Geotechnical Report

Sapp Building Relocation
to
Boone County Fairgrounds

Columbia, Missouri

May 15, 2008

Project No. 08052.01

For
Peckham & Wright Associates, Inc.
Columbia, Missouri

Prepared By:

Allstate Consultants, LLC
Columbia, Missouri

May 15, 2008

Peckham & Wright Associates, Inc.
15 South Tenth Street
Columbia, Missouri 65201

Attention: Mr. Nick Peckham, AIA

RE: Geotechnical Report
Sapp Building Relocation
Boone County Fairgrounds
Columbia, Missouri
Allstate Project No. 08052.01

Dear Mr. Peckham:

We have completed the subsurface exploration, laboratory testing and geotechnical engineering report for the Sapp Building Relocation to the Boone County Fairgrounds in Columbia, Missouri. The accompanying geotechnical report presents the findings of the subsurface exploration, the results of the laboratory tests and our engineering recommendations regarding earthwork and the design and construction of foundations for the proposed building.

It has been a pleasure to be of service to you during the initial phase of this project. If you have any questions regarding this geotechnical report, or if we may be of further service during the design or construction phases, please feel free to contact our office.

Sincerely,

Allstate Consultants, LLC

William A. Barrow

William A. Barrow, P.E., R. G.
Geotechnical Manager
Missouri: E-16978

WILLIAM A. BARROW, JR.
NUMBER
E-16978

5/15/08

WAB
Enclosures
3 Copies: Client
1 Copy: Ron Shy/Dave Weber

TABLE OF CONTENTS

GEOTECHNICAL REPORT

SAPP BUILDING RELOCATION
TO BOONE COUNTY FAIRGROUNDS
COLUMBIA, MISSOURI

ALLSTATE PROJECT NO. 08052.01
MAY 15, 2008

INTRODUCTION

Allstate Consultants, LLC has completed the subsurface exploration for the Sapp Building Relocation to the Boone County Fairgrounds in Columbia, Missouri. The project is located as shown on the Site Location Plan in the Appendix of this report.

Six (6) test borings, designated TB-1 through TB-6, were performed to depths of approximately 11 to 20 feet below the existing ground surface in the proposed building area. Laboratory tests were conducted on soil samples recovered from the borings and the soil samples were visually classified. The Test Boring Logs and a Test Boring Location Plan are included in the Appendix.

The purpose of this geotechnical engineering report is to describe the subsurface conditions encountered in the borings, evaluate the field and laboratory test data and provide geotechnical recommendations regarding earthwork and the design and construction of building foundations for the proposed project.

SITE AND PROJECT DESCRIPTION

The existing outdoor Horse Arena is located on the west side of Fairground Drive between the existing Expo Center on the north and an asphalt access road and existing Livestock Buildings # 1 to # 4 on the south.

The existing sand covered outdoor arena has an approximate surface elevation of 755 feet. Grass covered topography on the north side of the arena slopes very gently down to a shallow drainage swale then up to the Expo Center with its finished floor elevation of 758.8 feet. Existing grades in the asphalt parking lot on the east also slope gently from approximate elevation 758 feet on the north to elevation 756 feet the south. On the south and west sides of the existing arena the grass covered terrain slopes down to drainage ditches extending along the adjacent access roads. The ditches drain into a corrugated metal pipe at approximate elevation 748 to 749 feet near the southwest corner of the existing and proposed arenas.

Fill was placed to develop subgrades for the existing outdoor Horse Arena and surrounding buildings some 10 or more years ago. Although the fill appears to have performed well in the past, we are not aware of any test reports that might be available to document the placement and compaction of the fill.

The project consists of relocation of the Sapp Building to the site of the existing outdoor Horse Arena. The relocated metal building will have plan dimensions of 175 feet by 125 feet and will provide a new 22,000 square foot, indoor Horse Arena located as shown on the Test Boring Location Plan.

The new covered Horse Arena will have an earth floor with a sand surface established at elevation 756.3 feet. Approximately, 1 to 1.5 feet of earth and sand cover will be required to establish the finished surface of the new arena except for a narrow zone along the proposed south wall and existing south slope where some 2 to 4 feet of compacted fill will be needed to develop final grades. Site topography and grade constraints due to existing access roads and storm drainage features will result in some 30 or so feet of the exterior foundation wall being exposed to heights of about 1 to 3 feet near the new southwest building corner.

Available structural information indicates maximum downward axial wall and column loads will be less than 1 kip/lineal foot and 50 kips, respectively for the proposed clear span metal building. Maximum uplift and lateral loads will be on the order of 15 kips and about 60 kips, respectively. We understand basements and below grade pits will not be involved in this project.

FIELD EXPLORATION AND LABORATORY TESTING PROCEDURES

Test borings were located on the site by an Allstate Consultants geotechnical engineer using building corner stakes set by our survey crews. Ground surface elevations were determined using the building corner stakes and a topographic survey developed by our firm. Boring locations are shown on the Test Boring Location Plan in the Appendix.

Borings were performed using a truck-mounted, Mobile B-47 rotary drilling rig. Solid stem, continuous flight augers were used to advance the borings. At relatively close vertical intervals, the augers were removed from the boreholes and samples of the subsurface materials were obtained using the thin-walled tube and split-barrel sampling methods. Standard Penetration Tests (SPT) were performed during the split-barrel sampling procedure.

As the borings were advanced, the drilling crew recorded the results of the subsurface exploration on field boring logs. Information reported on the field boring logs included, the number, type, depth, recovery, penetration resistance and/or calibrated hand penetrometer reading for each sample. The field logs also included visual descriptions of the recovered samples; the driller's interpretation of subsurface conditions between samples based on drilling observations and the drill crew's groundwater measurements. Recovered soil samples were sealed to reduce moisture loss and transported to the laboratory for further testing and classification.

Thin-walled tube samples were tested in the laboratory to determine the field water content, dry unit weight and unconfined compressive strength. The unconfined compressive strength of some of the samples of clay soil was estimated using a calibrated hand penetrometer. The strength estimated using this device is approximate and was considered accordingly. Split-barrel samples were also tested in the laboratory to determine the field water content. On completion of laboratory testing, the soil samples were described and classified in general accordance with the Unified Soil Classification System (USCS) using visual-manual procedures. USCS Group Letter Symbols and Group Names were assigned based on visual-manual estimates.

The final Test Boring Logs included in this report present the results of the field exploration and the laboratory testing program. The final logs delineate the soil strata encountered in the borings and represent the geotechnical engineer's interpretation of subsurface conditions at the boring locations. These interpretations were developed from a review of the field boring logs with modifications based on the laboratory test results and on visual observations of the recovered samples. Graphical symbols depicting the soil strata are shown on the boring logs for illustrative purposes. It should be recognized that differing soil types could be present between samples and borings.

The Test Boring Log Notes included in the Appendix describe the symbols used on the Test Boring Logs and provide additional information regarding sampling procedures; soil and rock descriptions and classification; Standard Penetration Tests; laboratory test results; the consistency of fine grained soils; the relative density of coarse grained soils; and borehole water level observations.

The Unified Soil Classification System is also described in the Appendix and a legend is included relating the graphical symbols used on the boring logs to the USCS Group Letter Symbols and Group Names and to the principal rock types encountered in the project area.

SUBSURFACE CONDITIONS

Subsurface conditions encountered at the individual boring locations are indicated on the Test Boring Logs. Stratification lines shown on these logs represent approximate boundaries between soil and rock types. In-situ, the change between material types may be more gradual. Based on a review of the Test Boring Logs, subsurface conditions at the project site can be characterized as follows:

Soil and Rock Conditions

Borings typically encountered a few inches of topsoil in grass covered areas (TB-1 to TB-3); approximately 2 inches of gravel surfacing near the access road (TB-4); and about 5 inches of sand surfacing in the existing Horse Arena (TB-5 and TB-6). These surficial materials were underlain by previously placed fill, underlying native soil deposits and highly weathered Pennsylvanian aged bedrock.

