GEOTECHNICAL ENGINEERING REPORT

CHEROKEE NATION

TAG OFFICE

SKELLY DRIVE AND NORTH 161ST EAST AVENUE

CATOOSA, OKLAHOMA

Prepared for:

Childers Architect
45 South 4th Street
Fort Smith, Arkansas 72901

Prepared by:

- Geotechnical Services
- Environmental Services
- Material Testing Services

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PROJECT NUMBER: 264572

March 26, 2020

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March 26, 2020

Childers Architect
45 South 4th Street
Fort Smith, Arkansas 72901

Attn: Ms. Ana Sandoval
Email: ASandoval@ChildersArchitect.com

RE: Geotechnical Engineering Report
Cherokee Nation Tag Office
Skelly Drive and North 161st East Avenue
Catoosa, Oklahoma
PPI Project Number: 264572

Dear Ms. Sandoval:

Attached, please find the report summarizing the results of the geotechnical investigation conducted for the proposed new Cherokee Nation Tag Office in Catoosa, Oklahoma. We appreciate this opportunity to be of service. If you have any questions, please don't hesitate to contact this office.

PALMERTON & PARRISH, INC.
By:

R. Todd Hercules

R. Todd Hercules, P.E.
Geotechnical Engineer

PALMERTON & PARRISH, INC.
By:

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EXECUTIVE SUMMARY

A Geotechnical Investigation was performed for the new Cherokee Nation Tag Office located at Skelly Drive and North 161st East Avenue in Catoosa, Oklahoma. It is understood that a new steel or wood-framed building with slab on grade and associated parking/drive area will be constructed at the project site. Traffic loading was not provided but is assumed to be light. Cut and fill depths are anticipated to be between 1 to 3 feet across the subject site to provide finished subgrade elevations.

Based upon the information obtained from the borings drilled and subsequent laboratory testing, the site is suitable for the proposed Tag Office. Important geotechnical considerations for the project are summarized below. However, users of the information contained in the report must review the entire report for specific details pertinent to geotechnical design considerations.

- Surface materials generally consisted of 5 to 6 inches of pavements generally underlain by 8 inches aggregate base rock. In non-pavement areas, topsoil was noted to a depth of 3 inches. Pavements, base rock, and topsoil should be removed from the building location and from beneath new pavement sections;
- The subject site was previously developed and the former buildings were historically removed. Pavements for the former development were remaining at the time of the subsurface exploration. Former building elements, such as foundations, utilities, possible fuel tanks may be present and encountered in areas not explored;
- Possible fill was noted within the subsurface borings to depths of 3 to 3.3 feet below the ground surface. Based on the review of historical aerial imagery, the subject site was noted to formerly contain a truck stop and may have contained underground fuel tanks. Fill depths may be deeper in underground tank areas, if present. Foundations for the proposed building should be extended through all undocumented fill if encountered within the building area. Floor slab and pavement

