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November 27, 2018

Mr. Carl Gales
KAS Gales Company
18772 Harmon Road
Fayetteville, Arkansas 72704-8524

Subject: Report of Subsurface Exploration
Proposed Cherokee Heights Lift Station
Sportsmen Acres, Oklahoma
Building & Earth Project No.: OK180269

Dear Mr. Gales:

Building & Earth Sciences, Inc. completed the authorized subsurface exploration for the proposed Cherokee Heights Lift Station in Sportsmen Acres, Oklahoma. Our services were performed in accordance with our proposal numbered OK19325 (revision #2), dated November 1, 2018. You authorized our services by signing our proposal document on November 1, 2018.

GENERAL PROJECT INFORMATION

We understand the project site is located south of Sportsmen Acres, Oklahoma, adjacent to Quail Drive. The provided Google Earth image indicating the location of existing and proposed sanitary sewer infrastructure is shown in the following figure.

Based on the information provided to our office, we understand proposed construction will consist of a new lift station and force main to serve the Cherokee Heights development south of Sportsmen Acres. ***Our scope of work was limited to the proposed lift station location.***

A site grading plan was not available for our review at the time of this proposal. The maximum excavation depth for the lift station will be 15 feet.

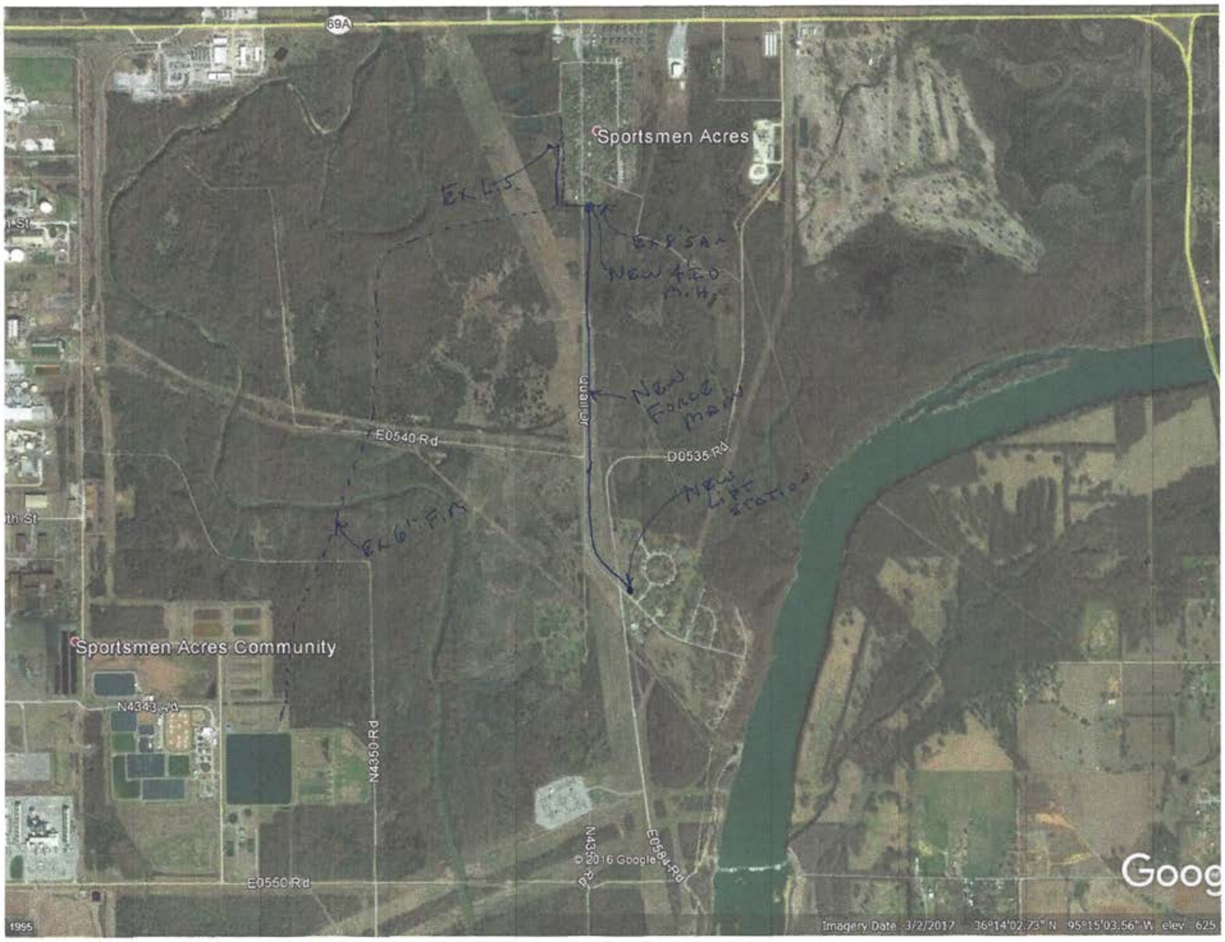

Figure 1: Existing and Proposed Sanitary Sewer Infrastructure

SUMMARY OF SUBSURFACE EXPLORATION

The authorized subsurface exploration was performed on November 9, 2018. The subsurface exploration consisted of one (1) test boring. The boring location is shown on the Boring Location Plan sheet found in the Appendix of this document. The boring was located in the field by a Building & Earth geologist using a handheld GPS device. As such, the boring location shown should be considered approximate. The ground surface elevation at the boring location was not determined as part of our scope of work.

The boring was drilled using a CME-45 drill rig equipped with hollow stem augers and a manual hammer until auger refusal occurred. The boring was advanced beyond auger refusal depth using a Diedrich D-50 equipped with rock core tooling. A Building & Earth field geologist observed drilling operations and logged the boring in the field.

