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July 9, 2015
Job No. 15-038

Clarksville-Johnson County Regional Chamber of Commerce
101 North Johnson Street
Clarksville, Arkansas 72830

Attn: Mr. Travis Stephens
CEO and Chief Economic Development Officer

RESULTS of PRELIMINARY GEOTECHNICAL INVESTIGATION PROPOSED CLARKSVILLE INDUSTRIAL PARK CLARKSVILLE, ARKANSAS

INTRODUCTION

Submitted herein are the results of the preliminary geotechnical investigation performed on the site being considered for the Clarksville Industrial Park in Clarksville, Arkansas. These services were authorized on behalf of the Clarksville-Johnson County Regional Chamber of Commerce by Mr. Travis Stephen on April 15, 2015. This preliminary geotechnical study was performed in general accordance with our proposal of March 19, 2015 (GHBW Proposal No. 15-040). The field studies were deferred due to wet site conditions.

We understand the new development is in the conceptual planning phase at this time and specific plans for the project have not been developed. We also understand that an approximately 120-acre site referred to as the "Massengale Road Property" is planned for potential development as an industrial park. We expect that the development will ultimately include storage facilities, distribution warehouses, plants, manufacturers, and/or processors with a variety of potential structure sizes and loading. The development is also expected to include drives, vehicle and equipment parking areas, and laydown areas. Site grading information has not been developed at this time.

The purposes of this preliminary geotechnical study were to perform a limited exploration of subsurface conditions at the site, to characterize general subsurface conditions, and to develop general conclusions regarding geotechnical factors of consequence to design and construction of foundations and infrastructure and construction considerations. The results of the field and laboratory studies are discussed in the following report sections. Conclusions and recommendations are discussed in subsequent report sections.

SUBSURFACE EXPLORATION

A limited exploration of subsurface conditions on the 120-acre site consisted of drilling four (4) sample borings to 25-ft depth. The boring locations were selected at reasonably accessible locations as needed to develop representative information across the site. The site vicinity is shown on Plate 1. The approximate boring locations are shown on the Plan of Borings, Plate 2. The boring logs, presenting descriptions of the soil strata encountered and results of the field and laboratory tests, are included as Plates 3 through 6. Keys to the terms and symbols used on the logs are presented as Plates 7 and 8 for soil and rock, respectively.

The borings were drilled with a truck-mounted SIMCO 2800 rotary-drilling rig using dry-auger drilling procedures. Samples were obtained at approximately 2-ft intervals to 10 ft and at 5-ft intervals thereafter. Samples were typically obtained using a 2-inch-diameter split-barrel sampler driven into the strata by blows of a 140-lb safety hammer dropped 30 inches, in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 inches of an 18-inch total drive, or portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the appropriate boring logs in the "Blows Per Ft" column. Where rock hardness precluded recovery with the SPT, representative cuttings were obtained for use in visual classification and laboratory testing.

All samples were removed from sampling tools in the field. They were then examined and visually classified by the geotechnical technician, placed in appropriate containers to prevent moisture loss and/or change in condition, and returned to our laboratory.

Groundwater conditions were observed during drilling operations. These are noted in the lower-right portion of each log and are discussed in subsequent sections of this report. All boreholes were backfilled after obtaining final water level readings.

LABORATORY TESTING

To evaluate the range of physical and engineering characteristics of the soil encountered in the borings, geotechnical laboratory tests consisting of natural water content determinations and classification tests were performed on selected representative soil and rock samples. A total of 32 natural water content determinations were performed on representative samples to develop *in-situ* water content data for each boring. The results of these tests are plotted on the logs as solid circles in accordance with the scale and symbols shown in the legend located in the upper-right corner of the logs.

To verify field classification and to evaluate soil plasticity, four (4) liquid and plastic (Atterberg) limit determinations and four (4) sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the logs as plus signs inter-connected with a dashed line using the water content scale or are noted as "non-plastic". The percent of soil passing the No. 200 Sieve is noted in the "Minus No. 200" column on the appropriate log forms. Classification test results, as well as soil classification by the Unified Soil Classification System and AASHTO Classification System, are summarized in Appendix A.

GENERAL SITE and SUBSURFACE CONDITIONS

Site Conditions

The subject 120-acre Massengale Road Property is located south of Interstate 40, approximately 3 miles west of Clarksville, Arkansas. The site is currently undeveloped and open. It is primarily covered by weeds and grass with several groves of trees. Several commercial developments are located on the northern border of the property which front the Interstate 40 corridor. An unimproved road bisects the property in the north-south direction. The site terrain is relatively flat to undulating with a general fall from south to north. Surface drainage is variable, with some areas of fair to good drainage and other areas of poor drainage.

Site Geology

The Geologic Map of Arkansas[1] indicates the subject site located in the mapped outcrop of the Pennsylvanian Period McAlester Formation. The McAlester Formation consists of several hundred feet of shale with thin sandstone and coal beds and is capped by several hundred feet of shale with occasional coal beds. The McAlester Formation rests conformably on the Hartshorne Sandstone and the Lower Hartshorne Coal is just above the base of the McAlester. The McAlester Formation is about 500 to 2300 feet thick.

