ATTACHMENT B

GEOTECHNICAL REPORT: PROPOSED GOODFELLOW AIR FORCE BASE DOG TRAINING AREA

SKG ENGINEERING, LLC

Geotechnical Report

Proposed Goodfellow Air Force Base
Dog Training Area
Goodfellow AFB, Texas 76908

C. JASON CLINTON
99195

12/20/2018
SKG Engineering, LLC
F-7608

PREPARED FOR:
Mr. Ron Trepainer
Senior Civil Engineer
460 East Kearney Blvd
San Angelo, Texas 76908

December 2018

18-E-1561

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December 20, 2018 18-E-1561

Mr. Ron Trepainer
Senior Civil Engineer
460 East Kearney Blvd
Goodfellow AFB, Texas 76908

Subject: Geotechnical Report, Proposed Goodfellow Air Force Base Dog Training Area, Goodfellow AFB, Texas

Mr. Trepainer,

In accordance with your authorization, SKG Engineering has completed its geotechnical investigation at the referenced site. The work was done in accordance with the proposal dated the 1st day of November, 2018. The data and results are included in the attached report.

If you have any questions or comments, or if we can be of any more service to you, please do not hesitate to contact us at (325) 655-1288.

Sincerely,
SKG Engineering, LLC

Jason Clinton

Jason Clinton, P.E.

C. JASON CLINTON
99195

SKG Engineering, LLC
F-7608

Attachments - Geotechnical Report

CC: File

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Attachments

1.0 Introduction

1.1 Overview

The purpose of this exploration was to determine subsurface materials and conditions and to establish the characteristics of these materials in order to recommend the criteria by which to establish foundation recommendations for the proposed dog training facility. A summary of field conditions is included in Attachment A.

2.0 Exploration

2.1 Soil Borings

The subsurface explorations were conducted on this site in December 2018. The borehole was drilled to a maximum depth of 20', and the log of the borehole is included in this report. The drilling was performed with a truck mounted air rotary drill rig. The drilling activities were performed in accordance with accepted methods and procedures. The borehole was conducted within the limits of the proposed building area. A location map showing the approximate borehole locations is included in Attachment B.

Material samples were recovered at various depths for testing. The primary means of extracting subsurface soil samples was by the use of a 3" Shelby-tube and/or a 2" O.D. split barrel sampler. Split spoon sampling procedures were performed in accordance with ASTM D 1586 and Shelby tube samples were obtained in accordance with ASTM D 1587. The samples were extruded or removed in the field and placed in moisture tight bags and labeled. The samples were then transported to the laboratory for testing and visual evaluation by geotechnical personnel. The Unified Soil Classification System was utilized in accordance with ASTM D 2487 to verify field classifications. Refer to the logs of borings located in Attachment C for lithology, sample locations and quantities.

2.2 Laboratory Tests

Tests were performed to determine engineering characteristics of the subsurface materials encountered including, but not limited to, soil moisture content (ASTM D 2216), Atterberg Limits (ASTM D 4318) and sieve analysis. The test results can be found in Attachment D. Samples not tested in the laboratory will be retained for a maximum of 60 days and then discarded unless otherwise notified in writing prior to disposal of the samples.

3.0 Subsurface Investigation

3.1 Subsurface Materials and Conditions

The specific subsurface stratum encountered in each borehole is described in the logs of boreholes included in Attachment C. The strata encountered at the boreholes conducted at the site can be divided into three major strata. The first stratum is a layer of fat clay that extends from a depth of 0' to 2'. The second soil stratum consists of lean clay that extends from a depth of 2' to 12'. The third stratum consists of gravel with silt and sand that extends from 12' to the depth of the boreholes.

3.2 Subsurface Water

There was no groundwater noted in the borehole at the time of the investigation. The absence of groundwater noted does not express or imply a groundwater study was performed, which is beyond the scope of this report. It should be noted that groundwater levels are subject to change based on seasonal and climatic conditions.

4.0 Site and Design Considerations

4.1 Basic Considerations

The properties of in-situ soils, site characteristics, and the level of tolerable deflection should be carefully considered during the design phase. A foundation should economically meet the functional requirements of the structure and minimize differential movement of the structure that could cause damage.