EXECUTIVE SUMMARY - CONTINUED

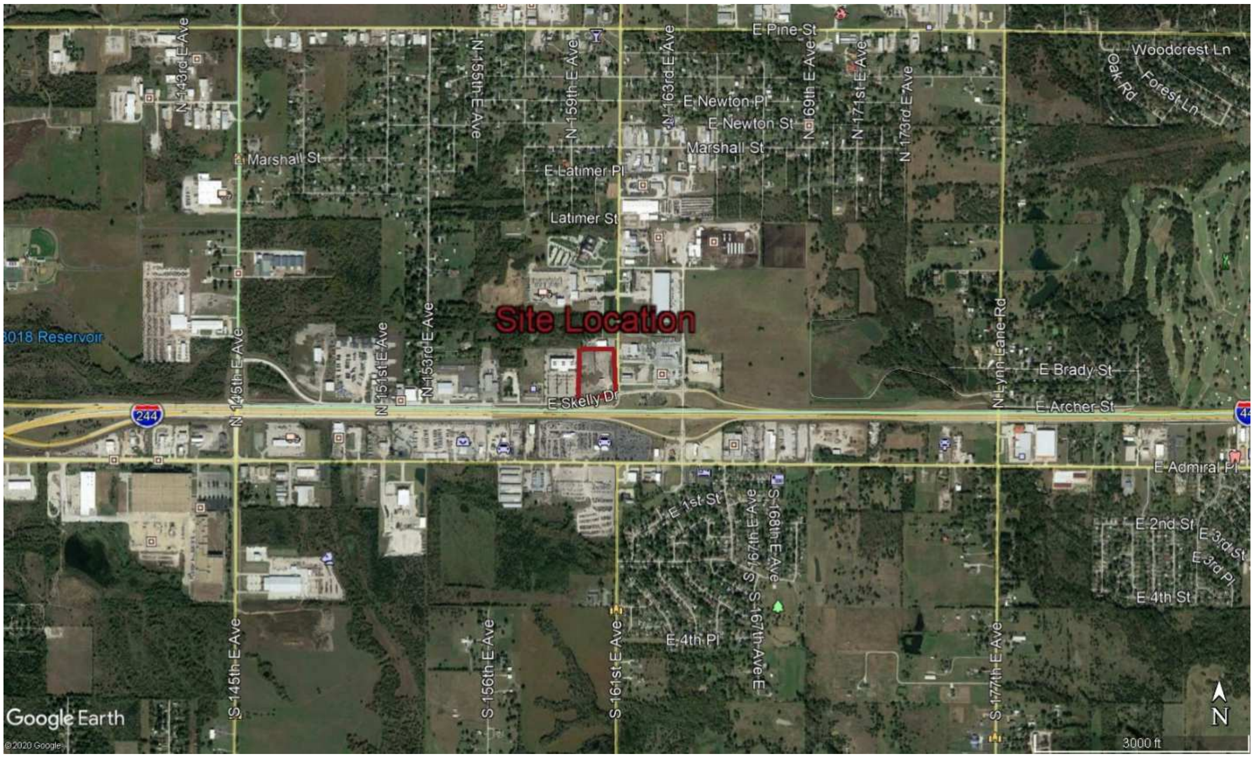
areas with undocumented fill should pass a proof roll prior to placement of controlled fill;

- Low to moderate swell potential soils are anticipated at the subject site. It is recommended that a minimum of 2 feet of LVC material be placed beneath slabs and building foundations to help reduce the swell potential of the fat clay soils. Additionally, it is recommended that a minimum of 1-foot of LVC material be placed beneath pavements. Pavement LVC may include aggregate base layers;
- Shallow, perched groundwater was noted in Boring 2 on the date drilled. Accordingly, the contractor should be prepared for this condition during earthwork procedures although it is anticipated to be isolated. It is anticipated that typical sump pumps will be suitable for the removal of water, if encountered during construction;
- Foundations bearing on 2 ft of LVC material for the new Tag Office can be designed for an allowable bearing capacity of 2,500 psf for column footings and 2,000 psf for continuous footings;
- The project site classifies as a Site Class C in accordance with Section 1613 of the 2015 International Building Code (IBC); and
- Palmerton & Parrish, Inc. should be retained for construction observation and construction materials testing. Close monitoring of subgrade preparation work is considered critical to achieve adequate pavement and subgrade performance.

GEOTECHNICAL ENGINEERING REPORT
CHEROKEE NATION
TAG OFFICE
SKELLY DRIVE AND NORTH 161ST EAST AVENUE
CATOOSA, OKLAHOMA

1.0 INTRODUCTION

This is the report of the Geotechnical Investigation performed for the proposed Cherokee Nation Tag Office located at Skelly Drive and North 161st East Avenue in Catoosa, Oklahoma. This investigation was authorized by a letter proposal dated March 4, 2020, and signed by Mr. Breck Childers, representing Childers Architect. The approximate site location is shown below:



The purpose of the Geotechnical Investigation was to provide information for foundation design and construction planning, and to aid in site development. Palmerton & Parrish Inc.'s (PPI) scope of services included field and laboratory investigation of the subsurface conditions in the vicinity of the proposed project site, engineering analysis of the collected data, development of recommendations for foundation design and construction planning, and preparation of this engineering report.

2.0 PROJECT DESCRIPTION

Item	Description
Site Layout	See Figure 1: Boring Location Plan
Building	The new Tag Office is anticipated to be steel or wood-frame construction with slab on grade and an approximate footprint of 5,200 square feet. The proposed building is anticipated to be one (1) to two (2) stories in height.
Pavements	Pavements are anticipated around the proposed building area.
Foundation Loadings	Anticipated to be light.
Existing Structure	Existing pavements.
Grading	Based on the provided Site topographic map, the proposed Tag Office is anticipated to have cut and/or fill depths of 1 to 3 feet.