Seismic Conditions

According to the Arkansas Building Authority (2005), the Johnson County, Arkansas site is located in Seismic Zone 1, i.e. the zone of least anticipated seismic potential. Based on the subsurface conditions encountered in the borings and the local geology, a Seismic Site Class B (rock profile) is preliminarily considered appropriate for this location with respect to the criteria of the International Building Code (IBC 2012). The seismic site class must be confirmed for specific projects by a specific geotechnical investigation as individual parcels are planned for development and layout and grading information is available. For specific determination of the seismic site class to be used in design, information on site grading and foundation type must be considered.

Based on IBC 2012 seismic design guidelines (Section 1613) and the project location, the mapped earthquake spectral response acceleration for a short (0.2 sec) period (S_S) and the mapped earthquake spectral response acceleration at 1-sec period (S_1) are reported to be 0.225g for S_S and 0.112g for S_1, respectively.

For a Seismic Site Class B as preliminarily determined for this site, the Site Coefficient for S_S, F_a, and the Site Coefficient for S_1, F_v, have been determined to be 1.0 for both F_a and F_v, respectively. Therefore, the maximum considered earthquake spectral response accelerations adjusted by the site coefficients, denoted as S_{MS} for short period and S_{M1} for 1-sec period, have been calculated to be 0.225g and 0.112g, respectively. The design earthquake spectral response accelerations are specified by IBC 2012 as two-thirds (0.67) of the maximum considered values and are denoted as S_{DS} for short period and S_{D1} for 1-sec period. Accordingly, these have been determined to be 0.150g for S_{DS} and 0.075g for S_{D1} for the project locale.

For the proposed Industrial Park, we expect Risk Categories I, II, or III will likely be fitting for most future development based on Table 1604.5 of IBC 2012. In light of the expected Risk Categories I, II, and III and design seismic accelerations of 0.150g and 0.075g for a short period and a 1-sec period, Table 1613.3.5 of IBC 2012 indicates that a Seismic Design Category A is likely fitting for project site.

The design response spectrum developed based on the IBC 2012 guidelines indicates a design peak ground acceleration (A_{max}) value of 0.07g is fitting for the subject location. The peak ground acceleration (PGA) is the mapped earthquake spectral response acceleration at a period of 0.00 second. A horizontal acceleration coefficient (k_h) of 0.07, which is the peak ground acceleration value ($1.0A_{max}/g$), is considered fitting to develop preliminary seismic lateral earth pressures for retaining structures at the project site.

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1 Geologic Map of Arkansas, Arkansas Geologic Commission and U.S. Geologic Survey; 1993

Generalized Subsurface Conditions

Based on the results of the limited number of borings performed for this study, on-site fill comprises the surface soils on the southern half of the property (see Borings 3 and 4). The fill consists of soft to stiff reddish brown, brown, and dark gray silty clay and shale fragments extending to about 1.5- to 2-ft depth. The shale fragment blend fill has low plasticity and exhibits variable poor to fair compaction, low shear strength, and moderate to high compressibility.

At the ground surface where the on-site fill is not present and below the fill is natural soft to stiff gray, tan, brown, and reddish brown silty, fine sandy clay and silty clay. The silty, sandy clay and silty clay contain variable amounts of ferrous stains, nodules and concretions. The shallow soils contain trace amounts of organics below the topsoil zone. Weathered shale and sandstone fragments, partings, and seams are locally present (see Borings 3 and 4). In the upper 3.5 to 4 ft, the surface and near-surface soils exhibit low to moderate shear strength and moderate compressibility. However, shear strength typically increases below 3.5- to 4-ft depth and the predominant silty clay units exhibit moderate to high strength and low compressibility. The silty, fine sandy clay and silty clay exhibit low to moderate plasticity with a low potential for shrink-swell activity.

The overburden soils are underlain below about 6- to 9-ft depth by low hardness to moderately hard brown, gray and reddish tan weathered shale with silty clay seams and layers. The upper zones of the weathered shale are highly weathered with very poor rock quality but moderate to high shear strength. The rock quality and competence of the weathered shale increases with depth and the frequency of silty clay seams and layers decreases.

The basal stratum encountered in the borings is moderately hard to hard dark gray shale found below about 8-to 13-ft depth. The basal shale represents competent, slightly weathered to fresh bedrock. The dark gray shale is competent with high shear strength and low compressibility.

The generalized subsurface stratigraphy discussed above has been developed based upon the results of a limited number of borings drilled over a wide area. In view of the natural variations in stratigraphy and conditions, variations from the stratigraphy discussed herein should be anticipated. Additionally, the natural transition between strata is generally gradual, and the stratigraphy described in the sections above may vary.

Groundwater Conditions

Groundwater was encountered in the borings at 3.5 to 6 ft below existing grades in May 2015. It is opined that the shallow groundwater is perched water accumulated in the more pervious surface and near-surface soils. Our experience in the area has been that perched water amounts are typically limited, but sustained flows can be developed in some areas. Perched groundwater could be encountered within the near-surface soils. In addition, seasonal surface seeps or springs could be present. These are more likely in existing drainage features and at the low sides of steeper terrain. Groundwater levels will be influenced by seasonal precipitation, surface infiltration and runoff, and stream levels in nearby waterways and should be expected to vary.