The topsoil, gravel and sand surfacing encountered in the borings was underlain by some 2 to 8 feet of fill consisting of a mix of olive brown to light gray and dark gray fat clay with occasional weathered claystone fragments, a trace of gravel and scattered traces of topsoil and a few thin roots. The predominantly fat clay fill was relatively moist and generally stiff to very stiff in consistency although occasional zones of medium consistency materials were also encountered. The fill extended to depths of about 5 to 8 feet beneath the existing surface or to elevation 747 feet at the location of TB-1 and TB-4, near the west end of the proposed building. The fill thickness appeared to gradually decrease to the east and the fill was about 2 to 3 feet thick in borings TB-3 and TB-6.

Beneath the fat clay fill, borings encountered native deposits of lean clay, lean to fat clay and fat clay. These soils extended to depths of about 11 to 13 feet beneath the existing surface in borings on the west and to depths of about 5 feet in TB-3 and TB-6 on the east. The native lean to fat clays were typically stiff to very stiff and occasionally hard.

Glacial drift was encountered below the native lean clays and fat clays in most of the borings. The preconsolidated, glacial drift typically consisted of stiff to very stiff, fat clay with sand and gravel; sandy lean clay with gravel; and gravelly fat clay. A very thin wet soft zone was encountered in the lower glacial drift just above shale bedrock in TB-3.

Borings penetrated the native soil deposits at depths of about 8 to 17 feet and encountered highly weathered Pennsylvanian shale that extended to auger refusal at depths of 11 to 13 feet in TB-2, TB-3, and TB-6 and a sequence of highly weathered shale and claystone that extended to the termination of drilling at depths of 20 feet in TB-1, TB-4 and TB-5. A thin blocky coal seam was detected between the weathered shale and claystone in TB-4.

Groundwater Conditions

Field observations were periodically made during drilling and sampling and immediately after boring completion to measure borehole water levels. Groundwater was encountered at a depth of 18 feet in TB-5 but was not observed at these times in the other test borings.

Borehole water level observations were also made some 1 to 4 hours after the test borings were completed. At these times, groundwater was observed at depths of about 11 to 12 feet in borings TB-4 and TB-5 but was not observed in the other borings.

It should be recognized that short term water level observations in open boreholes, drilled into low permeability soil and/or bedrock may not represent actual groundwater conditions in these materials. In fact, a considerable length of time may be required for a groundwater level to be detected and to stabilize in an open borehole extending into materials similar to those encountered in the test borings at this site.

Installation and long term observation of piezometers or groundwater observation wells, screened in the hydrologic units of interest and sealed to prevent the entrance of surface water, would be required to more accurately characterize and evaluate groundwater levels and fluctuations in these levels in this geologic setting. While these services can be provided if requested, they are beyond the scope of this investigation.

Groundwater levels often vary across a project site and typically fluctuate at individual locations with variations in seasonal and climatological conditions. Perched water tables can develop and groundwater levels can be influenced by alterations in site grades, other construction activities, modifications to adjacent sites and factors not readily evident at the time the borings are performed.

During construction and at other times during the life of the proposed development, groundwater levels may be higher or lower than the levels reported on the boring logs. The likelihood of fluctuating groundwater levels and the potential occurrence of seasonally perched groundwater in the near surface soils, should be appropriately considered during development of design and construction plans for this project.

GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

Geotechnical Evaluation

Borings, performed in the area of the proposed building and new indoor Horse Arena, typically encountered a few inches of topsoil, gravel and/or sand surfacing over previously placed clay fill and underlying native clays, glacial soil deposits and highly weathered Pennsylvanian aged shale, coal and claystone.

The existing fill extended to depths of about 2 to 8 feet and consisted of a mix of olive brown to light gray and dark gray fat clay with occasional weathered claystone fragments, a trace of gravel and scattered traces of topsoil and thin roots. The predominantly fat clay fill was relatively moist and generally stiff to very stiff in consistency although occasional zones of medium consistency materials were also encountered. The fill extended to depths of about 5 to 8 feet beneath the existing surface or to elevation 747 feet at the location of TB-1 and TB-4, near the west end of the proposed Horse Arena. The fill appeared to gradually decrease in thickness to the east and the fill was about 2 to 3 feet thick and extended to approximate elevations 752 to 754 feet in east borings TB-3 and TB-6.

The native soil deposits lying beneath the existing fill typically consisted of lean clays, lean to fat clays, fat clays, sandy lean clays and gravelly fat clays that were reasonably moist, stiff to very stiff and occasionally hard in consistency.

The proposed clear span metal building will have relatively low downward column and wall loads estimated to be less than 50 kips and 1 kip/lineal ft, respectively. Significant uplift and lateral loads are also anticipated and these loads can significantly impact the foundation design. Metal buildings of this type are typically relatively flexible and more tolerant to minor foundation movements than many other types of structures.

Although there are no records documenting the placement and compaction of the existing fill, we understand the fill has been in place for 10 years or more and it appears the fill and underlying native soils have provided an adequate subgrade for the active outdoor horse arena during this period. Based on the results of the field exploration, laboratory tests and a review of the soil samples obtained from the borings, we are of the opinion that the existing fill, underlying native site soils and an appropriately designed shallow foundation system will provide suitable support of the proposed metal building. Should larger loads than those described in this report or a different type of structure that is less tolerant to movement be considered at a later time, additional evaluation and recommendations would need to be developed. Further evaluation and recommendations would also need to be developed if the use of the building changes in time and a concrete floor slab is contemplated.

Based on the results of our subsurface exploration, laboratory testing program and engineering evaluation, we are of the opinion the proposed clear span metal building can be supported on shallow foundations designed and constructed as recommended in this report. Detailed earthwork and foundation recommendations are provided in the sections that follow.

Site Earthwork

Prior to site earthwork within and around the building area, vegetation, organic material, topsoil and any zones of loose or low strength material should be removed from proposed fill areas. We estimate approximately 1 foot to as much as 1.5 feet of loose surficial material will need to be removed from the grass covered slopes on the south and west where side hill fills will be benched in, placed and compacted to support the proposed building. Similarly, low strength materials will need to be removed from the ditch line around the southwest corner of the proposed building and from the drainage swale along the north building line.

The client may want to consider removing the sand surfacing from the existing outdoor arena and stockpiling this material in the open area lying to the east for use, as feasible, in developing the final sand surface for the new facility. Any existing drainage piping that may be present within or around the edges of the sand cover would also need to be removed.

After vegetation, topsoil, sand and loose or low strength materials are removed from proposed fill surfaces, the exposed existing fill soils should be probed and/or proof-rolled with suitable rubber tired equipment in the presence of the geotechnical engineer or his on-site representative. If additional low strength materials are identified, these unsuitable materials should also be removed as recommended. Proof-rolling with heavy trucks may need to be avoided to prevent the existing moist fill soils from beginning to pump and becoming spongy and elastic under the heavy loading. Areas requiring fill should be scarified, recompacted with a sheepsfoot roller and provided with controlled, compacted fill constructed as recommended below.

Lean clay soils and fat clay soils from available borrow sources that have a liquid limit less than 55 and are free of organic matter, debris, large size gravel and cobbles are suitable for use as controlled, compacted fill in fill areas around and inside the proposed building if these soils are placed, moisture conditioned and compacted as recommended in this report.

Controlled, compacted fill should be placed in horizontal lifts having a maximum loose thickness of 8 to 10 inches. Lean clay and fat clay soils, suitable for use as controlled, compacted fill, should be placed and moisture conditioned to within the range of the optimum moisture content to 4 percent above the optimum moisture content and compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D698). Sheepsfoot and/or padfoot rollers are recommended for compaction of clay soils.

