1,050	Moderately Hard
1,050 - 2,600	Hard
>2,600	Very Hard

ROCK BEDDING THICKNESSES

Description	Criteria
Very Thick Bedded	Greater than 3-foot (>1.0 m)
Thick Bedded	1-foot to 3-foot (0.3 m to 1.0 m)
Medium Bedded	4-inch to 1-foot (0.1 m to 0.3 m)
Thin Bedded	1¼-inch to 4-inch (30 mm to 100 mm)
Very Thin Bedded	½-inch to 1¼-inch (10 mm to 30 mm)
Thickly Laminated	1/8-inch to ½-inch (3 mm to 10 mm)
Thinly Laminated	1/8-inch or less "paper thin" (<3 mm)

ROCK VOIDS

Voids	Void Diameter
Pit	<6 mm (<0.25 in)
Vug	6 mm to 50 mm (0.25 in to 2 in)
Cavity	50 mm to 600 mm (2 in to 24 in)
Cave	>600 mm (>24 in)

GRAIN-SIZED TERMINOLOGY

(Typically Sedimentary Rock)

Component	Size Range
Very Coarse Grained	>4.76 mm
Coarse Grained	2.0 mm - 4.76 mm
Medium Grained	0.42 mm - 2.0 mm
Fine Grained	0.075 mm - 0.42 mm
Very Fine Grained	<0.075 mm

ROCK QUALITY DESCRIPTION

Rock Mass Description	RQD Value
Excellent	90 -100
Good	75 - 90
Fair	50 - 75
Poor	25 -50
Very Poor	Less than 25

DEGREE OF WEATHERING

Slightly Weathered:	Rock generally fresh, joints stained and discoloration extends into rock up to 25 mm (1 in), open joints may contain clay, core rings under hammer impact.
Weathered:	Rock mass is decomposed 50% or less, significant portions of the rock show discoloration and weathering effects, cores cannot be broken by hand or scraped by knife.
Highly Weathered:	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

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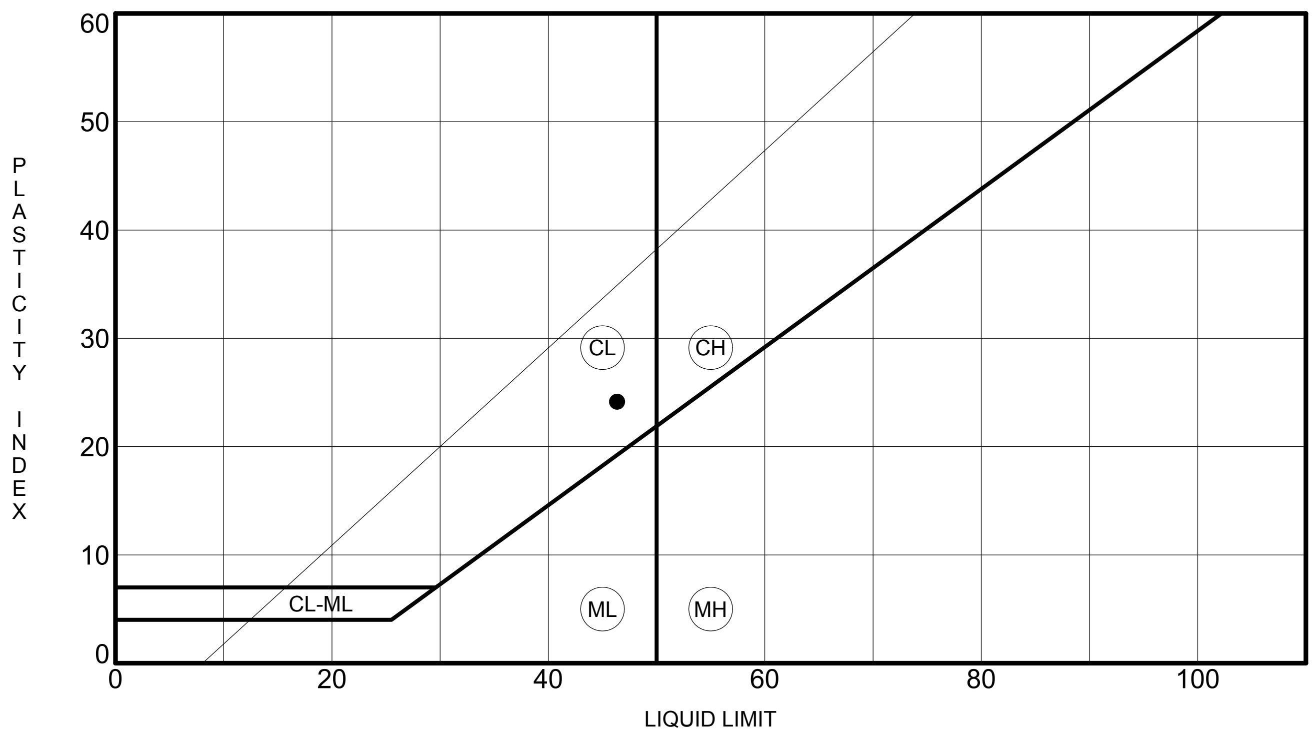
Laboratory Data



	Boring	Depth (ft)	LL	PL	PI	Fines	Classification (*Visual)
●	**B-6**	**1.5**	**46**	**22**	**24**		

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ATTERBERG LIMIT RESULTS

PSI Job No.: 338-882
Project: VA Medical Center
Location: 4801 Linwood Boulevard
Kansas City, Missouri

Boring B-2

Boring B-4

Boring B-6	
Boring B-6