Further details about Standard Penetration Testing (SPT) and rock coring procedures can be found in the Appendix of this document.

The soil and rock samples retrieved from the boring location were visually examined by our engineer and soil descriptions were provided. The project engineer prepared a Boring Log summarizing the subsurface conditions at the boring location. Laboratory testing was excluded from our scope of work. The following section summarizes the general subsurface conditions encountered in the boring.

GENERAL SUBSURFACE CONDITIONS

Topsoil with thickness of about 6 inches was encountered at the surface. The topsoil was underlain by dark gray-brown residual lean clay that exhibited a medium stiff consistency and that appeared to have low to moderate plasticity characteristics. The clay stratum extended to a depth of about 1.2 feet below the ground surface.

The residuum was underlain by a weathered zone of light gray to gray, limestone that contained clayey shale seams and that was highly jointed. Auger drilling resumed to a depth of about 3.5 feet where auger refusal occurred on harder limestone.

Upon encountering auger refusal, drilling procedures converted to rock coring to further evaluate the condition of the limestone unit beyond auger refusal to depth of about 8.5 feet. The limestone was light gray to gray in color with yellow discolored bedding planes. Multiple clayey shale seams with thickness ranging from about 1.5 to 3 inches were noted throughout the formation to a depth of roughly 7 feet. The limestone was thin bedded with thickness ranging between 0.5 and 4 inches. Below a depth of about 7 feet, the limestone became thicker bedded, ranging in thickness between 6 to 12 inches. The first core run extended from a depth 3.5 feet to 5 feet, which had 94 percent recovery and a Rock Quality Designation (RQD) of 25 percent. Between depths of 5 and 8.5 feet, core recovery of 94 percent and RQD of 71 percent were recorded. In general, rock mass with RQD of 25 to 50 percent is considered to be of poor quality and a rock mass with RQD of 51 to 75 percent is considered to be of fair quality.

Groundwater was not encountered prior to the start of rock coring operations. Groundwater was not measured prior to backfilling due to the introduction of water during rock coring to aid with cooling of the drill bit and flushing of the drill cuttings from the borehole.