Significant Conditions

The significant site and subsurface conditions considered pertinent to planning and preliminary design on the 120-acre site are summarized below.

a) The vacant and open site with a predominant ground cover or grass and weeds but some wooded areas.

b) The undulating to flat site terrain with a general fall from south to north and localized undulations.

c) The variable poor to fair surface water drainage.

d) The localized on-site fill comprised of a mixture of silty clay and shale fragments and extending to 1.5- to 2-ft depth, with the potential for variable fill content, depth, and compaction across the site.

e) The natural silty, sandy clay and silty clay comprising the surface and near-surface soils with variable low to moderate shear strength to 3.5- to 4-ft depth but increasing strength and decreasing compressibility with depth.

f) The low potential for shrink-swell activity.

g) The low hardness to moderately hard weathered shale at 6- to 9-ft depth with variable weathering but generally moderate to high shear strength and low compressibility.

h) Moderately hard to hard dark gray shale at 8-to 13-ft depth with high shear strength and low compressibility.

i) Shallow groundwater at 3.5 to 6 ft in May 2015 which represents shallow perched groundwater, with the potential for seasonal surface seeps or springs and seasonal variations in groundwater levels.

CONCLUSIONS and RECOMMENDATIONS

Foundations

Specific plans for site layout, structure types and loads, and site grading have not been developed at this time. Selection of safe and economical foundation systems will be dependent on structure design, magnitude of loads, site grading plans, and specific foundation conditions.

In light of the results of the borings and the observed site conditions, it is expected that light to moderate structural loads can appropriately be supported on footing foundation systems. For heavy loads or some specialty applications, a deep foundation system of drilled piers could be considered. Specific foundation considerations and design recommendations will depend on the particular characteristics of individual projects planned for the site, final site grading plans, and a site- and project-specific geotechnical investigation. This will require developing additional data on subsurface conditions via exploration and laboratory testing. General considerations related to foundations are discussed below.

Shallow Foundation Systems

Light to moderate structural loads may typically be supported on continuous or individual footings founded in the natural stiff to very stiff silty clay below about 3.5- to 4-ft depth. Footings supported in the natural stiff to very stiff strata can typically be designed with respect to maximum net allowable soil bearing pressure values of 3000 to 4500 lbs per sq foot. Alternatively, footing foundations could be supported in compacted select fill. In this case, allowable bearing pressures on the order of 1500 to 3500 lbs per sq ft would be expected, depending on total and differential fill thickness and the fill composition.

As noted, the surface and near-surface soils are locally weak and compressible to 3.5- to 4-ft depth. At locations where the surface soils are weak, footing excavations or footing undercuts must extend through the weak zones to develop suitable bearing in the stiff to very stiff silty clay predominant below 3.5- to 4-ft depth, more or less.

Long-term post construction settlement will be a function of footing size, bearing pressure, and the bearing stratum compressibility. In general, lightly- to moderately-loaded footings (i.e., 20- to 100-kip column loads) underlain by less than about 6 ft of compacted fill are expected to have less than 1 in. of total settlement. Specific information regarding foundation loads and footing sizes will be needed to develop specific estimates of settlement.

Perimeter footings and footings in unheated areas should extend at least 2 ft below lowest adjacent grade for frost protection. Depending on the structure type, support of interior foundation elements at shallower depths may be suitable. For planning purposes, a minimum width of 18 in. is typically recommended for continuous footings and a minimum dimension of 24 in. is generally suitable for individual footings.

Deep Foundation Systems – Drilled Piers

Where foundation loads are high or structures have particular foundation requirements related to uplift, lateral load capacity, dynamic loads, or other concerns, a deep foundation system could be warranted. A foundation system utilizing drilled, straight-shaft piers would be suitable for this site. Drilled piers are commonly constructed in the project area. Piling foundations are not typically utilized for commercial structures in the development locale due to the shallow depth to rock.

Drilled piers should extend through the silty, sandy clay and silty clay overburden soils and low hardness weathered shale zones to be founded in competent weathered shale or the moderately hard to hard dark gray shale. Drilled piers founded at least one (1) shaft diameter into the moderately hard to hard dark gray shale may typically be designed using maximum net allowable end-bearing pressures of 20 to 30 kips per sq foot. Drilled piers extending deeper into the moderately hard to hard shale can normally be designed for increased bearing values on the order of 40 to 60 kips per sq ft or more. Post-construction settlement of properly installed drilled piers founded in the weathered shale or shale should be less than 0.5 to 0.75 in. and within tolerable limits for most structures.

A minimum shaft diameter of 24 in. is generally recommended to facilitate clean up and inspection. Groundwater may be encountered in drilled pier excavations. Limited groundwater seepage amounts can typically be controlled by close coordination of drilling and concrete placement. Temporary casing could be required to stabilize excavations through zones where groundwater seepage becomes a problem. It has been our experience that most drilled piers in the project area can be constructed without temporary casing. However, it is not unusual for casing to be required.