Routing of drainage should be addressed in the design phase of the project to ensure drainage is routed away and around proposed foundation systems and erosive conditions on the moderate slopes are avoided.

4.2 Subsurface Moisture

Water, in the form of a liquid, can rise upward through subsurface soils by capillary action, absorption or gravitational pull well above the water table. Water changes from a liquid to a vapor as it evaporates. Water vapor will move from areas of high vapor pressure to a lower vapor pressure through diffusion. Diffusion is how water vapor distributes itself above the water table and occurs in both soils and concrete.

It is generally recognized that the relative humidity in the soils below a foundation will be close to 100%. Such a high relative humidity is reached even when the moisture content in the material below the foundation is found to be low. Without a capillary break or vapor barrier below the foundation, a high relative humidity or water source below a foundation can contribute moisture to the concrete. This can cause soluble alkalis in the concrete to enter into solution thus raising the pH. Moisture induced pH levels in concrete can be on the range of 10 to 12 while normal cured levels can be on the range of 7 to 9.

The impact of subsurface moisture can be reduced by the use of a vapor barrier or capillary break. A vapor barrier below the foundation is recommended when floor coverings or adhesives are sensitive to moisture or alkaline conditions. A vapor barrier can be in the form of poly vinyl sheets and a capillary break can be a sand or granular base. Verification of the vapor emission limitations from the foundation is vital to the selection of the proper vapor barrier system.

4.3 Shrink/Swell Considerations

Shrink/swell movements of the in-situ soils with changes in the soil moisture content are anticipated to be moderate at the site. The Potential Vertical Rise (PVR) was calculated to be on the order of 1-3/4" using the McDowell PVR Method. The PVR was approximated using the McDowell's initial dry soil condition and a potential active zone to fifteen feet below grade. The intent of this section is to provide for a soil removal and replacement for the depths noted below. No finished floor elevations were provided at the time of this report and consideration of specific elevations would have to be reviewed when additional information is available.

The PVR can be reduced to be on the order of 1" by providing a 3' layer of engineered fill below the foundation. The PVR can be reduced to be on the order of ½" by providing a 10' layer of engineered fill below the foundation. When engineered fill is utilized to reduce the PVR, the continuous footings have to bear at the same depth as the depth of the engineered fill or engineered fill should be placed below the grade beam to accomplish the required depth. Refer to the Engineered Fill section for placement and specifications.

The PVR and moreover foundation movement is effected by many factors that influence its magnitude and rate of change. Factors include: seasonal variations in the moisture content between the interior and perimeter of the foundation, topographic relief, vegetative cover, confining pressures, fluctuating and shallow water tables, and the composition of underlying soils. In-situ clays can expand with the introduction of moisture and shrink with decreases in moisture.

4.4 Foundation System and Recommendations

We recommend an adequately reinforced slab on grade foundation system with grade beams placed as determined by the structural engineer with spread footings to support concentrated point loads and provide lateral stability where necessary. Pier parameters are provided herein, if the structural engineer chooses to utilize a foundation supported by piers. The pier recommendations are for a structurally suspended slab, because of the moderate PVR. We do not recommend to utilize piers with a slab bearing on grade due to the potential movement variation between piers and the slab. We do not foresee the structurally suspended slab as being a feasible option for this project. We recommend to utilize a soil removal and replacement as required by the owner’s tolerance for movement. We would recommend a maximum of 1” PVR for any slab on grade foundation system, as a minimum criterial.

4.4.1 Grade Supported Foundation

We recommend a vapor barrier in the form of a poly vinyl sheet directly beneath the foundation with a minimum 8" thick layer of granular base beneath the vapor barrier and a minimum 3’ layer of engineered fill beneath the base or as required to bring the finished floor elevation to design grade. Footings shall bear to a depth of 3’ below existing grade or engineered fill shall be provided below the perimeter grade beams to a depth of 3’ below existing grade to accommodate the soil modification plan. A depth of 8” shall be utilized for the design frost depth. We recommend the poly vinyl vapor barrier to be a minimum 10 ml thickness. The placement of these materials shall be in accordance with the Site Preparation section of this report. We recommend for the poly vinyl to be installed over a sand bed of approximately 1” thick to minimize tears in the vinyl experienced when installed over a granular base. We recommend installing the vapor barrier in a manner to minimize tears and abrasions to the vinyl. We recommend doing a pre-pour inspection to verify that the vinyl is not torn and if so, that it is taped up and sealed, prior to placement of concrete.