Permanent fill slopes located outside the building area should be constructed no steeper than 3 horizontal to 1 vertical. Compacted fills placed on terrain having a slope steeper than 6 horizontal to 1 vertical should be placed in relatively horizontal lifts and should be properly benched into the existing site materials.

We recommend each lift of controlled, compacted fill be observed during placement and compaction and be subjected to in-place field density testing by the geotechnical engineer's on-site representative. Should the field density test results indicate the recommended moisture and compaction levels have not been achieved, the area(s) represented by the test(s) should be reworked and/or recompacted and retested until the moisture and compaction requirements are met.

The geotechnical engineer of record's firm should be retained on a full time basis during earthwork construction to perform necessary tests and observations during removal of unsuitable materials, probing and proof-rolling of subgrades, placement and compaction of controlled, compacted fills, backfilling of any utility trench, foundation and other excavations and final subgrade preparation just prior to placement of the finished sand surfacing as specified by the client.

Building Foundations

In our opinion, the proposed clear span metal building can be supported on shallow foundations bearing on stiff, existing clay fill and underlying stiff native site clays, similar to those encountered in the test borings or on new controlled, compacted clay fill constructed as recommended in this report where additional compacted fill is needed.

Shallow foundations supported on stiff clay soils, as described above, should be proportioned using a net allowable total load design bearing pressure of 2000 psf. The net allowable bearing pressure refers to the pressure at the footing bearing level in excess of the minimum surrounding overburden pressure.

Footings beneath unheated areas and footings around the perimeter of the building should extend a minimum depth of at least 36 inches below the lowest adjacent finished grade for frost protection and to reduce the effects of seasonal, moisture-related, volume change in the supporting soils. We recommend isolated footings have a minimum width of 36 inches and continuous formed footings a minimum width of at least 16 inches.

Trench footings and frost walls should have a minimum width of 12 inches or such other width as determined by the structural engineer.

Foundations will be subjected to lateral and uplift loads. For lateral loads of short duration, we recommend sliding be resisted by an allowable base adhesion of 400 psf acting on the bottom contact area of the foundation that is in compression or by an allowable passive resistance of 800 psf acting on the vertical face of the foundation element in the direction perpendicular to the lateral load. Passive resistance should not be relied upon within 3 feet of finished grade. For any sustained lateral loads of long duration, we recommend an ultimate coefficient of friction of 0.25 be used on the bearing area of the foundation that is in compression. An appropriate factor of safety should be applied to the ultimate lateral base resistance calculated using this value. Lateral loads can also be resisted by lateral tie rods designed by the structural engineer. Uplift loads can be resisted by the effective weight of an appropriate portion of the reinforced concrete foundation system and any overlying backfill as determined by the structural engineer.

Surface water and/or perched groundwater may enter foundation excavations during construction. In our opinion, water entering foundation excavations from these sources should be promptly removed using sump pumps or gravity drainage ditches.

The bearing surface of all foundation excavations should be free of water and loose or unsuitable soil prior to placing concrete. Reinforcement and concrete should be placed soon after excavation to minimize disturbance of the bearing surface and supporting soils. Should the bearing soils become dry, disturbed, saturated, or frozen, the impacted soil should be removed to suitable material prior to placing concrete. The geotechnical engineer of record's firm should be retained to observe and test the foundation bearing materials during construction.

If unsuitable bearing materials are identified by the geotechnical engineer or his on-site representative, the foundation excavations should be extended deeper to suitable soils. Foundations could bear directly on these deeper suitable materials or on lean concrete backfill placed in the excavations if these measures are approved by the structural engineer.

Foundations designed and supported on existing subgrades similar to those described in this report or on new controlled, compacted fill prepared as recommended herein are expected to experience total settlements on the order of about 1 inch and differential settlements between adjacent foundation elements of approximately ¾ of the total settlement due to immediate and long term consolidation of the supporting soils. Due to unknowns regarding the placement and compaction of the existing fill there is some risk that the fill may not be as uniform as anticipated and may be lower in strength than indicated by the borings and laboratory tests. As a result, maximum total and differential settlements could be somewhat larger than those estimated and described above. However, based on the results of our exploration and laboratory testing program, the apparent performance of the fill to date and the length of time the existing fill has been in place, we are of the opinion the risk that large settlements will occur is relatively small.

Seismicity

Building foundations should be capable of supporting earthquake loads as stipulated in the International Building Code, 2006, or other such applicable code as determined by the structural engineer of record. Based on the results of the subsurface exploration and our experience with geologic conditions in the project area, we recommend the proposed site be classified as Site Class C as defined in Table 1613.5.2 in Section 1613.5.2 if IBC, 2006 governs the design.

Arena Subgrade

After the Horse Arena subgrade construction is complete, care should be taken to maintain the recommended subgrade moisture and density prior to placement of the sand surfacing as specified by others and any drainage systems that may be needed to drain the sand surface. Completed subgrades that become dry, saturated, frozen, disturbed or altered by construction activity should be reconditioned to meet the recommendations of this report prior to placement of the sand surfacing.

Lateral Earth Pressures for Exposed Foundation Walls

We understand exposed foundation walls could retain up to 2 to 3 feet of backfill in the southwest corner of the proposed building. Walls retaining earth backfill on one side will be subjected to lateral earth pressures. Exposed concrete foundation walls that are provided with appropriate lateral support are commonly designed for the "at rest" lateral earth pressure. This earth pressure is the minimum lateral pressure that should be used to design restrained walls that will experience essentially no wall rotation. Cantilever retaining walls founded on soil and not restrained from lateral movement, typically experience a small amount of rotation and are typically designed for the "active" lateral earth pressure. Additional lateral earth pressures can develop that exceed the "at rest" and "active" earth pressures. The actual earth pressures developed will depend on the structural design, wall bracing and restraint, construction sequence and methods, backfill compaction procedures and the type and shear strength of the wall backfill.

For the "at rest" condition and controlled compacted granular backfill, we recommend exposed foundation walls be designed for an earth pressure equivalent to that of a fluid exerting a lateral pressure of at least 55 pounds per cubic foot (pcf) per foot of wall height. Where, moisture conditioned, controlled compacted lean clay or marginally fat clay soil meeting the requirements of this report (liquid limit less 55) is used for general wall backfill, we recommend a design equivalent fluid pressure of at least 75 pcf per foot of wall height be used for the "at rest" condition.

We recommend that cantilever retaining walls backfilled with controlled, compacted granular materials be designed for an earth pressure equivalent to that of a fluid exerting a lateral pressure of at least 40 pounds per cubic foot (pcf) per foot of wall height. Where moisture conditioned, controlled compacted lean clay or marginally fat clay soil meeting the requirements of this report are used for general wall backfill, we recommend a design equivalent fluid pressure of at least 55 pcf per foot of wall height be used for the "active" condition.

The above minimum design earth pressures do not include a factor of safety and assume the wall backfill will consist of controlled, compacted fill placed in horizontal lifts as recommended in this report. The recommended minimum design earth pressures do not include the additional lateral stresses that can develop during compaction of the wall backfill or due to heavy construction equipment that may be operated too close to walls or other surcharge loads that may be present above or below finished grade. The minimum design earth pressures also do not account for possible hydrostatic forces that may develop on the walls due to the presence of groundwater.

In our opinion, the backfill placed behind the exposed portions of the foundation walls should consist of controlled compacted granular fill. The lower design earth pressures recommended for compacted granular backfill are only valid if the granular backfill extends out from the heel of the wall footing at an angle of 45 degrees or less from the horizontal.

Whether the general wall backfill consists of granular material or lean to fat clay soil meeting the recommendations of this report, we recommend the exposed foundation walls be provided with wall drains to reduce the potential that hydrostatic loads will be applied to these walls.