Conventional heavy-duty drilling equipment can typically advance piers to the required depth. In some cases, the use of rock coring tools is required to advance drilled pier excavations through localized sandstone units or more resistant shale units. Where increased penetration into shale is required to develop suitable bearing capacity, the potential increases for rock drilling methods.

Floor Slab Systems

It is expected that slab-on-grade floor slab systems will be suitable for conventional structures. Depending on seasonal site conditions and site grading plans, subgrade preparation may require some undercut and recompaction or replacement to develop a stable subgrade. Undercut requirements will be highly dependent on grading plans and seasonal site conditions. Where moisture transmission through floor slabs is a design or operational concern, use of a 4- to 6-in. crushed stone base layer will be warranted below floor slabs as a capillary barrier. The crushed stone layer should be underlain by an impervious membrane as a moisture retarder. We recommend that all below-grade floor slabs be underlain by a subfloor drainage system.

For a properly prepared subgrade of the on-site silty, sandy clay or silty clay or compacted fill of similar materials, a modulus of subgrade reaction (k) value of 100 lbs per sq in. per in. may generally be utilized for design of at-grade floor slabs and mats. An increased modulus of subgrade reaction value can usually be developed by placing a minimum of 12 in. of compacted crushed stone base (AHTD Standard Specifications Section 303, Class 7) on the prepared subgrade. In this case, a modified k value of 175 to 225 lbs per cubic in. may typically be used in design. Where moisture transmission through floor slabs or mats is an issue, the clean stone layer should be placed over the crushed stone base.

Considerations for Pavements

The industrial development project is expected to include roadways, drives and parking areas. The subgrade soils are expected to vary from the relatively poor on-site silty, sandy clay/silty clay, classifying as A-6 by the AASHTO system, to select fill, which should provide improved subgrade support. The following properties are typically suitable for use in evaluation of preliminary pavement alternatives in conjunction with an on-site silty clay or imported select fill subgrade.

Subgrade: on-site or imported silty clay or shale fragment blend
California Bearing Ratio (CBR): 4 to 6
Modulus of Subgrade Reaction (k): 100 lbs per cu inch

It is our opinion that suitable and economical pavement sections can be constructed on this site in conjunction with good subgrade preparation and positive site drainage.

Site Grading Considerations

Site preparation should begin with clearing and grubbing and stripping the zone of organic-containing soils. Based on the results of the borings, the required depth of stripping is expected to be about 6 to 9 in., more or less. Following stripping and cutting, and prior to fill placement, the Geotechnical Engineer should evaluate the subgrade by observing proof-rolling or other suitable means. Soft or weak soils should be undercut to suitable materials. Stumpholes should be backfilled with select fill.

Specific subgrade preparation requirements will depend on structural requirements, site grading plans, and seasonal site conditions. The results of the preliminary borings indicate that undercuts of 3.5 to 4 ft, more or less, below existing grades could be warranted. Depending on specific site conditions, mass undercut may be warranted. Some reduction in undercut requirements might be achieved by the use of geosynthetics, such as a heavy geotextile, combined with granular fill.

The on-site soils, free of organics, debris, and with a maximum plasticity index (PI) of 18 are expected to be suitable for select fill and backfill use in building and pavement areas. However, the use of the on-site soils will likely require water content adjustment and processing. Imported borrow for fill or backfill should consist of an approved silty clay/shale fragment blend, select clayey sand (SC), sandy clay (CL), silty clay (CL) or clayey gravel (GC) having a liquid limit less than 40 and a maximum PI of 18, or an approved alternate. Maximum particle size in fill and backfill in building and pavement areas should be limited to about 6-in. dimension.

CONSTRUCTION CONSIDERATIONS

Positive surface drainage must be established at the start of the work, be maintained during construction and following completion of the project to prevent surface water ponding and subsequent saturation of subgrade soils. Density and water content of all earthwork should be maintained until the building slabs and pavements are completed. Foundation or subgrade soils that become saturated by ponding water or runoff should be excavated to suitable soils.

All temporary excavations must comply with Local, State and Federal requirements for worker safety. Based on the results of the borings and site observations, the surface and near-surface typically classify as Type B or C by OSHA criteria. Consequently, temporary open-cut excavations can probably be made on 1-½ -horizontal to 1-vertical (1.5H:1V) configurations. Stability of short-term excavations must be evaluated in the field by qualified personnel based on specific site observations. Temporary slopes should be monitored on a continuing basis and flattened as warranted by site conditions.

Based on the results of the borings, it is expected that shallow cuts in the overburden soils, weathered shale and shale can be performed with conventional heavy-duty excavation equipment. Narrow excavations advanced into the more resistant weathered or dark gray shale could encounter more resistant shale or localized sandstone inclusions or seams. The use of hoerams, jackhammers, or similar methods may be required for some deeper excavations, particularly narrow excavations and excavations where sandstone and more resistant shale units are encountered.