We recommend grade beams not supported by piers to be a minimum of 12" wide, the dimensions of spread footings should be a minimum of 30" on all sides, and all footings properly reinforced for the anticipated design loads to minimize the possibility of a local bearing capacity failure.

Shallow continuous footings used for any portion of the foundation system should be structurally tied to the grade beams, spread footings, piers or other structural elements. We recommend bearing the footings a minimum of 1' below finished grade. The allowable bearing pressure exerted by the grade beams or spread footings on the in-situ soils from a depth of 1' to 2' is 2,100 psf and from a depth of 2' to 4' is 2,900 psf. The value of 125 pci for subgrade modulus may be used for design purposes. The value of 28 degrees may be utilized for the internal friction angle of the clayey soils for design purposes. The value of 0.35 for the ultimate lateral sliding resistance coefficient may be utilized for design in regard to the foundation on an engineered fill. The allowable bearing pressure exerted by grade beams bearing into an engineered fill, placed in accordance with the specifications in Site Preparation of this report, is 3,500 psf.

4.4.2 Drilled Piers

Floor slabs that have a high performance criteria and a low tolerance for movement should be structurally suspended on piers. Void cartons should be utilized under grade beams and the slab. The void cartons should be a minimum of 10” thick. If a crawlspace is provided, it should be graded to drain so that water is not permitted to accumulate beneath the floor slab. We recommend to install a vapor barrier for the proposed crawl spaces. We recommend the poly vinyl vapor barrier to be a minimum 10 ml thickness. We do not recommend the use of trapezoidal void forms, due to the varied results of concrete placement typically experienced. Wall loads should be transmitted to the drilled piers by grade beams and the grade beam should be structurally connected to the piers.

Straight shaft piers can be used for foundation support where column loads are less than 50 kips. The piers should bear a minimum of 15' up to 18' below existing grade, bearing into the firm gravels and clays. The piers should be located below the active zone and founded on a firm, stable stratum. We recommend foregoing utilizing side shear resistance for the allowable bearing capacity of the piers between 0 and 10 feet of depth. The piers can be designed with an allowable side shear resistance of 450 psf for the portion of shaft extending from a depth of 10' to the depth of the borehole, in addition to the allowable end bearing pressure stated below. An allowable side shear resistance of 350 psf for the portion of shaft extending from a depth of 10' to the depth of the borehole may be utilized for uplift resistance. The allowable lateral bearing of the piers on the clayey soils may be taken as 150 psf/f and 50psf/f in the gravels. Field adjustments to some shafts depths may be required due to the variation in the site elevations and varied soils encountered. The allowable end bearing pressure exerted by the piers on the soils 15' to 18' below existing grade is 10,500 psf.

We do not recommend the use of underreamed piers in the subsurface gravel encountered due to the difficulty of construction. We recommend a minimum and maximum shaft diameter of 24" and 42", respectively for piers. Adjacent piers should maintain a minimum center to center spacing of 3 times the end bearing diameter. Piers spaced as specified do not require a reduction in the load carrying capacity of the individual piers due to group action.

Settlement of properly constructed piers are estimated to be less than ½" for loads of 50 kips or less. Additional settlement may occur if the load exceeds 50 kips.

Piers should be inspected for proper size, depth and reinforcement placement prior to the placement of any concrete. It is essential that the bearing stratum of the piers be identified by the engineer or his representative. A representative from SKG Engineering should be present during drilling activities to approve the bearing strata. Each pier excavation should be completed and concrete placed within one day. In no instance should any pier excavation be left open overnight. We recommend alternating the drilling and placement of concrete for shafts in groups. Foundation concrete should be placed in clean, dry holes. Bottoms of pier excavation should be cleared of loose debris prior to the placement of concrete.