GENERAL EXCAVATION CONSIDERATIONS

Based on the subsurface conditions encountered in our boring, we anticipate that the overburden residuum can be excavated using a backhoe in good working condition to depth of roughly 1 to 1.5 feet. Weathered limestone and a thin bedded limestone with clayey shale seams encountered between depths of about 1.5 and 7 feet likely can be excavated using a large track hoe equipped with rock teeth and a hydraulic hoe ram. It should be noted that auger refusal occurred in limestone at depth of about 3.5 feet. Below depth of 7 feet, the limestone became thicker bedded and no clayey seams were noted within the rock formation to boring termination depth of 8.5 feet.

Our scope of work excluded rock coring to anticipated lift station depth of 15 feet; thus, excavation difficulty considerations below explored depth of 8.5 feet cannot be provided based on subsurface information available at the time of preparing this report.

The contractor will need to anticipate rock excavation techniques, including blasting below a depth of about 7 feet, where thicker bedded limestone was encountered. The ability to excavate hard limestone rock is a function of the material, the equipment used, the skill of the operator, the desired rate of removal and other factors. The contractor should review the borings log and should use his own method to evaluate excavation difficulty.

CLOSING

We appreciate the opportunity to provide subsurface exploration services for the subject project. If you have any questions regarding the information in this report or need any additional information, please call us.

Respectfully submitted,
BUILDING & EARTH SCIENCES, INC.
Certificate of Authorization #3975, expires 6/30/2020

REGISTERED PROFESSIONAL ENGINEER
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Dharmateja Maganti, E.I.
Project Manager

BUILDING & EARTH

Appendix Table of Contents

GEOTECHNICAL INVESTIGATION METHODOLOGIES

The subsurface exploration, which is the basis of the recommendations of this report, has been performed in accordance with industry standards. Detailed methodologies employed in the investigation are presented in the following sections.

DRILLING PROCEDURES – STANDARD PENETRATION TEST (ASTM D1586)

Samples were obtained at standard sampling intervals with a split-spoon sampler. The borehole was first advanced to the sample depth by augering and the sampling tools were placed in the open hole. The sampler was then driven 18 inches into the ground with a 140-pound automatic hammer free-falling 30 inches. The number of blows required to drive the sampler each 6-inch increment was recorded. The initial increment is considered the "seating" blows, where the sampler penetrates loose or disturbed soil in the bottom of the borehole.

The blows required to penetrate the final two (2) increments are added together and are referred to as the Standard Penetration Test (SPT) N-value. The N-value, when properly evaluated, gives an indication of the soil's strength and ability to support structural loads. Many factors can affect the SPT N-value, so this result cannot be used exclusively to evaluate soil conditions.

Samples retrieved from the boring location were labeled and stored in plastic bags at the jobsite before being transported to our laboratory for analysis. The project engineer prepared a Boring Log summarizing the subsurface conditions at the boring location.

ROCK CORING

Rock coring was performed in accordance with ASTM Specification D2113. During the coring operations, the rock cores were placed in core boxes at the site and transported to our laboratory for identification and classification. At the laboratory, the rock type was identified and the "recovery" and "rock quality designation" (RQD) was determined. The recovery is the ratio of the length of sample obtained to the length of the run cored, as a percent. The RQD is the percentage of the length of the core run which has rock segments of moderately hard or harder rock four inches or greater in length, compared to the total length of the run. The percent recovery and RQD are related to rock soundness and continuity. Generalized rock descriptions, percent recovery, and RQD values are shown on the boring log.

BORING LOG DESCRIPTION

Building & Earth Sciences, Inc. used the gINT software program to prepare the attached boring logs. The gINT program provides the flexibility to custom design the boring logs to include the pertinent information from the subsurface exploration and results of our laboratory analysis. The soil and laboratory information included on our logs is summarized below:

DEPTH AND ELEVATION

The depth below the ground surface and the corresponding elevation are shown in the first two columns.

SAMPLE TYPE

The method used to collect the sample is shown. The typical sampling methods include Split Spoon Sampling, Shelby Tube Sampling, Grab Samples, and Rock Core. A key is provided at the bottom of the log showing the graphic symbol for each sample type.

SAMPLE NUMBER

Each sample collected is numbered sequentially.