Slotted or perforated rigid plastic drain piping should be installed behind these walls. The drainage piping should provide positive gravity drainage and should be surrounded by clean, free draining granular material graded to prevent plugging due to intrusion of fines. If graded filter materials are not preferred, clean, free draining gravel may be used if the gravel is surrounded with a suitable nonwoven geotextile designed to prevent migration of fines into the drainage material. Prefabricated drainage products protected with geotextiles and designed for the intended use can also be used if appropriately selected.

We recommend the backfilled side of the exposed foundation walls be provided with wall drains installed above the drainage piping and surrounding drainage material. The wall drains should consist of clean, free draining material protected from plugging due to intrusion of fines. The wall drains should be at least 2 feet thick and should extend to finished subgrade level when located inside the building. Wall drainage systems and perforated piping should discharge into independent, non-perforated or non-slotted discharge piping sloped to drain away from the building by gravity.

Surface Drainage

We recommend final grading plans rapidly direct surface run-off away from the building area. Roof gutter and downspout discharge should be channeled well away from the building to reduce the potential that water will accumulate adjacent to the facility. Future foundation and/or utility trench backfill settlement around the perimeter of the building should be corrected to prevent ponding of water in these areas. We recommend that plants and trees with significant moisture requirements not be located adjacent to the proposed building.

Additional Considerations

The clay soils in the project area are prone to shrinkage and swelling with variations in moisture content. High plasticity soils such as fat clay generally have a greater potential for moisture induced volume change than less plastic materials such as lean clay. However, even lean clay can shrink and swell with variations in moisture levels. We recommend subgrades be constructed and observed as recommended in this report and that close attention be paid to maintaining moisture levels in subgrades prior to installation of foundations; providing adequate surface and subsurface drainage and keeping plants and trees well outside the area where they can adversely influence building performance.

The procedures recommended in this report for removal of low strength site soils; probing and proof-rolling of proposed fill surfaces; construction of controlled, compacted fills may not eliminate all future subgrade volume change and resultant foundation and movement. However, the recommendations described in this report should significantly reduce the potential for consolidation settlement, subgrade volume change and future building movements.

CONCLUSION AND LIMITATIONS

The authorized geotechnical engineering services have been completed. The resulting geotechnical recommendations included in this report provide a basis for development of earthwork and foundation designs for the proposed development. We recommend that

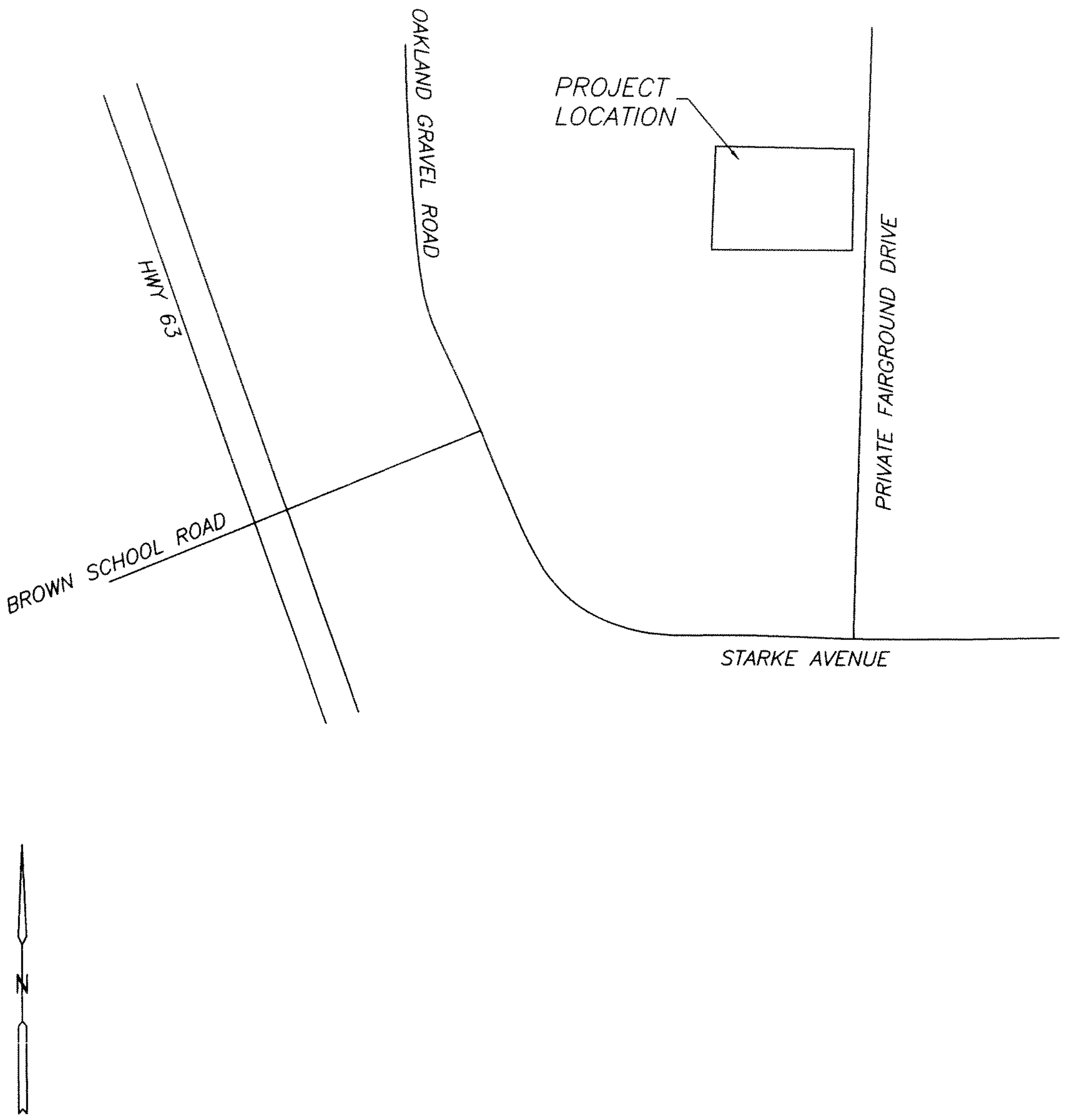
Allstate Consultants be retained to review the final project plans and specifications so that we can comment on and assist in the interpretation and implementation of our geotechnical recommendations.

Allstate Consultants should be retained during construction of this project to provide geotechnical observation and testing services for earthwork and foundation construction.

The evaluations, analyses and recommendations provided in this report are based on the subsurface conditions encountered in the test borings performed at the locations indicated on the Test Boring Location Plan and from other information discussed in this report. Our geotechnical report does not consider variations that could occur between boring locations or changes that may occur due to the passage of time, the modifying effects of weather or adjacent construction activities. The character and extent of such variations may not become evident until during or after construction. Should variations be identified, we should be notified immediately so that further evaluations and additional recommendations can be developed.

The scope of our geotechnical engineering services does not include either specifically or by implication any environmental evaluation of this site nor identification of contaminated or hazardous materials or conditions. Further, we have performed no assessment of the possible presence of bacteria or fungi nor the potential for development of problems associated with mold. If the owner or client is concerned about the potential for such issues, other environmental studies should be performed.

This geotechnical report has been prepared for the exclusive use of our client for specific application to this project only and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended to be made. During construction, site safety, excavation support, and dewatering will be the responsibility of others. Should changes occur in the nature, design or location of the proposed building, as described in this report, the evaluations, recommendations and conclusions contained herein shall not be considered valid unless Allstate Consultants reviews the changes and provides written verification or modification of the conclusions of this report.