SUMMARY

Based on the results of this preliminary study, it is our opinion that no foundation or infrastructure issues are anticipated for the subject site which would be unusual for the project locale. The shallow depth to relatively strong stiff to very stiff silty clay suitable for use in a shallow foundation system is considered a positive factor for this site. The low potential for shrink-swell activity is also a positive factor. Though not unusual for the project locale, the soft surface soils will likely warrant some undercut during site grading operations. The soft surface and near-surface soils are considered to be seasonally impacted by recent heavy rains. Consequently, the potential for undercut could likely be reduced by performing site grading operations during drier seasons and maintaining positive surface drainage during the work.

This geotechnical report has been prepared to provide preliminary information regarding site and subsurface conditions. The conclusions and comments contained herein have been developed based on a discrete number of widely spaced borings. This information is intended for use in planning and conceptual design only. Final design recommendations must be based on an appropriate geotechnical study utilizing specific site grading plans, building layout, building tolerances and structure loading information. We are available to assist with developing an appropriate scope of work for the final geotechnical investigation as plans are more developed.

The following illustrations are attached and complete this report.

Plate 1	Site Vicinity
Plate 2	Plan of Borings
Plates 3 through 6	Boring Logs
Plates 7 and 8	Keys to Terms and Symbols
Appendix A	Classification Test Results

* * * * *

We appreciate the opportunity to be of service to you on this phase of project. Should you have any questions regarding this report, or if we may be of additional assistance during final design or construction, please call on us.

Sincerely,

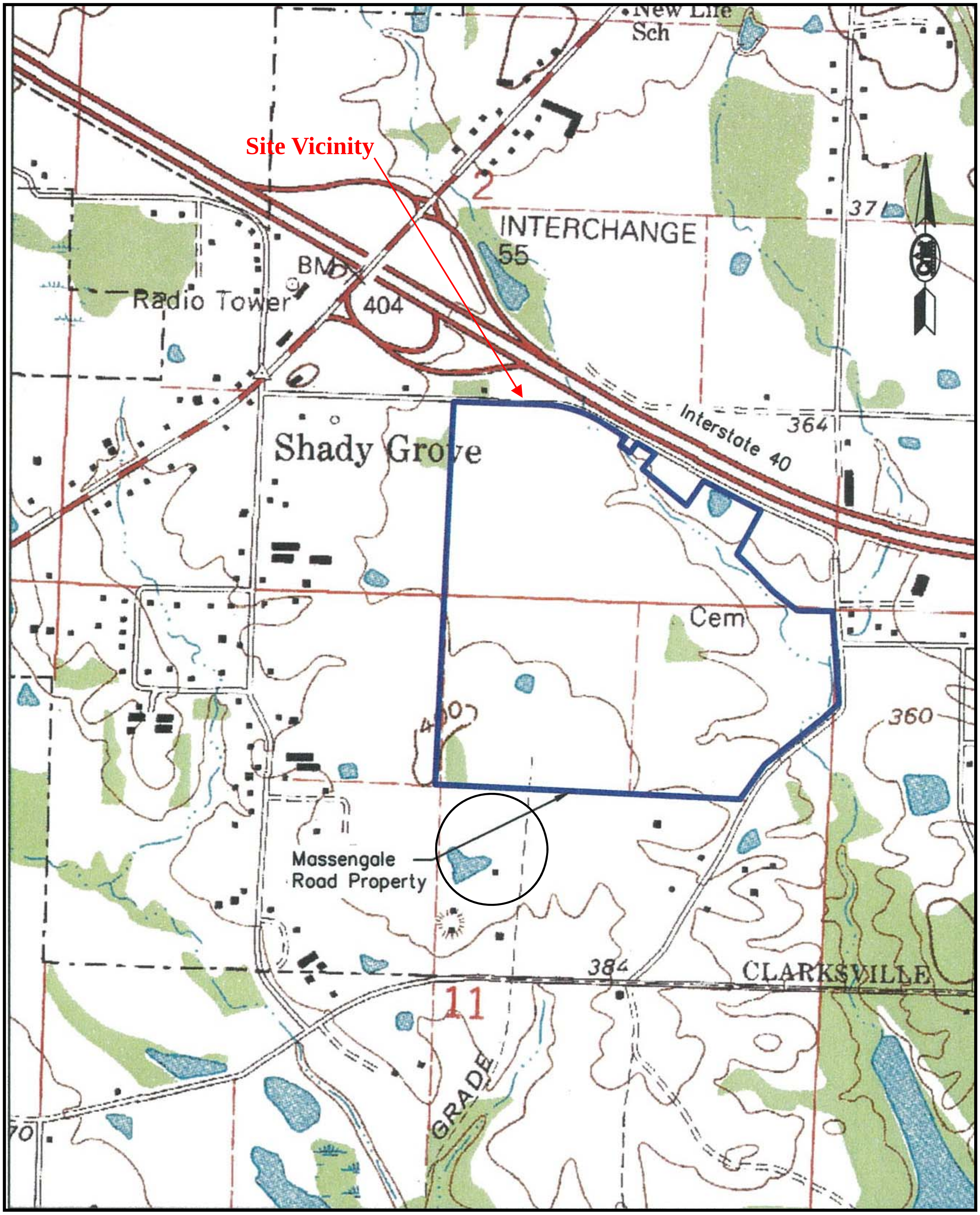
GRUBBS, HOSKYN,
BARTON & WYATT, INC.