BLOWS PER INCREMENT, REC%, RQD%

When Standard Split Spoon sampling is used, the blows required to drive the sampler each 6-inch increment are recorded and shown in column 5. When rock core is obtained the recovery ration (REC%) and Rock Quality Designation (RQD%) is recorded.

SOIL DATA

Column 6 is a graphic representation of four different soil parameters. Each of the parameters use the same graph, however, the values of the graph subdivisions vary with each parameter. Each parameter presented on column 6 is summarized below:

- N-value- The Standard Penetration Test N-value, obtained by adding the number of blows required to drive the sampler the final 12 inches, is recorded . The graph labels range from 0 to 50.
- Qu – Unconfined Compressive Strength estimate from the Pocket Penetrometer test in tons per square foot (tsf). The graph labels range from 0 to 5 tsf.
- Atterberg Limits – The Atterberg Limits are plotted with the plastic limit to the left, and liquid limit to the right, connected by a horizontal line. The difference in the plastic and liquid limits is referred to as the Plasticity Index. The Atterberg Limits test results are also included in the Remarks column on the far right of the boring log. The Atterberg Limits graph labels range from 0 to 100%.
- Moisture – The Natural Moisture Content of the soil sample as determined in our laboratory.

SOIL DESCRIPTION

The soil description prepared in accordance with ASTM D2488, Visual Description of Soil Samples. The Munsel Color chart is used to determine the soil color. Strata changes are indicated by a solid line, with the depth of the change indicated on the left side of the line and the elevation of the change indicated on the right side of the line. If subtle changes within a soil type occur, a broken line is used. The Boring Termination or Auger Refusal depth is shown as a solid line at the bottom of the boring.

GRAPHIC

The graphic representation of the soil type is shown. The graphic used for each soil type is related to the Unified Soil Classification chart. A chart showing the graphic associated with each soil classification is included.

REMARKS

Remarks regarding borehole observations, and additional information regarding the laboratory results and groundwater observations.

Major Divisions			Symbols		Group Name & Typical Description
			Lithology	Group	
Coarse Grained Soils *More than 50% of material is larger than No. 200 sieve size*	***Gravel and Gravelly Soils*** *More than 50% of coarse fraction is larger than No. 4 sieve*	***Clean Gravels*** *(Less than 5% fines)*		**GW**	*Well-graded gravels, gravel – sand mixtures, little or no fines*
				GP	*Poorly-graded gravels, gravel – sand mixtures, little or no fines*
		Gravels with Fines *(More than 12% fines)*		**GM**	*Silty gravels, gravel – sand – silt mixtures*
				GC	*Clayey gravels, gravel – sand – clay mixtures*
	Sand and Sandy Soils *More than 50% of coarse fraction is smaller than No. 4 sieve*	***Clean Sands*** *(Less than 5% fines)*		**SW**	*Well-graded sands, gravelly sands, little or no fines*
				SP	*Poorly-graded sands, gravelly sands, little or no fines*
		Sands with Fines *(More than 12% fines)*		**SM**	*Silty sands, sand – silt mixtures*
				SC	*Clayey sands, sand – clay mixtures*
Fine Grained Soils *More than 50% of material is smaller than No. 200 sieve size*	***Silts and Clays*** *Liquid Limit less than 50*	***Inorganic***		**ML**	*Inorganic silts and very find sands, rock flour, silty or clayey fine sands or clayey silt with slight plasticity*
				CL	*Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays*
		Organic		**OL**	*Organic silts and organic silty clays of low plasticity*
	Silts and Clays *Liquid Limit greater than 50 sieve*	***Inorganic***		**MH**	*Inorganic silts, micaceous or diatomaceous fine sand, or silty soils*
				CH	*Inorganic clays of high plasticity*
		Organic		**OH**	*Organic clays of medium to high plasticity, organic silts*
Highly Organic Soils				**PT**	*Peat, humus, swamp soils with high organic contents*

Table 1: Soil Classification Chart (based on ASTM D2487)