We anticipate temporary pier casing will have to be used to prevent caving or sloughing of the hole during pier drilling operations, due to the subsurface stratum. The groundwater encountered will hinder pier installation processes and possibly the pier drilling. The contractor should anticipate utilizing all measures required to install the piers which may include: casing the piers, dewatering the pier excavations by means of pumps and pumping of concrete from the bottom of the pier.

4.4.3 Uplift Loads

The piers could experience tensile loads as a result of post construction heave of the clay soils. The shafts must contain sufficient reinforcing steel for the length of the shaft to accommodate the net tensile loads. There are several factors affecting the magnitude of the loads, such as; shaft diameter, soil parameters and in-situ moisture levels during and after construction.

4.5 Seismic Design Criteria

We have provided the seismic criteria for use in the structural design phase of the project. The seismic criteria is based on the 2015 International Building Code. The stratum referenced in this section refer to those described in the section Subsurface Materials and Conditions of this report. Please refer to the following table for seismic design parameters.

Mapped Spectral Response Acceleration					
Description	Site Class	Short Periods (S_s)	1 Second Period (S_1)	Site Coefficients	
				F_a	F_v
Stratum I	E	0.09g	0.04g	2.5	3.5
Stratum II	D	0.09g	0.04g	1.6	2.4
Stratum III	C	0.09g	0.04g	1.2	1.7

The International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The scope of our geotechnical services requested does not include the 100 foot soil profile determination. Additional services can be performed if requested or required, since our scope terminated the boreholes at a depth of 20 feet. We would recommend utilizing a Seismic Site Classification of D for this site, based on the soil conditions to a depth of 20 feet.

4.6 Lateral Design Criteria

Retaining walls that are sensitive to movements on the order of 1-3/4" should be supported by piers bearing a minimum of 15' below existing grade in a firm stable stratum. We recommend that wall footings bear a minimum of 2' below finished grade and be designed to withstand the lateral forces applied by earth pressures described below. The footings should not exceed the allowable bearing capacity of the soil on which it bears. The allowable passive earth pressure is 298 psf/ft of the depth, to a maximum of 1,500 psf.

Lateral earth pressures acting on the retaining walls will depend on several parameters such as; backfill used, drainage conditions and loads of adjacent structures. Recommended lateral earth pressures expressed as equivalent fluid pressures are presented below. The pressures below are assuming positive drainage is provided to prevent hydrostatic pressures.

Equivalent Fluid Pressures		
Material	At Rest (psf/ft)	Active (psf/ft)
Stratum I	--	--
Stratum II&III	100	60
Engineered Fill	55	35

4.7 Backfill Material and Compaction

Retaining walls should be backfilled with a 12" width of pea gravel for the height of the wall. Backfill behind the pea gravel should be a non-expansive fill material with a maximum particle size of 4" nominal diameter three quarters of the wall height and a clay cap on the top quarter of the wall height. We recommend providing weep holes along the bottom of the retaining wall height at 10' on center maximum spacing for the length of the wall. We recommend placing fill in maximum 8" loose lifts and compacted to between 93% to 97% of the Standard Proctor Density. Compaction tests should be performed on each lift.

4.8 Drainage

Positive drainage away from the foundation must be provided and maintained to reduce subsurface moisture variations. The minimum recommended slope away from the foundation is 5% for the first 10 feet for areas not covered by a sidewalk or pavement. Water shall not be permitted to pond on the finished site.

Due to the presence of in-situ clays, we recommend through the design and construction phase an emphasis on maintaining a stable moisture content in the soils beneath and adjacent to the foundation be a major priority. Temporary and permanent control measures should be properly designed and installed to ensure positive drainage away from the foundation to maintain a quasi stable soil moisture content. The measures include, but are not limited to gutters, sprinkler systems, and a site grading plan.

4.9 Underground Utilities

The backfill material used for underground utility trenches should be on-site materials or imported clayey materials. We recommend not using a granular material to avoid the possibility of water migration through the trenches and possibly under foundation systems at the site.