LOCATION MAP
(NOT TO SCALE)

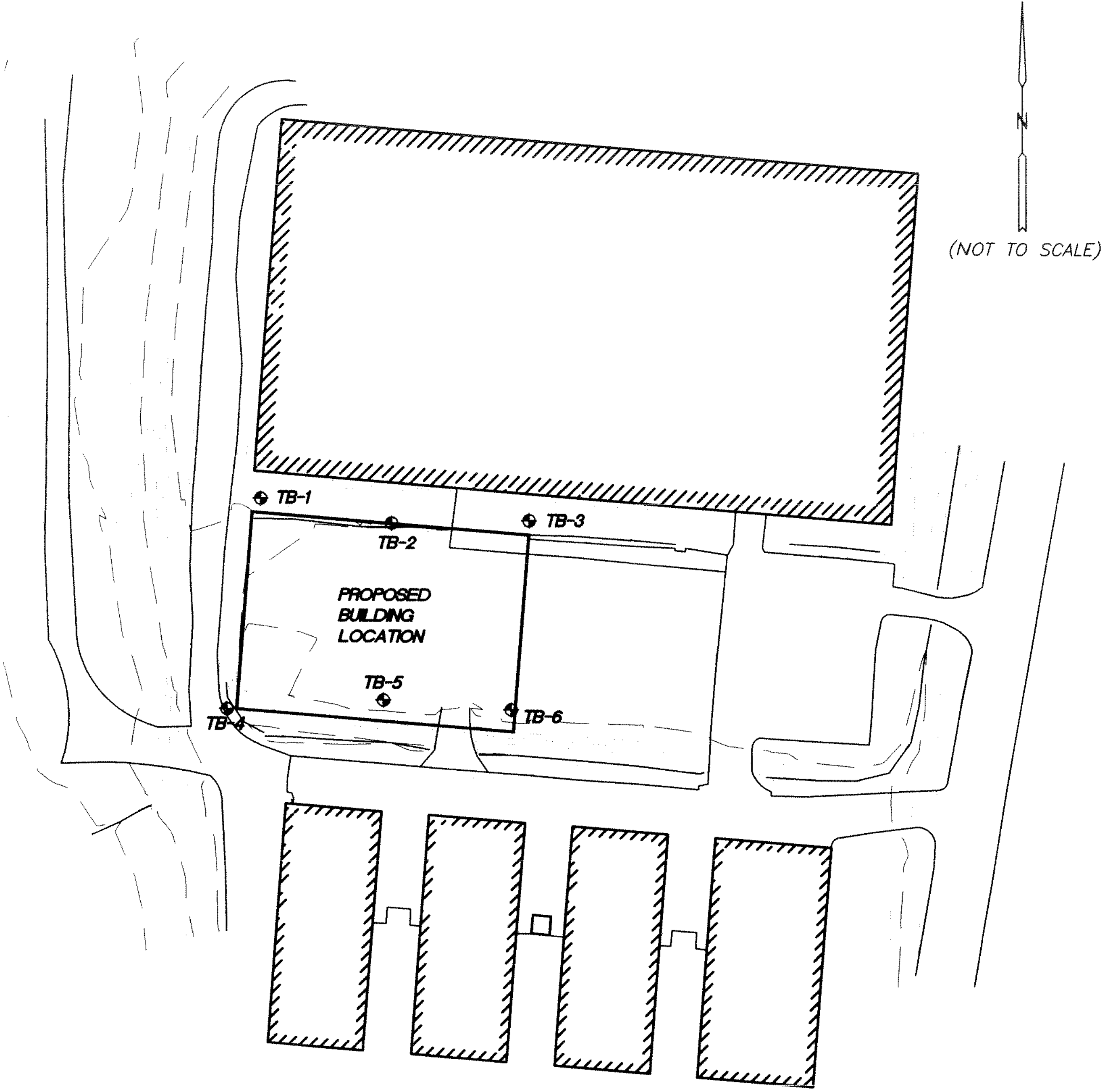
PREPARED BY:

ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MISSOURI 65201
phone (573) 875-8799
fax (573) 875-8850

DATE: MAY 12, 2008

SITE LOCATION PLAN
SAPP BUILDING RELOCATION TO BOONE COUNTY FAIRGROUNDS
COLUMBIA, MISSOURI

DRAWN BY:	PROJECT MGR:	PROJECT NUMBER:
AJ	W.A.B.	08052.01



PREPARED BY:

ALLSTATE CONSULTANTS
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MISSOURI 65201
phone (573) 875-8799
fax (573) 875-8850

DATE: MAY 12, 2008

TEST BORING LOCATION PLAN SAPP BUILDING RELOCATION TO BOONE COUNTY FAIRGROUNDS COLUMBIA, MISSOURI

DRAWN BY:	PROJECT MGR:	PROJECT NUMBER:
AJ	W.A.B.	08052.01

TEST BORING LOG
TEST BORING NO. 1

PROJECT: Sapp Building Relocation to Fairgrounds
CLIENT: Peckham & Wright Associates, Inc.
SITE LOCATION: Boone County Fairgrounds, Columbia, MO
PROJECT NO: 08052.01

DEPTH (feet)	SAMPLES NUMBER	TYPE	RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION Approx. Surface Elevation: 755.0	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT PL – FIELD WATER CONTENT – LIQUID LIMIT LL (10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						1" TOPSOIL				
	1	3ST	11	CH		**FILL**, Fat Clay, With Weathered Claystone Fragments,		● 34.0	92	1480
5	2	3ST	14	CH		Olive Brown to Light Gray, Medium to Stiff, CH		● 30.6	93	1990
	3	3ST	19	CH		Grading Dark Gray, Trace Topsoil		● 26.4	97	2380
8						& Occasional Thin Roots 747.0				
10	4	3ST	21	CH		**FAT CLAY,** Light Gray Mottled Brown,		● 25.9	99	4460
	5	3ST	19	CH		Very Stiff, CH		● 24.4	102	4220
13						742.0				
15	6	SS	18	CH		**FAT CLAY,** Trace Sand & Gravel, Yellow Brown Mottled Gray, Very Stiff, CH	6/9/12	● 34.7		*4500
17						738.0				
						WEATHERED CLAY SHALE, Dark Gray				
20	7	SS	2			735.0	50-3"			*9000+
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock classification estimated from disturbed samples. Coring and lab analyses may reveal other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: BOWERS & ASSOCIATES, INC.
DRILLING METHOD: MOBILE B47 WITH 4" CONTINUOUS FLIGHT AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE AB ▼
DEPTH TO WATER 3 HOURS AFTER BORING COMPLETION: NONE ▼

ALLSTATE CONSULTANTS, LLC
COLUMBIA, MISSOURI

BORING
STARTED: 4/23/08
COMPLETED: 4/23/08
LOG APPROVED BY: WAB

TEST BORING NO. 1
PAGE 1 OF 1

TEST BORING LOG

TEST BORING NO. 2

PROJECT: Sapp Building Relocation to Fairgrounds
CLIENT: Peckham & Wright Associates, Inc.
SITE LOCATION: Boone County Fairgrounds, Columbia, MO
PROJECT NO: 08052.01

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION Approx. Surface Elevation: 755.0	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT PL — FIELD WATER CONTENT — LIQUID LIMIT LL (10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						1" TOPSOIL				
3	1	3ST	16	CH		**FILL,** Fat Clay, Trace Gravel, Olive Brown to Gray, Stiff, CH 752.0		29.4	95	4590
4.5	2	3ST	16	CL		**LEAN CLAY,** Dark Gray, Hard, CL 750.5		19.1	108	11800
7.5	3	3ST	16	CH		**FAT CLAY,** Dark Olive Gray, Very Stiff, CH 747.5		22.4	104	7890
10	4	3ST	20	CL		**SANDY LEAN CLAY,** With Gravel, Yellow to Red Brown, Stiff, CL 745.0		23.1	99	3940
	5	3ST	22			**HIGHLY WEATHERED SHALE,** Olive to Yellow Brown, Very Stiff		25.8	99	4100
13.5	6	SS	0			741.5	50-0"			
						AUGER REFUSAL AT 13.5 FT.				