Matthew R. Satterfield, P.E.
Senior Project Engineer

Mark E. Wyatt, P.E.
President

MRS/MEW:jw

Copies submitted: Clarksville-Johnson County Regional Chamber of Commerce
Attn: Mr. Travis Stephens (3+email)



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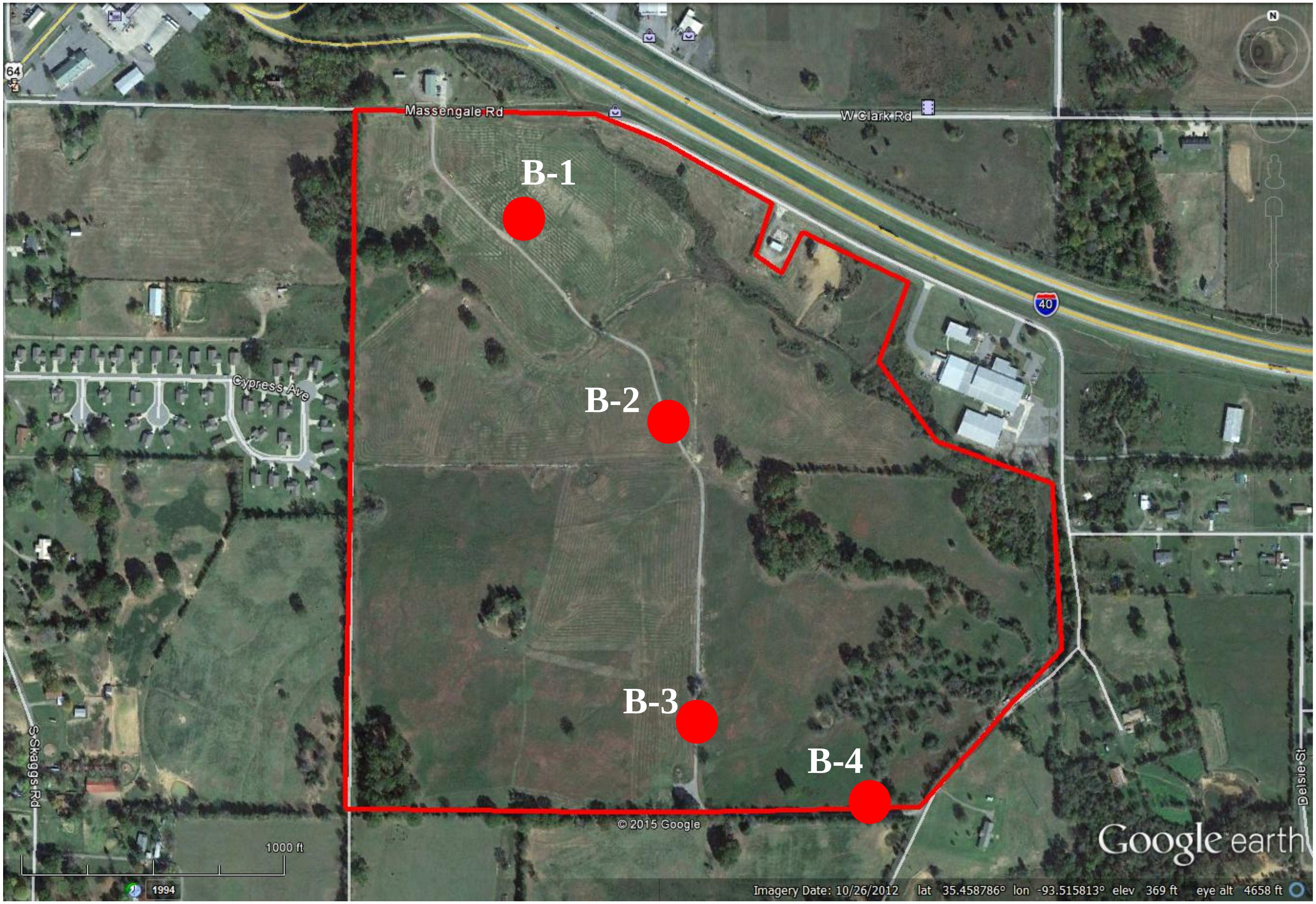
SITE VICINITY MAP
Preliminary Study - Industrial Park
Clarksville, Arkansas

Job No. 15-038

Plate 1



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PLAN OF BORINGS
PRELIMINARY STUDY - INDUSTRIAL PARK
Clarksville, Arkansas

Scale: See Above	
Job No. 15-038	
Plate No. 2	

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LOG OF BORING NO. 1

Clarksville Preliminary Study-Industrial Park
Clarksville, Arkansas

TYPE: Auger

LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL SURF. EL:	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			Stiff brown silty clay w/ very frequent ferrous nodules and concretions	12			
			Soft gray and reddish brown fine sandy clay, silty w/ferrous stains and nodules	5			70
5			Very stiff brown and gray silty clay w/ferrous stains and nodules	27			
			- very stiff with silty fine sand partings below 6 ft	40			
10			Moderately hard brown, gray and reddish tan completely weathered shale w/numerous silty clay seams and layers	50/7"			
15			Moderately hard to hard dark gray shale	50/2"			
20				25/0"			
25				25/0"			