4.10 Exterior Flatwork Considerations

Engineered fill shall be used as needed to bring the flatwork to grade. Control joints should be cut at a maximum spacing of 6' for the length of the flatwork and expansion joints at a maximum spacing of 50'. We recommend installing flatwork as not to impound water adjacent to structural foundations.

4.11 Trenching and Excavation Requirements

The guidelines specified by Occupational Safety and Health Administration (OSHA) should be followed for all excavation activities. The OSHA Standards (29 CFR Part 1926 revised, 1989) require all trenches that exceed 5' in depth to be shored or benched appropriately unless the soil stratum is "solid" rock.

The OSHA standards should be strictly adhered to for all excavation activities. The classification of the soils encountered at the site are Type B soils. The soil classifications are based on soils encountered in the boreholes conducted at the site. Refer to the following OSHA Table B-1 for slope requirements for excavations that are less than 20 feet in depth. Trenches in excess of 20 feet in depth should be designed by a registered professional engineer.

Maximum Allowable Slopes		
Stratum	Horizontal	Vertical
Stable Rock	Vertical	1
Type A	3/4	1
Type B	1	1
Type C	1-1/2	1

The above information is provided for temporary excavations. We recommend that any permanent trenches proposed for the site should have a minimum of 4:1 side slopes. Any permanent trenches or channels should be lined with erosion control measures.

5.0 Site Preparation

5.1 Subgrade

Remove the top 6" of surface soils, any deleterious material, and in-situ soils as necessary to bring the finished floor elevation to design grade. The top 6" of material should then be scarified, moisture conditioned, and compacted to at least 95% of the Standard Proctor Density within 2% points of the optimum moisture content. Any soft or pumping areas are to be excavated and an engineered fill shall be used as backfill. Where existing slopes exceed ten horizontal to one vertical, the cross slope should be benched to provide a minimum of 6' bench width.

5.2 Engineered Fill

An approved select fill shall be used to bring the foundation system to grade. It shall be a non-granular, cohesive soil, free of deleterious material, have a liquid limit of less than 40, and a plasticity index between 6 and 14. The select fill shall meet the following percent retained on sieve requirements: 2-1/2": 0-5%, No. 4: 40-80%, and No. 40: 50-85% or obtain approval from the geotechnical engineer. The fill should be installed in maximum eight inch loose lifts and compacted to at least 95% of the Standard Proctor Density within 3% points of the optimum moisture content. Base consisting of TxDOT Type A, Grade 2 limestone will be accepted as engineered fill. Blended materials utilized for engineered fill will have to meet the specifications herein and be approved by the geotechnical engineer. If a blended material is approved, the contractor shall blend the material and have one stockpile for the entire project. Continuous blending of material throughout the duration of the project is not acceptable.

5.3 Flexible Base Material

Provide compacted base consisting of Type A, Grade 2, limestone material below the foundation. Compact to 96% of the Standard Proctor Density within 2% points of the optimum moisture content. Material shall be placed in lifts not to exceed 8". Alternative flexible base materials provided by a local suppliers which do not meet theses specifications shall be approved by the Engineer of record.

5.4 Testing

Test results of the engineered fill shall be submitted to the engineer of record for approval prior to incorporating into the work. Arrange for a testing agency to verify flexible base, engineered fill, and subgrade compaction and moisture content. To confirm the compaction of the subgrade, engineered fill, and base we recommend the more stringent of three density test for each lift placed or one density test for every 2,000 square feet of foundation area for each lift placed. The Standard Proctor Density shall be determined in accordance with ASTM D698.

6.0 Limitations

The recommendations presented in this report are based upon the information obtained from the borings performed at the site and from other information discussed in this report. This report is based upon the findings from the borings made and may not identify all subsurface variations which exist across the site. The nature and extent of such variations may not become evident until construction. If significant variations appear, contact SKG Engineering to further access the design criteria and the recommendations contained within this report.

The scope of services for this project does not include either specifically or by implication any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such conditions, the appropriate investigations should be performed.

No warranties, either expressed or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report are made, the recommendations contained in this report shall not be considered valid unless SKG Engineering reviews the changes and either verifies or modifies the conclusions of this report in writing.