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock classification estimated from disturbed samples. Coring and lab analyses may reveal other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: BOWERS & ASSOCIATES, INC.
DRILLING METHOD: MOBILE B47 WITH 4" CONTINUOUS FLIGHT AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ∇
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE AB ▼
DEPTH TO WATER 1 HOUR AFTER BORING COMPLETION: NONE ▼

ALLSTATE CONSULTANTS, LLC
COLUMBIA, MISSOURI
BORING
STARTED: 4/23/08
COMPLETED: 4/23/08
TEST BORING NO. 2
LOG APPROVED BY: WAB
PAGE 1 OF 1

TEST BORING LOG
TEST BORING NO. 3

PROJECT: Sapp Building Relocation to Fairgrounds
CLIENT: Peckham & Wright Associates, Inc.
SITE LOCATION: Boone County Fairgrounds, Columbia, MO
PROJECT NO: 08052.01

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION Approx. Surface Elevation:	756.5	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT PL — FIELD WATER CONTENT — LIQUID LIMIT LL (10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						1" TOPSOIL					
2	1	SS	18	CH		FILL, Fat Clay, Stiff, CH	754.5	4/5/6	25.8		*4000
						FAT CLAY,					
						Gray Mottled Red Brown,					
5	2	SS	18	CH		Very Stiff, CH	751.5	7/11/13	24.1		*6000
						GRAVELLY FAT CLAY,					
	3	SS	18	CH		Olive to Dark Brown,		4/6/10	35.6		*3000
						Stiff, CH					
9.5	4	SS	18	CH		With Red Brown, Wet, Soft Zone	747.0	3/6/20	50.4		*500 *9000+
						HIGHLY WEATHERED SHALE,					
11.1	5	SS	1				745.4	50-1"	29.6		*9000+

AUGER REFUSAL AT 11.1 FT

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual.
Rock classification estimated from disturbed samples. Coring and lab analyses may reveal other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: BOWERS & ASSOCIATES, INC.
DRILLING METHOD: MOBILE B47 WITH 4" CONTINUOUS FLIGHT AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE AB ▼
DEPTH TO WATER HOURS AFTER BORING COMPLETION: ▼

BORING
STARTED: 4/23/08
COMPLETED: 4/23/08
LOG APPROVED BY: WAB

ALLSTATE CONSULTANTS, LLC
COLUMBIA, MISSOURI

TEST BORING NO. 3
PAGE 1 OF 1

TEST BORING LOG
TEST BORING NO. 4

PROJECT: Sapp Building Relocation to Fairgrounds
SITE LOCATION: Boone County Fairgrounds, Columbia, MO
CLIENT: Peckham & Wright Associates, Inc.
PROJECT NO: 08052.01

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION Approx. Surface Elevation: 752.0	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT PL — FIELD WATER CONTENT — LIQUID LIMIT LL (10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						2" GRAVEL				
	1	3ST	16	CH		**FILL,** Fat Clay, Trace Topsoil, With Weathered Claystone Fragments, Olive Brown to Dark Gray,		● 27.4	97	2340
5	2	3ST	16	CH		5 Stiff, CH 747.0		● 23.8	103	2840
	3	3ST	12	CL		**LEAN CLAY,** Jointed, Dark Gray, Stiff, CL 7.5 744.5		● 23.5	102	3750
10	4	3ST	24	CH		**FAT CLAY,** Gray Mottled Red Brown, 11 Very Stiff, CH 741.0		● 24.4	102	5180
	5	3ST	24			**HIGHLY WEATHERED CLAY SHALE,** Olive to Yellow Brown, Stiff ▼		● 34.5	88	3150
15	6	SS	18			Grading Light to Dark Gray, Very Stiff 17 735.0	6/7/12	● 33.2		*5000
						17.5 **COAL,** Black, Blocky 734.5				
20	7	SS	18			**HIGHLY WEATHERED CLAYSTONE,** 20 Light Gray, 732.0	15/20/33	● 22.4		*9000
						BOTTOM OF BORING AT 20 FT.				
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual.
Rock classification estimated from disturbed samples. Coring and lab analyses may reveal other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: BOWERS & ASSOCIATES, INC.
DRILLING METHOD: MOBILE B47 WITH 4" CONTINUOUS FLIGHT AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE AB ▼
DEPTH TO WATER 4 HOURS AFTER BORING COMPLETION: 12.5 FT ▼

ALLSTATE CONSULTANTS, LLC
COLUMBIA, MISSOURI
BORING
STARTED: 4/28/08
COMPLETED: 4/28/08
LOG APPROVED BY: WAB
TEST BORING NO. 4
PAGE 1 OF 1

TEST BORING LOG
TEST BORING NO. 5

PROJECT: Sapp Building Relocation to Fairgrounds
CLIENT: Peckham & Wright Associates, Inc.
SITE LOCATION: Boone County Fairgrounds, Columbia, MO
PROJECT NO: 08052.01

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION (Approx. Surface Elevation: 755.0)	ELEV.	SPT BLOW COUNTS (Blows/6")	FIELD WATER CONTENT (PL ⊢ ● ⊣ LL; 10 20 30 40 50 60)	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						5" SAND					
	1	3ST	9	CH		**FILL,** Fat Clay, With Weathered Claystone Fragments,			22.1	104	2800
5	2	3ST	19	CH		Olive Brown to Dark Gray, Stiff, CH	750.0		24.3	104	3160
8	3	3ST	23	CL CH		**LEAN TO FAT CLAY,** Dark Gray to Olive Gray, Hard, CL/CH	747.0		20.8	107	10110
11	4	3ST	24	CH		**FAT CLAY,** With Sand & Gravel, Red Brown to Gray, Very Stiff, CH	744.0		23.7	100	6420
						▼					
	5	3ST	24			**HIGHLY WEATHERED CLAY SHALE,**			25.5	99	4080
	6	SS	18			Olive to Yellow Brown, Stiff to Very Stiff		5/10/11	38.2		*2000 *6000
18						With Cobble Zones ∇ ▼	737.0				
20	7	SS	18			**HIGHLY WEATHERED CLAYSTONE,** Light Gray	735.0	24/22/27	17.5		*9000+
						BOTTOM OF BORING AT 20 FT.					

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock classification estimated from disturbed samples. Coring and lab analyses may reveal other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: BOWERS & ASSOCIATES, INC.
DRILLING METHOD: MOBILE B47 WITH 4" CONTINUOUS FLIGHT AUGERS
DEPTH WATER FIRST ENCOUNTERED: 18 FT ∇
DEPTH TO WATER AFTER BORING COMPLETION (AB): 18 FT ▼
DEPTH TO WATER 2 HOURS AFTER BORING COMPLETION: 11.5 FT ▼

ALLSTATE CONSULTANTS, LLC
COLUMBIA, MISSOURI

BORING
STARTED: 4/28/08
COMPLETED: 4/28/08
LOG APPROVED BY: WAB

TEST BORING NO. 5
PAGE 1 OF 1

TEST BORING LOG
TEST BORING NO. 6

PROJECT: Sapp Building Relocation to Fairgrounds
SITE LOCATION: Boone County Fairgrounds, Columbia, MO
CLIENT: Peckham & Wright Associates, Inc.
PROJECT NO: 08052.01