Building & Earth Sciences classifies soil in general accordance with the Unified Soil Classification System (USCS) presented in ASTM D2487. Table 1 and Figure 1 exemplify the general guidance of the USCS. Soil consistencies and relative densities are presented in general accordance with Terzaghi, Peck, & Mesri's (1996) method, as shown on Table 2, when quantitative field and/or laboratory data is available. Table 2 includes Consistency and Relative Density correlations with N-values obtained using either a manual hammer (60 percent efficiency) or automatic hammer (90 percent efficiency). The *Blows Per Increment* and *SPT N-values* displayed on the boring logs are the unaltered values measured in the field. When field and/or laboratory data is not available, we may classify soil in general accordance with the Visual Manual Procedure presented in ASTM D2488.

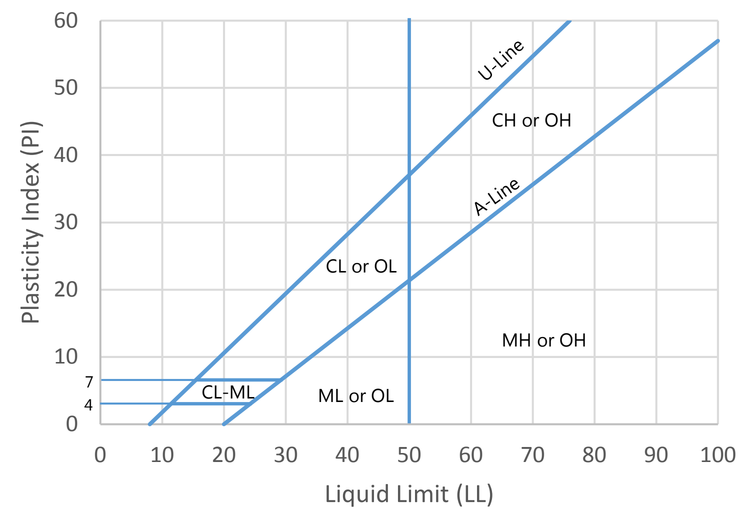

Figure 1: Plasticity Chart (based on ASTM D2487)

Non-cohesive: Coarse-Grained Soil			Cohesive: Fine-Grained Soil			
SPT Penetration (blows/foot)		**Relative Density**	**SPT Penetration (blows/foot)**		**Consistency**	**Estimated Range of Unconfined Compressive Strength (tsf)**
Automatic Hammer*	Manual Hammer		Automatic Hammer*	Manual Hammer		
			< 2	< 2	Very Soft	< 0.25
0 - 3	0 - 4	Very Loose	2 - 3	2 - 4	Soft	0.25 – 0.50
3 - 8	4 - 10	Loose	3 - 6	4 - 8	Medium Stiff	0.50 – 1.00
8 - 23	10 - 30	Medium Dense	6 - 12	8 - 15	Stiff	1.00 – 2.00
23 - 38	30 - 50	Dense	12 - 23	15 - 30	Very Stiff	2.00 – 4.00
> 38	> 50	Very Dense	> 23	> 30	Hard	> 4.00

Table 2: Soil Consistency and Relative Density (based on Terzaghi, Peck & Mesri, 1996)

* - Modified based on 80% hammer efficiency

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	Standard Penetration Test ASTM D1586 or AASHTO T-206		Dynamic Cone Penetrometer (Sower DCP) ASTM STP-399
	Shelby Tube Sampler ASTM D1587		No Sample Recovery
	Rock Core Sample ASTM D2113		Groundwater at Time of Drilling
	Auger Cuttings		Groundwater as Indicated

Table 1: Symbol Legend

Soil	Particle Size	U.S. Standard
Boulders	Larger than 300 mm	N.A.
Cobbles	300 mm to 75 mm	N.A.
Gravel	75 mm to 4.75 mm	3-inch to #4 sieve
Coarse	75 mm to 19 mm	3-inch to ¾-inch sieve
Fine	19 mm to 4.75 mm	¾-inch to #4 sieve
Sand	4.75 mm to 0.075 mm	#4 to #200 Sieve
Coarse	4.75 mm to 2 mm	#4 to #10 Sieve
Medium	2 mm to 0.425 mm	#10 to #40 Sieve
Fine	0.425 mm to 0.075 mm	#40 to #200 Sieve
Fines	Less than 0.075 mm	Passing #200 Sieve
Silt	Less than 5 μm	N.A.
Clay	Less than 2 μm	N.A.