Attachment A

Field Conditions

Summary of Field Conditions

The following field conditions were observed during the field exploration activities.

1. The site is developed with current facilities. The accessibility of some types of equipment should be verified in some of the areas of the site where multiple buildings are in the area.

2. The surface soil conditions on the site are generally clay that is considered a soft soil material. The soil conditions will probably prove to hinder mobilization of some types of construction equipment during rain events that saturate the soils.

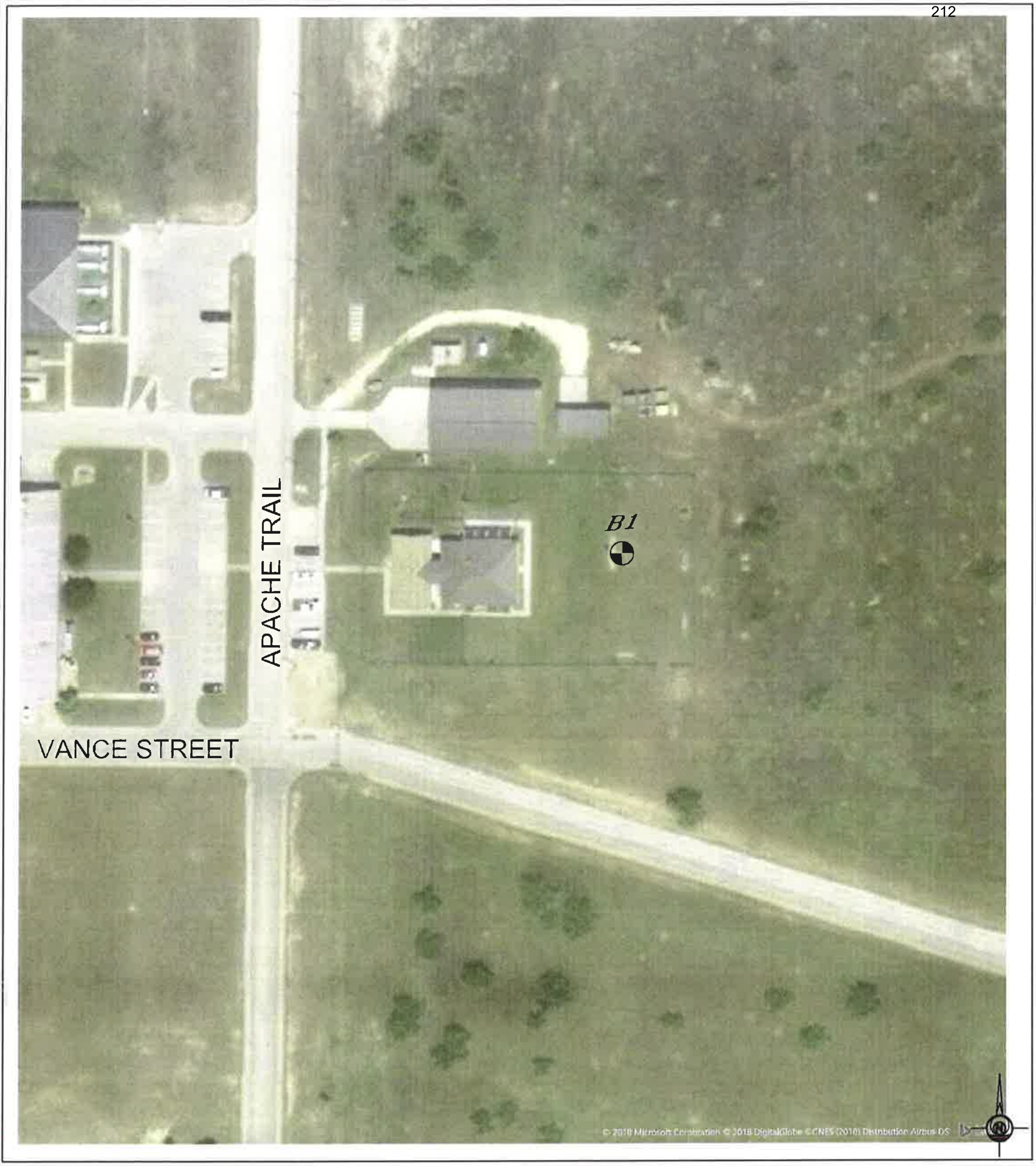
3. Groundwater was not present at the time of drilling activities in any of the boreholes.