DEPTH (feet)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES RECOVERY (inches)	USCS SYMBOL	GRAPHICAL SYMBOL	MATERIAL DESCRIPTION Approx. Surface Elevation: 755.0	SPT BLOW COUNTS (Blows/6")	PLASTIC LIMIT PL — FIELD WATER CONTENT — LIQUID LIMIT LL 10 20 30 40 50 60	DRY UNIT WEIGHT pcf	UNCONFINED COMPRESSIVE STRENGTH psf
						5" SAND				
3	1	SS	18	CH		**FILL,** Fat Clay, Olive to Dark Gray,Very Stiff, CH 752.0	4/8/8	● 21.4		*5000
5	2	SS	18	CH		**FAT CLAY,** Gray Mottled Red Brown, Very Stiff, CH 750.0	7/10/15	● 24.4		*8000
8	3	SS	18	CH		**FAT CLAY,** With Sand & Gravel, Red Brown to Yellow Brown, Very Stiff, CH 747.0	8/10/14	● 30.5		*7000
10	4	SS	18			**HIGHLY WEATHERED CLAY SHALE,** Olive Brown,	3/14/49	● 22.2		*5000 *9000+
12.3	5	SS	10			742.7	35/50-4"	● 18.5		*9000+
						AUGER REFUSAL AT 12.5 FT				
15										
20										
25										
30										
35										

Note: Stratification lines represent approximate boundaries between soil and rock types. In-situ, the transition between strata may be gradual. Rock classification estimated from disturbed samples. Coring and lab analyses may reveal other rock types. * Based on Calibrated Hand Penetrometer.

DRILLING CONTRACTOR: BOWERS & ASSOCIATES, INC.
DRILLING METHOD: MOBILE B47 WITH 4" CONTINUOUS FLIGHT AUGERS
DEPTH WATER FIRST ENCOUNTERED: NONE ▽
DEPTH TO WATER AFTER BORING COMPLETION (AB): NONE AB ▼
DEPTH TO WATER 1 HOUR AFTER BORING COMPLETION: NONE ▼

ALLSTATE CONSULTANTS, LLC
COLUMBIA, MISSOURI

BORING STARTED: 4/28/08
COMPLETED: 4/28/08
LOG APPROVED BY: WAB

TEST BORING NO. 6
PAGE 1 OF 1

TEST BORING LOG NOTES

SAMPLE TYPE

3ST	SHELBY TUBE SAMPLE – Obtained by pushing a standard 3 inch OD thin-walled tube sampler using the hydraulic stroke of the drilling rig.
S S	SPLIT-SPOON SAMPLE – Obtained by driving a standard 2 inch OD by 1 3/8 inch ID split-barrel sampler during performance of a Standard Penetration Test (SPT).
C S	CONTINUOUS SAMPLE - Obtained by inserting a 3 inch OD by 2 ¼ ID continuous split-barrel sampler into the lead section of a hollow stem auger string and advancing the sampler with the hollow stem auger as the auger penetrates into the underlying soil.
N X	ROCK CORE SAMPLE - Obtained by coring the rock with an NX size core barrel and diamond bit. The NX size core is approximately 2 1/8 inches in diameter. An NQ size core is approximately 2 inches in diameter.

SOIL AND ROCK DESCRIPTIONS AND CLASSIFICATION

Soil samples are described and classified in general accordance with the Unified Soil Classification System (USCS) using visual-manual procedures. All USCS Group Letter Symbols and Group Names are based on visual-manual estimates except where accompanied by results of Atterberg limits tests and grain size analyses. A brief description of the USCS is attached.

Fine-grained soils are also described in terms of their consistency and coarse-grained soils in terms of their in-place relative density. For fine-grained soils, the consistency is based on the unconfined compressive strength (Table 1). For coarse-grained soils the relative density is related to the N value determined from the Standard Penetration Test (Table 2).

Rock strata penetrated by flight augers or rock bits and intermittently sampled with a split-barrel sampler are described and classified based on drilling performance and visual observation of disturbed samples. Rock cores may reveal other rock types.

Rock core samples, obtained with a core barrel and diamond bit, are visually described and classified based on lithology, bedding, structure, degree of weathering, and hardness. All rock descriptions and classifications are based on visual observations. Petrographic analyses may indicate other rock types. Rock core recovery is expressed as the ratio of the length of core recovered to the length of the core run. Rock Quality Designation (RQD) is the ratio of the total length of the pieces of core that are hard, sound and 4 inches or longer to the length of the core run. Both core recovery and RQD are expressed as a percentage.

Soil and rock strata, delineated on the boring log, represent the geotechnical engineer's interpretation of subsurface conditions at the boring location. The interpretation is developed from the field boring log with modifications based on the laboratory test results and visual observations of the soil and rock samples. Graphical symbols depicting the soil and rock strata are shown on the boring logs for illustrative purposes. Different soil or rock types could be present between samples. A legend relating the graphical symbols to the USCS Group Letter Symbols and Group Names and the principal rock types encountered in the project area is attached. Stratification lines shown on the boring logs represent approximate boundaries between the various soil and rock types. In-situ, the transition between the soil and rock strata may be gradual.

STANDARD PENETRATION TEST

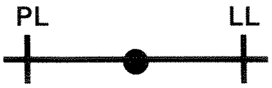
A standard split-barrel sampler (2 inch OD by 1 3/8 inch ID) is driven 18 inches into the soil by a 140 pound hammer repeatedly dropped from a height of 30 inches. The hammer blows are recorded for each 6 inches of penetration and the penetration resistance or N Value is considered the number of blows required for the final 12 inches of sampler penetration. Blows per 6 inch interval are recorded as 8/18/23 etc. under the Test Boring Log heading *SPT Blow Counts*. Where the sampler penetrated less than 6 inches under 50 hammer blows for one of the intervals, the results are recorded as 8/18/50-3".

LABORATORY TEST RESULTS AND SYMBOLS

PLASTIC LIMIT (PL) - Water content at which a soil will just begin to crumble when rolled into a thread approximately 1/8 inch in diameter. Generally represents the water content below which the soil develops cracks upon significant deformation.

LIQUID LIMIT (LL) - Water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of ½ inch under the impact of 25 blows in a standard liquid limit apparatus. Generally represents the water content above which the soil is in suspension and has minimal shear strength.

FIELD WATER CONTENT - Water content of the soil or rock at depth indicated at time of exploration. The water content may fluctuate with seasonal and climatological conditions and may be altered by excavation, exposure and other construction activities or by conditions not apparent during exploration.



- Relationship between plastic limit (PL), field water content, and liquid limit (LL). The plasticity index, (PI), is the difference between the liquid and plastic limits. In general, the higher the liquid limit and PI, the more a soil is inherently prone to volume change. However, soils with lower liquid limits and PI's can also experience volume change.

Soils having field water contents approaching the liquid limit typically have low shear strength and high compressibility. Soils having water contents near the plastic limit typically have higher shear strength and lower compressibility.

UNCONFINED COMPRESSIVE STRENGTH _ The load per unit area at which an unconfined cylindrical specimen of soil will fail in a simple, quick compression test without lateral support. Expressed in pounds per square foot on the boring log.

* Indicates unconfined compressive strength estimated using a calibrated hand penetrometer.

TABLE 1

CONSISTENCY OF FINE-GRAINED SOILS

UNCONFINED COMPRESSIVE STRENGTH, Qu, psf	CONSISTENCY
Less than 500 psf	Very Soft
500 - 1,000	Soft
1,000 - 2,000	Medium
2,000 - 4,000	Stiff
4,000 - 8,000	Very Stiff
Above - 8,000	Hard

TABLE 2

RELATIVE DENSITY OF COARSE-GRAINED SOILS

SPT N VALUE Blows/ft.	RELATIVE DENSITY
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
Above 50	Very Dense

TABLE 3

ROCK QUALITY DESIGNATION RQD

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

WATER LEVEL SYMBOLS AND OBSERVATIONS:

WS or WD - Borehole water level observation *While Sampling* or *While Drilling* - ∇

AB - Borehole water level observation *After Boring* completion - ▼

24 Hrs AB – Water level observation *24 Hrs After Boring* completion - ▼
or other such time as recorded on the boring log.