Table 2: Standard Sieve Sizes

N-Value	Standard Penetration Test Resistance calculated using ASTM D1586 or AASHTO T-206. Calculated as sum of original, field recorded values.	Atterberg Limits PL LL	A measure of a soil's plasticity characteristics in general accordance with ASTM D4318. The soil Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL).
Qu	Unconfined compressive strength, typically estimated from a pocket penetrometer. Results are presented in tons per square foot (tsf).	% Moisture	Percent natural moisture content in general accordance with ASTM D2216.

Table 3: Soil Data

Hollow Stem Auger	Flights on the outside of the shaft advance soil cuttings to the surface. The hollow stem allows sampling through the middle of the auger flights.
Mud Rotary / Wash Bore	A cutting head advances the boring and discharges a drilling fluid to support the borehole and circulate cuttings to the surface.
Solid Flight Auger	Flights on the outside bring soil cuttings to the surface. Solid stem requires removal from borehole during sampling.
Hand Auger	Cylindrical bucket (typically 3-inch diameter and 8 inches long) attached to a metal rod and turned by human force.

Table 4: Soil Drilling Methods

Descriptor	Meaning
Trace	Likely less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

Table 5: Descriptors

Manual Hammer	The operator tightens and loosens the rope around a rotating drum assembly to lift and drop a sliding, 140-pound hammer falling 30 inches.
Automatic Trip Hammer	An automatic mechanism is used to lift and drop a sliding, 140-pound hammer falling 30 inches.
Dynamic Cone Penetrometer (Sower DCP) ASTM STP-399	Uses a 15-pound steel mass falling 20 inches to strike an anvil and cause penetration of a 1.5-inch diameter cone seated in the bottom of a hand augered borehole. The blows required to drive the embedded cone a depth of 1-3/4 inches have been correlated by others to N-values derived from the Standard Penetration Test (SPT).

Table 6: Sampling Methods

Non-plastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be re-rolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be re-rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Table 7: Plasticity

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

Table 8: Moisture Condition

Stratified	Alternating layers of varying material or color with layers at least ½ inch thick.
Laminated	Alternating layers of varying material or color with layers less than ¼ inch thick.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensides	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

Table 9: Structure

Hatch	Description	Hatch	Description	Hatch	Description
	GW *- Well-graded gravels, gravel – sand mixtures, little or no fines*		*Asphalt*		*Clay with Gravel*
	GP *- Poorly-graded gravels, gravel – sand mixtures, little or no fines*		*Aggregate Base*		*Sand with Gravel*
	GM *- Silty gravels, gravel – sand – silt mixtures*		*Topsoil*		*Silt with Gravel*
	GC *- Clayey gravels, gravel – sand – clay mixtures*		*Concrete*		*Gravel with Sand*
	SW *- Well-graded sands, gravelly sands, little or no fines*		*Coal*		*Gravel with Clay*
	SP *- Poorly-graded sands, gravelly sands, little or no fines*		***CL-ML*** *- Silty Clay*		*Gravel with Silt*
	SM *- Silty sands, sand – silt mixtures*		*Sandy Clay*		*Limestone*
	SC *- Clayey sands, sand – clay mixtures*		*Clayey Chert*		*Chalk*
	ML *- Inorganic silts and very find sands, rock flour, silty or clayey fine sands or clayey silt with slight plasticity*		*Low and High Plasticity Clay*		*Siltstone*
	CL *- Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays*		*Low Plasticity Silt and Clay*		*Till*
	OL *- Organic silts and organic silty clays of low plasticity*		*High Plasticity Silt and Clay*		*Sandy Clay with Cobbles and Boulders*
	MH *- Inorganic silts, micaceous or diatomaceous fine sand, or silty soils*		*Fill*		*Sandstone with Shale*
	CH *- Inorganic clays of high plasticity*		*Weathered Rock*		*Coral*
	OH *- Organic clays of medium to high plasticity, organic silts*		*Sandstone*		*Boulders and Cobbles*
	PT *- Peat, humus, swamp soils with high organic contents*		*Shale*		*Soil and Weathered Rock*