4. No rock was encountered in any of the boreholes conducted at the site.

5. Site soils are not of quality to be used for engineered fill material under the foundation systems.

Attachment B

Borehole Location Map



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PROPOSED DOG TRAINING AREA
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SAN ANGELO, TEXAS

BORROWHOLE LOCATION MAP

DWG BY: DLH
DWG. DATE: 12.20.2018
JOB NO. 18-E-1561
SHEET NO. BH1
SCALE: 1"=100'

Attachment C

Logs of Boreholes

UNIFIED SOIL CLASSIFICATION SYSTEM

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

MOISTURE CONTENT

DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH.
DAMP	SOME PERCEPTIBLE MOISTURE; BELOW OPTIMUM.
MOIST	NO VISIBLE WATER; NEAR OPTIMUM MOISTURE CONTENT.
WET	VISIBLE FREE WATER, USUALLY SOIL IS BELOW WATER TABLE.

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	POCKET PENETROMETER READING IN TONS/FT2	N-VALUE (BLOWS/FOOT)
VERY SOFT	0 TO 0.25	<2
SOFT	0.25 TO 0.5	2 TO 4
FIRM	0.5 TO 1.0	4 TO 8
STIFF	1.0 TO 2.0	8 TO 15
VERY STIFF	2.0 TO 4.0	15 TO 30
HARD	>4.0 OR 4.5+	>30

CLAY	SILT	SAND			GRAVEL		COBBLES	BOULDERS
		FINE	MEDIUM	COARSE	FINE	COARSE		

0.005mm No.200 No.40 No.10 No.4 ¾" 3" 12"

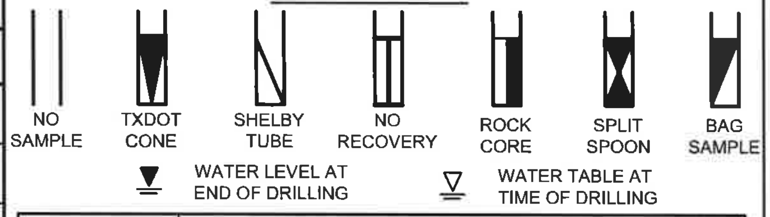
U.S. STANDARD SIEVE SIZE

RELATIVE DENSITY-GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY LOOSE	0 TO 4
LOOSE	5 TO 10
MEDIUM DENSE	11 TO 30
DENSE	31 TO 50
VERY DENSE	>50 OR 50+

REFERENCE: THE UNIFIED SOIL CLASSIFICATION SYSTEM, CORPS OF ENGINEERS, U.S. ARMY TECHNICAL MEMORANDUM NO. 3–357, VOL. 1 MARCH, 1953 (REVISED APRIL, 1960)

SAMPLER TYPE



SOIL TERMS	DESCRIPTION
BLOCKY	CONTAINS CRACKS OR FAILURE PLANES RESULTING IN ROUGH CUBES OF MATERIAL.
CALCAREOUS	CONTAINS APPRECIABLE QUANTITIES OF CALCIUM CARBONATE.
FISSURED	CONTAINS SHRINKAGE CRACKS, WHICH ARE FREQUENTLY FILLED WITH FINE SAND OR SILT. THE FISSURES ARE USUALLY NEAR VERTICAL IN ORIENTATION.
INTERBEDDED	COMPOSED OF ALTERNATING LAYERS OF DIFFERENT SOIL TYPES.
LAMINATED	COMPOSED OF THIN LAYERS OF VARYING COLOR AND TEXTURE.
NODULES	SECONDARY INCLUSIONS THAT APPEAR AS SMALL LUMPS ABOUT 0.1 TO 0.3 INCH IN DIAMETER.
PARTINGS	INCLUSION OF DIFFERENT MATERIAL LESS THAN ⅛ INCH THICK EXTENDING THROUGH THE SAMPLE.
POCKETS	INCLUSION OF DIFFERENT MATERIAL THAT IS SMALLER THAN THE DIAMETER OF THE SAMPLE.
SEAMS	INCLUSION OF DIFFERENT MATERIAL BETWEEN ⅛ AND 3 INCHES THICK, AND EXTENDS THROUGH THE SAMPLE.
SLICKENSIDED	HAS INCLINED PLANES OF WEAKNESS THAT ARE SLICK AND GLOSSY IN APPEARANCE. SLICKENSIDES ARE COMMONLY THOUGHT TO BE RANDOMLY ORIENTED.
STREAKS OR STAINS	STAINS OF LIMITED EXTENT THAT APPEAR AS SHORT STRIPES, SPOTS OR BLOTCHES.