3.0 SITE DESCRIPTION

Item	Description
Physical Location	Skelly Drive and North 161st East Avenue in Catoosa, Oklahoma
Latitude: Longitude: (± Center of Project Site)	36.164539° -95.798106°
Available Historic Aerial Photography	Based on available historic imagery, the subject site formerly contained a truck fueling station.
Current Ground Cover	Asphalt and concrete pavements with grass covered areas.
Existing Topography	Gently sloping with decreasing elevation to the north.
Drainage Characteristics	Poor

4.0 SUBSURFACE INVESTIGATION

Subsurface conditions were investigated through completion of nine (9) subsurface borings and subsequent laboratory testing. An additional offset boring was performed for Boring 3 labeled Boring 3A due to shallow refusal.

4.1 Subsurface Borings

Boring locations were selected by the client and staked in the field by PPI using a site plan provided by the Client. Approximate boring locations are shown on Figure 1, Boring Location Plan. The Oklahoma One-Call System was notified prior to the investigation to assist in locating buried public utilities.

Logs of the borings showing descriptions of soil and rock units encountered, as well as results of field tests, laboratory tests and a "Key to Symbols" are presented in Appendix II.

Borings were drilled on March 12, 2020 using 4.5-inch O.D. continuous flight augers powered by an ATV-mounted drill-rig. Soil samples were collected at 2.5 to 5-foot centers during drilling. Soil sample types included split spoon samples collected while performing the Standard Penetration Test (SPT) in general accordance with ASTM D1586 and thin walled Shelby tubes pushed hydraulically in advance of drilling in accordance with ASTM D1587. Please refer to Appendix III for general notes regarding boring logs and additional soil sampling information.

4.2 Laboratory Testing

Collected samples were sealed and transported to the laboratory for further evaluation and visual examination. Laboratory soil testing included the following:

- Moisture Content (ASTM D2216);
- Atterberg Limits (ASTM D4318);
- Swell Tests (ASTM D4546); and
- Pocket Penetrometers.

Laboratory test results are shown on each boring log in Appendix II and are summarized in the following table.

Boring	Depth (ft.)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Moisture Content (%)	USCS Symbol	Percent Swell (%)	Swell Pressure (tsf)
2	1.0	47	16	31	14.5	CL-CH	-	-
3	3.5	56	18	38	27.9	CH	1.36	1.00

5.0 SITE GEOLOGY

Based on available information from the United States Geological Survey (USGS), the subject site is located over the Oolagah Formation. This formation is known to primarily contain limestone and shale with some amount of sandstone possible. The subsurface exploration encountered auger refusal in what is anticipated to primarily be limestone; however, some amounts of residual shale and sandstone were noted.

6.0 GENERAL SITE SUBSURFACE CONDITIONS

Based upon subsurface conditions encountered within the borings drilled at the project site, generalized subsurface conditions are summarized in the table below. Soil stratification lines on the boring logs indicate approximate boundary lines between different types of soil units based upon observations made during drilling. In-situ transitions between soil and some rock types are typically gradual.

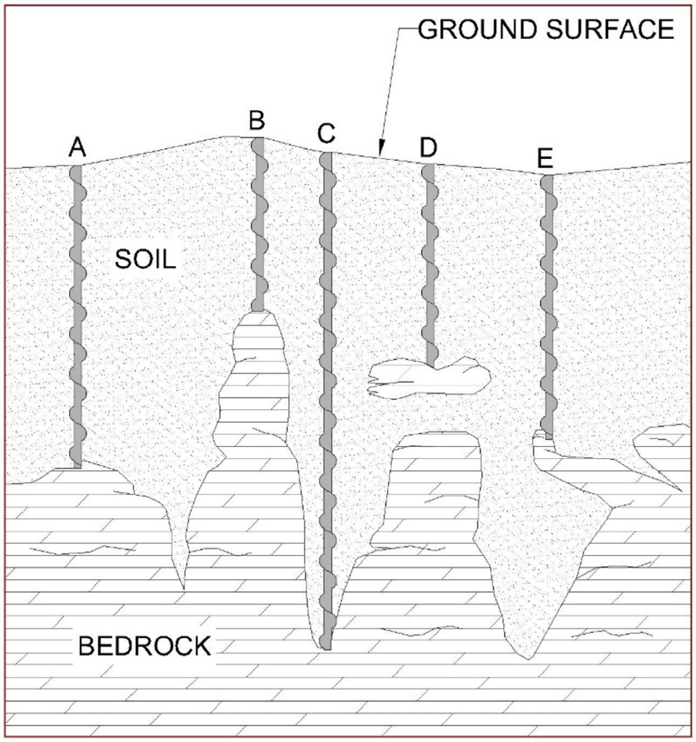
6.1 Soils

Generalized subsurface conditions are summarized in the table below:

Encountered Soil	Considerations
SURFACE MATERIALS • Topsoil – 3 inches in depth in Boring 9 • Portland Cement Concrete – 6 inches in depth in Boring 8. • Asphalt with Aggregate Base – Noted in all remaining borings to depths of 13 inches below the ground surface.	• Remove from building areas; • Topsoil should be removed form pavement areas; and • Aggregate base may be re-used according to Section 8.9.
NATIVE LEAN TO FAT AND FAT CLAY – Varying amounts of gravel and sand.	• Not suitable for use as LVC Material without being treated.
NATIVE CLAYEY GRAVEL	• Suitable for reuse according to Section 8.9.
AUGER REFUSAL - Encountered in Borings 1, 2, 3, 3A, 6, and 9. Based on the rock dust from the augers and split-spoon sampler, this material was identified as being probable limestone or boulders.	

6.2 Auger Refusal

Auger refusal is defined as the depth below the ground surface at which a boring can no longer be advanced with the soil drilling technique being used. Auger refusal is subjective and is based upon the type of drilling equipment and types of augers being used, as well as the effort exerted by the driller. Several different auger refusal conditions are possible in the general site area. These conditions are represented graphically in the adjacent figure: (A) on the upper surface of continuous bedrock, (B) on rock “pinnacles”, (C) in widened joints that may extend well below the surrounding bedrock surface, (D) slabs of unweathered rock suspended in the residual soil matrix, or “floaters”, or (E) on the upper surface of discontinuous bedrock.



Note: The bedrock conditions illustrated above are for reference only and do not indicate conditions encountered at the project site.

6.3 Groundwater

Shallow perched groundwater was observed within Boring 2 at depth of 1.25 feet below the existing ground surface on the date drilled. Groundwater levels should be expected to fluctuate with changes in site grading, precipitation, and regional groundwater levels. Groundwater may be encountered at shallower depths during wetter periods. Development of perched groundwater at the soil-bedrock contact can occur in the general site area.

7.0 GEOTECHNICAL CONSIDERATIONS

Based on the subsurface exploration, laboratory testing, and general site observations, PPI has noted the following geotechnical considerations influencing site design, development, and construction. These considerations have been listed in the table below with the report sections that they can be found in and the phases of construction that they affect:

Geotechnical Consideration	Report Sections	Construction Phases
Surface Materials	Section 8.2	Earthwork
Shallow Groundwater	Section 8.3	Earthwork
Possible Undocumented Fill	Section 8.4, 9.0, 11.0, and 12.0	Earthwork, Foundations, Floor Slabs, and Pavements
Moderate Volume Change Material	Section 8.5, 9.0, 11.0, and 12.0	Earthwork, Foundations, Floor Slabs, and Pavements
Shallow Bedrock	Section 8.6 and 9.0	Earthwork and Foundations

8.0 EARTHWORK

8.1 Site Preparation

Proposed grading plans for the new Tag Office were not provided. Based on the existing topographic survey plans provided by the client for the subject site, it is anticipated that between 1 and 3 feet of cut and/or fill will be required to establish final grades. The initial phase of site preparation should include the steps listed below;

- **It is recommended that a representative from PPI be present during site preparation to help identify the conditions described below**;
- Stripping and removal of all topsoil, vegetation, and pavements as described in Section 8.2;
- Shallow perched groundwater was encountered in Boring 2. Although it is anticipated to be isolated, contractors should be prepared for this condition according to Section 8.3;

- Undocumented fill and former building elements may be encountered at the project site. Any former building elements, if encountered, should be removed from the project site. Undocumented fills, if encountered, should be handled according to Section 8.4;
- Fat clay with low to moderate swell potential was noted in the subsurface investigation. It is recommended that a minimum of 2 feet of LVC material be placed beneath building foundations and floor slabs according to Section 8.5. Additionally, a minimum of 1-foot of LVC material is recommended below pavements as described in Section 8.5;
- Structure areas that encounter a combination of partial rock and soil bearing should be treated as noted in Section 8.6; and
- All areas scheduled to receive new fill should be proof-rolled as described below**.** Fill should not be placed on a frozen subgrade.