Table 1: Key to Hatches Used for Boring Logs and Soil Profiles

KEY TO HATCHES

BORING LOCATION PLAN

REFERENCE USED TO PRODUCE THIS DRAWING:	BORING LOCATION PLAN		DATE: 11/26/2018	BUILDING & EARTH Geotechnical, Environmental, and Materials Engineers
Google Earth aerial image dated 10/27/2017	PROJECT NO. OK180269	PROJECT NAME / LOCATION: Cherokee Heights Lift Station Sportsmen Acres, Oklahoma	SCALE: As Shown	

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: B-01

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PROJECT NAME: Cherokee Heights Lift Station
PROJECT NUMBER: OK180269
DRILLING METHOD: HSA/Rock Core
EQUIPMENT USED: CME 45 and Diedrich D-50
HAMMER TYPE: Manual
BORING LOCATION: Lift Station

LOCATION: Sportsmen Acres, OK
DATE DRILLED: 11/9/18
WEATHER: Sunny
ELEVATION:
DRILL CREW: Mohawk Drilling
LOGGED BY: Taru Holinsworth

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	N-Value (10 20 30 40) / Qu (tsf) (1 2 3 4) / Atterberg Limits (20 40 60 80) / % Moisture (20 40 60 80)	SOIL DESCRIPTION	GRAPHIC	REMARKS
0–0.5						TOPSOIL		
0.5–1.2		Split Spoon	1	3-50/3"	Qu ▲; N-Value >>	LEAN CLAY (CL): medium stiff, dark gray-brown, with tree root, low to moderate plasticity, moist		
1.2–3.5		Split Spoon	2	50/2"	N-Value >>	WEATHERED LIMESTONE: hard, light gray to gray, with clayey shale seams, yellow discolored bedding planes, highly jointed		
3.5–8.5		Rock Core	3	REC=94 RQD=25		LIMESTONE: hard, light gray to gray, with clayey shale seams (~2-3"), yellow discolored bedding planes (slightly weathered), thin bedded (~0.5-4")		AUGER REFUSAL on limestone, converted to rock coring
5						- clayey shale seam (~2.5" thick) at 4.8'		Groundwater not encountered in boring while auger drilling. Boring dry when converting to rock coring procedures
		Rock Core	4	REC=94 RQD=71		- clayey shale seams (~1.5") at 6.3' and 6.7'		
						- no weathering, and thicker bedding of 6" to 12" below 7'		Boring backfilled on 11/9/2018
8.5								Consistency/ Relative density based on manual hammer
						Boring terminated at 8.5 ft.		

SAMPLE TYPE: Split Spoon, Rock Core

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE
Qu UNCONFINED COMPRESSIVE STRENGTH FROM POCKET PENETROMETER

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED

Birmingham, AL • Auburn, AL • Huntsville, AL • Montgomery, AL • Mobile, AL • Tuscaloosa, AL
Columbus, GA • Louisville, KY • Raleigh, NC • Dunn, NC • Jacksonville, NC
Springdale, AR • Little Rock, AR • Tulsa, OK • Oklahoma City, OK • Durant, OK

LABORATORY TEST PROCEDURES

A brief description of the laboratory tests performed is provided in the following sections.

DESCRIPTION OF SOILS (VISUAL-MANUAL PROCEDURE) (ASTM D2488)

The soil samples were visually examined by our engineer and soil descriptions were provided. Representative samples were then selected and tested in accordance with the aforementioned laboratory-testing program to determine soil classifications and engineering properties. This data was used to correlate our visual descriptions with the Unified Soil Classification System (USCS).

Important Information about This

Geotechnical-Engineering Report

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

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

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

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

Read the Full Report

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

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are Not Final

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

A Geotechnical-Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Environmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

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

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

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