WCI - *Wet Cave In*

DCI - *Dry Cave In*

Borehole water level measurements were made at the times and under the conditions indicated on the boring logs. Groundwater levels may vary across the site and will fluctuate with seasonal and climatological conditions. Groundwater levels may also be altered by site grading and/or other construction activities. Borehole water level measurements in highly pervious soils may represent groundwater conditions in these units at the time of the observations. In semi-pervious and fine-grained soils, short term water level measurements in borings may not represent actual groundwater conditions. Long term observations of piezometers, screened in the hydrologic units of interest, and sealed from the influence of surface water are typically required to evaluate groundwater conditions and fluctuations in groundwater levels in low permeability soils.

SOIL AND ROCK SYMBOLS FOR BORING LOGS

SOIL SYMBOLS

GRAPHICAL SYMBOL	USCS Group Symbol	USCS Group Name
⁂	GW	Well-graded gravel
⁘	GP	Poorly graded gravel
▥	GM	Silty gravel
▨	GC	Clayey gravel
⁂	SW	Well-graded sand
░	SP	Poorly graded sand
▥	SM	Silty sand
▨	SC	Clayey sand
▨	CL	Lean clay
▥	ML	Silt
▨	CL-ML	Silty Clay
▨	OL	Organic clay
┆		Organic silt
▨	CH	Fat clay
▥	MH	Elastic silt
▨	OH	Organic clay
┆		Organic silt
〰	PT	Peat

ROCK SYMBOLS

GRAPHICAL SYMBOL	MAJOR ROCK TYPE
▥	SILTSTONE
☰	SHALE
░	SANDSTONE
▦	LIMESTONE
▤	DOLOMITE
■	COAL
▧	UNDERCLAY
⁜	CLAYSTONE

OTHER SYMBOLS

▩	CL	Lean Clay, with Sand and Gravel (Glacial Drift)
▩	CH	Fat Clay, with Sand and Gravel (Glacial Drift)

ALLSTATE CONSULTANTS, P.C.
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MO 65201
(573) 875-8799

UNIFIED SOIL CLASSIFICATION SYSTEM

Soil Classification Chart

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	**Silts and Clays** **Liquid limit less than 50**	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays **Liquid limit 50 or more**	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit – oven dried}}{\text{Liquid limit – not dried}} < 0.75$	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
HIGHLY ORGANIC SOILS		Primarily organic matter, dark in color, and organic odor		PT	Peat

Footnotes

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\qquad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

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

[N] PI ≥ 4 and plots on or above "A" line.

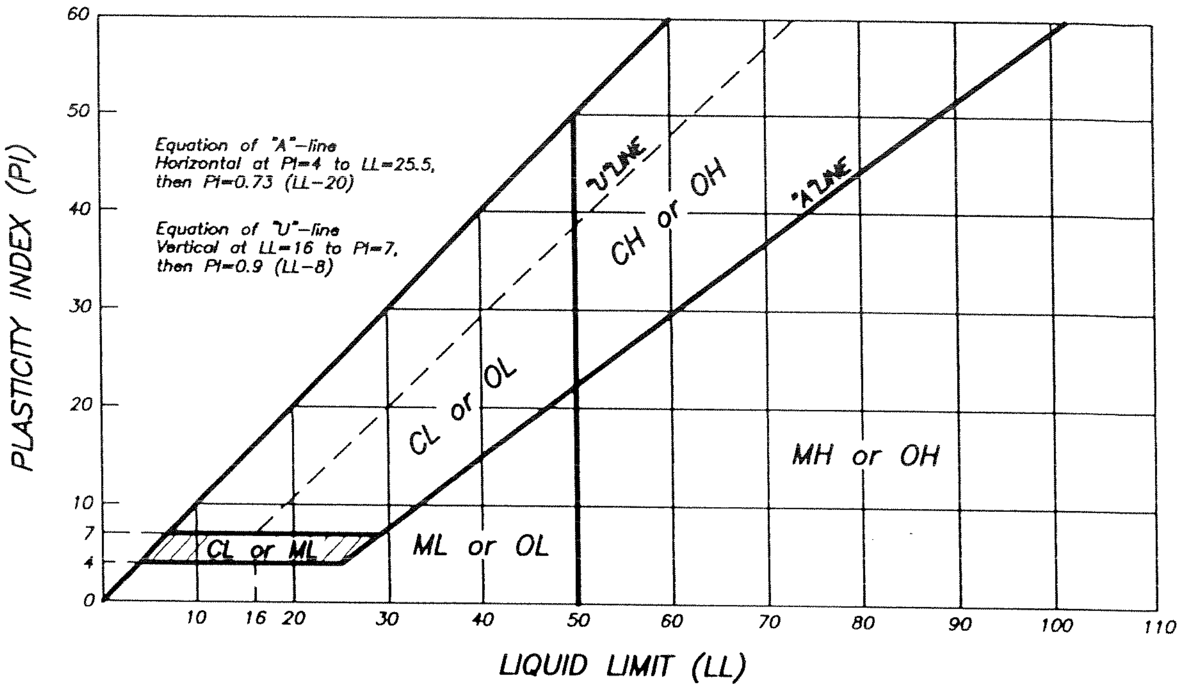
[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

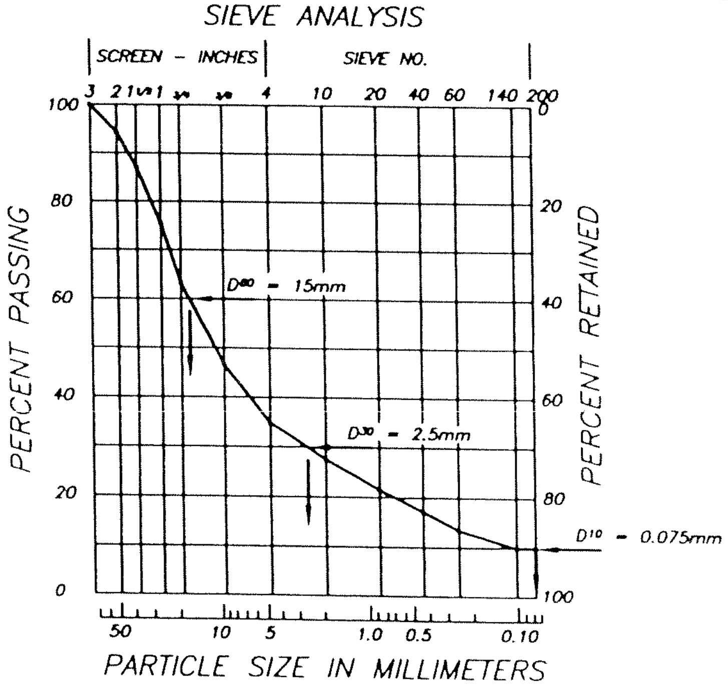
[Q] PI plots below "A" line.

ALLSTATE CONSULTANTS, P.C.
3312 LEMONE INDUSTRIAL BLVD.
COLUMBIA, MO 65201
(573) 875-8799

UNIFIED SOIL CLASSIFICATION SYSTEM



PLASTICITY CHART FOR CLASSIFICATION OF FINE-GRAINED SOILS AND FINE-GRAINED FRACTION OF COARSE-GRAINED SOILS.



$$Cu = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200$$

$$Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$

Cumulative Particle-Size Plot

FOR CLASSIFICATION OF COARSE-GRAINED SOILS WITH 12% OR LESS FINES.

ALLSTATE CONSULTANTS, P.C.
3312 LEMONE INDUSTRIAL BLVD
COLUMBIA, MO 65201
(573) 875-8799