Proof-rolling consists essentially of rolling the ground surface with a loaded tandem axle dump truck or similar heavy rubber-tired construction equipment and noting any areas which rut or deflect during rolling. All soft subgrade areas identified during proof-rolling should be undercut and replaced with compacted fill as outlined below. Proof-rolling, undercutting, and replacement should be monitored by a qualified representative of the Geotechnical Engineer. The depth and areal extent of undercutting, if any, should be minimal but will be largely dependent upon the time of year and related soil moisture conditions. If construction is initiated during wetter spring or winter months, the requirement for undercutting soft surficial soils below normal topsoil stripping should be anticipated and reflected in contract documents.

8.2 Surface Materials

Topsoil and pavements with aggregate base rock were noted in the subsurface exploration to depths of 3 to 6 inches below the ground surface with aggregate baserock extending to depths of approximately 13 inches below the ground surface. This material should be stripped from building areas. Topsoil should also be removed from all structural areas. Existing pavements should be removed in areas of the building footprint or new pavement sections, if applicable.

It should be noted that the use of the term topsoil within this report is for site construction and does not imply that the material is suitable for sale as topsoil. Due to the increased gravel and sand contents and the plasticity of some of the topsoil, some of this material may not be suitable for re-use as a surficial landscaping material.

8.3 Shallow Ground Water

Perched groundwater was encountered during the subsurface exploration at a depth of 1.25 feet below the ground surface in Boring 2. As previously mentioned, water levels at the subject site should be anticipated to fluctuate with seasonal changes in moisture. Contractors should be prepared to encounter areas of shallow perched groundwater at the subject site. Generally, the shallow perched groundwater is anticipated to be isolated and should be able to be removed with conventional pumping equipment.

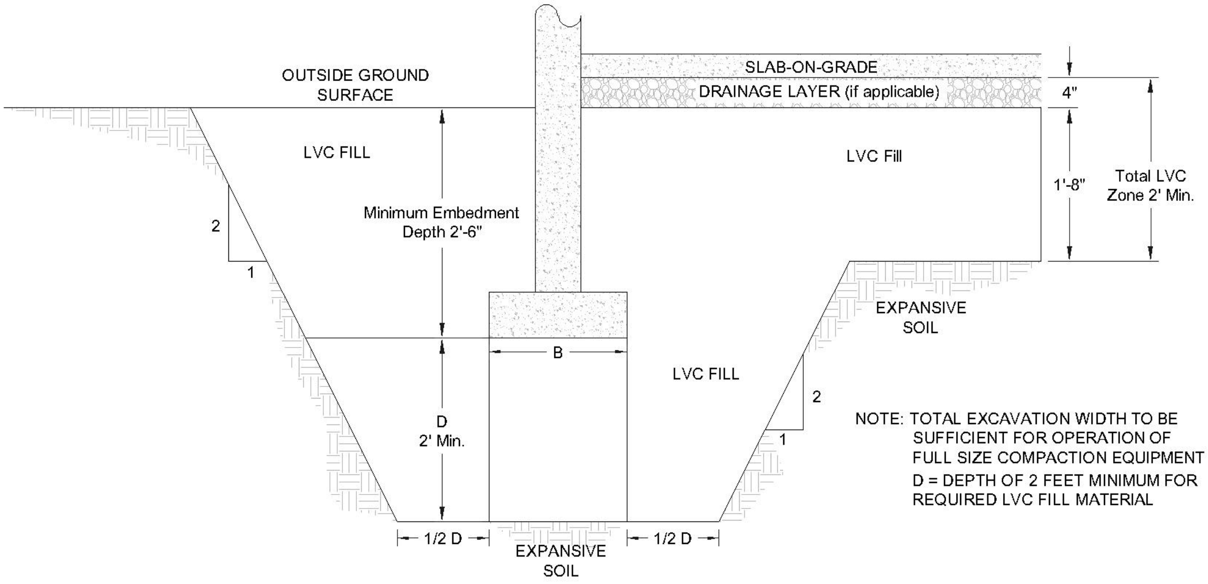
8.4 Former Building Features and Undocumented Fills

The subject site was formerly developed. Based on available aerial imagery, the subject site appeared to be a former truck stop structure that was removed prior to the year 1995. It is understood that the removal of the former structure was not observed. Accordingly, the subject site may contain former building elements; however, these are not anticipated in the proposed building location based on the provided site plans and the former building locations. Additionally, undocumented fills may be present in areas of former tank locations, if any.