COMPLETION DEPTH: 25.0 ft
DATE: 5-27-15

DEPTH TO WATER
IN BORING: 3.5 ft

DATE: 5/27/2015

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LOG OF BORING NO. 2

Clarksville Preliminary Study-Industrial Park
Clarksville, Arkansas

TYPE: Auger LOCATION: See Plate 2

COHESION, TON/SQ FT: 0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT + - - - WATER CONTENT ● - - - LIQUID LIMIT +: 10 20 30 40 50 60 70

DEPTH, FT	DESCRIPTION OF MATERIAL (SURF. EL:)	BLOWS PER FT	UNIT DRY WT LB/CU FT	- No. 200 %
0–2	Stiff brown silty clay w/trace organics	17		
2–4	Soft tan and reddish brown fine sandy clay, silty w/ferrous stains and nodules	6		
4–9	Stiff gray silty clay w/ferrous stains and nodules	16		81
	- very stiff below 6 ft	26		
9–13	Low hardness gray and reddish brown completely weathered shale w/silty clay seams and layers	36		
13–25	Moderately hard to hard dark gray shale	50/2"		
		25/0"		
		25/0"		

COMPLETION DEPTH: 25.0 ft
DATE: 5-27-15

DEPTH TO WATER
IN BORING: 6 ft

DATE: 5/27/2015

15-038

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LOG OF BORING NO. 3

Clarksville Preliminary Study-Industrial Park
Clarksville, Arkansas

TYPE: Auger

LOCATION: See Plate 2

SURF. EL:

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT / PLASTIC LIMIT, WATER CONTENT, LIQUID LIMIT	- No. 200 %
Soft reddish brown and dark gray silty clay w/shale fragments (fill)	6			34
Firm to stiff reddish brown fine sandy clay, silty w/sandstone fragments	10			
Very stiff brown, reddish tan and gray silty clay w/weathered shale and sandstone partings and seams	50/11"			
- with more frequent weathered shale and sandstone seams below 6 ft	50/6"			
Moderately hard gray, reddish brown and tan completely weathered shale w/silty clay seams and layers, occasional sandstone partings and ferrous stains	50/2"			
Moderately hard to hard dark gray shale	25/0"			
	25/0"			
	25/0"			

DEPTH, FT: 5, 10, 15, 20, 25

COMPLETION DEPTH: 25.0 ft
DATE: 5-27-15

DEPTH TO WATER
IN BORING: Dry

DATE: 5/27/2015

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LOG OF BORING NO. 4

Clarksville Preliminary Study-Industrial Park
Clarksville, Arkansas

TYPE: Auger

LOCATION: See Plate 2

SURF. EL:

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	WATER CONTENT (approx.)	PLASTIC LIMIT / LIQUID LIMIT	- No. 200 %
0–2	Stiff brown and dark gray silty clay and shale fragments (fill)	12				
2–3.5	Firm to stiff reddish brown fine sandy clay, silty w/shale and sandstone fragments and ferrous nodules	10				
3.5–6	Very stiff gray, reddish brown and tan silty clay w/weathered shale and sandstone partings and seams	50/8"				27
6–8	Low hardness gray, reddish brown and tan highly weathered shale w/silty clay seams and layers, occasional sandstone partings and ferrous stains	50				
8–25	Moderately hard to hard dark gray shale	50/3"				
		50/2"				
		25/0"				
		25/0"				

COHESION, TON/SQ FT: 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT: 10, 20, 30, 40, 50, 60, 70

COMPLETION DEPTH: 25.0 ft
DATE: 5-27-15

DEPTH TO WATER IN BORING: Dry

DATE: 5/27/2015

LGBNEW 15-038.GPJ 7-9-15

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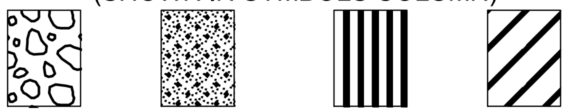
SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES

(SHOWN IN SYMBOLS COLUMN)

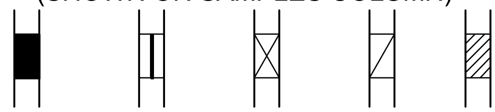


Gravel Sand Silt Clay

Predominant type shown heavy

SAMPLER TYPES

(SHOWN ON SAMPLES COLUMN)



Shelby Tube Rock Core Split Spoon No Recovery Cutting

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	N-VALUE	RELATIVE DENSITY
VERY LOOSE	0-4	0-15%
LOOSE	4-10	15-35%
MEDIUM DENSE	10-30	35-65%
DENSE	30-50	65-85%
VERY DENSE	50 and above	85-100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT.
VERY SOFT	Less than 0.25
SOFT	0.25-0.50
FIRM	0.50-1.00
STIFF	1.00-2.00
VERY STIFF	2.00-4.00
HARD	4.00 and higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

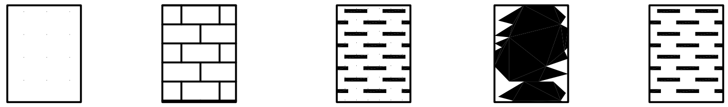
SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance.
FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
LAMINATED - composed of thin layers of varying color and texture.
INTERBEDDED - composed of alternate layers of different soil types.
CALCAREOUS - containing appreciable quantities of calcium carbonate.
WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.
POORLY GRADED - predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.

Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

Grubbs, Hoskyn,
Barton & Wyatt, Inc.
Consulting Engineers

BORING LOG TERMS – ROCK

ROCK TYPES
(SHOWN IN SYMBOLS COLUMN)



Sandstone Limestone Siltstone Coal Shale

Joint Characteristics –

Spacing	
Very Close	0.75 to 2.5 in.
Close	2.5 to 8 in.
Moderately Close	8 to 24 in.
Wide	2 to 6 ft
Very Wide	More than 6 ft

Bedding Characteristics –

Very Thin	0.75 to 2.5 in.
Thin	2.5 to 8 in.
Medium	8 to 24 in.
Thick	2 to 6 ft
Massive	More than 6 ft

Lithologic Characteristics –

Clayey
Shaly
Calcareous (limy)
Siliceous
Sandy (Arenaceous)
Silty
Plastic Seams

Parting – Less than 1/16 inch
Seam – 1/16 to 1/2 inch
Layer – 1/2 to 12 inches
Stratum – Greater than 12 inches

Hardness–

Soft (S) – Reserved for plastic material alone.

Friable (F) – Easily crumbled by hand, pulverized or reduced to powder and is too soft to be cut with a pocket knife.

Low Hardness (LH) – Can be gouged deeply or carved with a pocket knife.

Moderately Hard (MH) – Can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and scratch is readily visible after the powder has been blown away.

Hard (H) – Can be scratched with difficulty; scratch produces little powder and is often faintly visible; traces of the knife steel may be visible.

Very hard (VH) – Cannot be scratched with a pocket knife. Knife steel marks left on surface.

Texture –

Fine – Barely seen with naked eye
Medium – Barely seen up to 1/8 in.
Coarse – 1/8 in. to 1/4 in.

Structure –

Bedding
- Flat – 0° – 5°
- Gently Dipping – 5° – 35°
- Moderately Dipping – 55° – 85°
- Steeply Dipping – 55° – 85°

Fractures, scattered
- Open
- Cemented or Tight

Fractures, closely spaced
- Open
- Cemented or Tight

Brecciated (Sheared and Fragmented)
- Open
- Cemented or Tight

Joints
- Faulted
- Slickensides

Degree of Weathering –

Fresh – No visible signs of decomposition or discoloration. Rings under hammer impact.

Slighty Weathered – Slight discoloration inwards from open fractures, otherwise similar to fresh.

Moderately Weathered – Discoloration throughout. Weaker minerals such as feldspar decomposed. Strength somewhat less than fresh rock, but cores cannot be broken by hand or scraped by knife. Texture preserved.

Highly Weathered – Most minerals somewhat decomposed. Specimens can be broken by hand with effort or shaved with knife. Core stones present in rock mass. Texture becoming indistinct but fabric

Completely Weathered – Minerals decomposed to soil but fabric and structure preserved (Saprolite). Specimens easily crumbled or penetrated.

Residual Soil – Advanced state of decomposition resulting in plastic soils. Rock fabric and structure completely destroyed. Large volume change.

Solution and Void Conditions –

Solid, contains no voids
Vuggy (pitted)
Vesicular (igneous)
Porous
Cavities
Cavernous

Swelling Properties –

Nonswelling
Swelling

Slaking Properties –

Nonslaking
Slakes slowly on exposure
Slakes readily on exposure

Rock Quality Designation (RQD) –

RQD (Percent)	Diagnostic Description
Greater than 90	Excellent
75 – 90	Good
50 – 75	Fair
25 – 50	Poor
Less than 25	Very Poor

KEYROCK FHWA 3-2-12

APPENDIX A

SUMMARY of CLASSIFICATION TEST RESULTS

PROJECT: Preliminary Study - Industrial Park Preliminary
LOCATION: Clarksville, Arkansas
JOB NUMBER: 15-038

BORING NO.	SAMPLE DEPTH (ft)	WATER CONTENT (%)	ATTERBERG LIMITS			SIEVE ANALYSIS PERCENT PASSING						UNIFIED CLASS.	AASHTO CLASS.
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	3/4 in.	3/8 in.	#4	#10	#40	#200		
1	2.5-3.5	23	36	21	15	100	94	89	85	81	70	CL	A-6
2	4.5-5.5	21	42	22	20	---	---	---	---	---	81	CL	A-6
3	0.5-1.5	13	38	22	16	100	83	69	56	43	34	SC	A-2-6
4	4.5-5.5	9	31	22	9	---	---	---	---	---	27	SC	A-2-4