ROCK TERMS	
BEDDING PLANE	A SURFACE PARALLEL TO THE SURFACE OF DEPOSITION, GENERALLY MARKED BY CHANGES IN COLOR OR GRAIN SIZE.
FRACTURE	A NATURAL BREAK IN ROCK ALONG WHICH NO DISPLACEMENT HAS OCCURED.
JOINT	A NATURAL BREAK ALONG WHICH NO DISPLACEMENT HAS OCCURED, WHICH GENERALLY INTERSECTS PRIMARY SURFACES.
% RECOVERY	THE RATIO OF TOTAL LENGTH OF RECOVERY TO THE TOTAL LENGTH OF CORE RUN, EXPRESSED AS A PERCENTAGE.
RQD - ROCK QUALITY DESIGNATION	THE RATIO OF TOTAL RECOVERED LENGTH OF FRAGMENTS LONGER THAN 4 INCHES TO THE TOTAL RUN LENGTH, EXPRESSED AS A PERCENTAGE.
WEATHERING	THE PROCESS BY WHICH ROCK IS BROKEN DOWN AND DECOMPOSED.

KEY
TO SYMBOLS AND TERMS

SKG
ENGINEERING

Project: **Proposed Dog Training Facility**
San Angelo, Texas

B-1

Boring Location: Refer to the borehole location map

Date Started: December 13, 2018 | **Date Finished:** December 13, 2018

Drilling Method: Air rotary

Hammer Weight: 140 lbs | **Drop:** 30 inches

Sampler: Shelby tube/2" split barrel sampler

Depth (feet)	Material Description	Samples			Laboratory		
		Number	Type	SPT	M%	PI	Pen (tsf)
	Surface Elevation:						
0	fat CLAY (CH); brown			2/4/5	24.3	31	
	lean CLAY (CL); tan			7/9/10			
5				6/7/8	12.9	27	
10				50-5"	16.2	24	
	silty clayey GRAVEL (GC-GM)						
15				50-3"			
				50-2"			
20	Boring completed at a depth of 20'. Groundwater was not present at the time of drilling activities.						
25							
30							
35							

SKG Engineering, LLC | **18-E-1561** | **Plate A- 1**

Attachment D

Laboratory Results

SKG
ENGINEERING, LLC
SURVEYING ♦ ENVIRONMENTAL ♦ LAB/CMT

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SAN ANGELO, TEXAS 76903
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ANALYSIS RESULTS

CLIENT: GAFB
PROJECT: Dog Training Area
PROJECT #: 18-E-1561
DATE: 12/20/2018

Lab No.	Description	Plastic Limit (%) *	Liquid Limit (%)*	Plasticity Index *	Moisture (%) *	Pass # 4 Sieve (%)*	Pass # 40 Sieve (%)*	Pass # 200 Sieve (%)*
1258	B1 0' 1.5'	20	51	31	24.3	99.0	94.6	75.0
1259	B1 3.5' 5'	21	48	27	12.9	99.2	87.4	62.2
1260	B1 8.5' 10'	20	44	24	16.2	95.6	90.3	86.5

Average PL	20
Average LL	48
Average PI	27
Average % Clay	74.6

Stephanie Cheatheam

Stephanie Cheatheam
Lab/CMT Manager