Possible undocumented fill was noted in Borings 7 through 9 to depths between 3 to 3.3 feet below the ground surface. If undocumented fill is noted in the building location, building foundation excavations should be extended through the undocumented fill then replaced back with structural fill with a minimum 2 ft of LVC material placed immediately below the footing. Undocumented fill in floor slabs and pavement areas should pass a proof-roll prior to placement of controlled fill.

8.5 Low to Moderate Volume Change Material

Based on laboratory testing of samples from the project site, as well as past experience of this firm on nearby project sites, soils with low to moderate swell potential are present on the site. These materials can excessively swell and sometimes shrink with the addition or evaporation of moisture. The excessive swelling or shrinkage can cause cracks in foundations, concrete slabs, and pavements to form. The material prone to swell at the project site includes materials noted as Lean to Fat Clay (CL-CH), Fat Clay (CH), and materials designated as shaley. As a result, foundations and slabs-on-grade should be undercut sufficient to provide a minimum of 2-foot low volume change (LVC) fill material placed below these structures. The LVC material should also extend a minimum of 12 inches beyond the footing width and be sloped up at a 1H:2V angle as shown in the below image. Material suitable as LVC material is described in Section 8.9 and includes treated soils as described in Section 8.8.

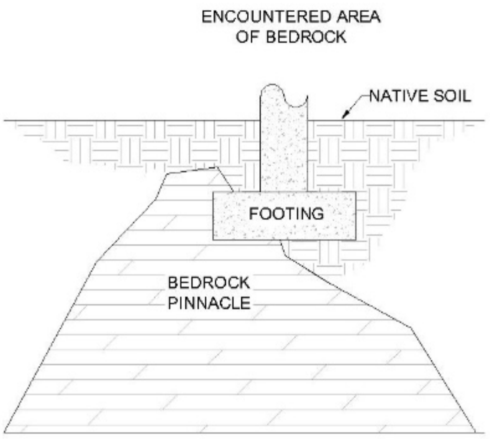


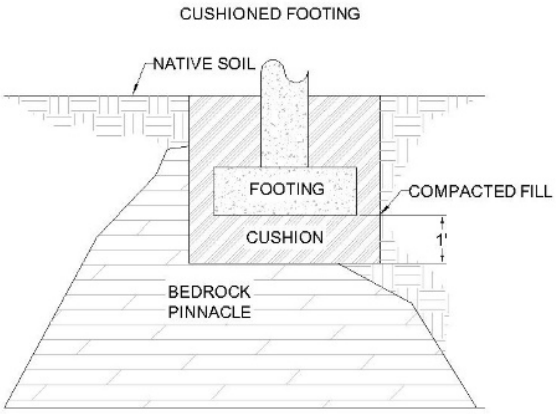
Low to moderate swell potential materials may also be encountered in pavement areas. Where these soils are present in proposed pavement areas, moisture contents of the subgrade soils should be adjusted and **maintained** above optimum to limit the potential for shrink/swell. Further, pavement areas should be undercut sufficient depth to allow placement of 1 ft of LVC material immediately below the pavement section,.

8.6 Shallow Bedrock Considerations

The subsurface exploration program encountered areas of shallow bedrock and shallow auger refusal at the project site. Bedrock at the project site is anticipated to consist primarily of limestone. Because of the variable degrees of weathering, there is the potential for structures to encounter a condition where areas of intact, competent bedrock are mixed with relatively soft soils. In view of the increased potential for differential settlement between foundation units installed upon bearing strata with widely varying compressibility characteristics (incompressible bedrock versus firm clay), one of the following corrective measures should be implemented if bedrock is exposed in footing excavations or immediately below footing bottom elevation:

- The bedrock be over-excavated sufficient to allow placement of a minimum 12-inch "cushion" below footing bottoms as shown below. This "cushion" material may consist of a well-compacted low plasticity earth fill (if no groundwater is present), shot rock fill or compacted baserock. Bedrock heaved by blasting is not considered acceptable as cushion material. Caution should be exercised to limit over-shot of bedrock.





- Sufficient reinforcing steel added to the footing/foundation wall system in order to allow the footing/foundation wall to span at least 20 feet each side of the edge of rock. Further, use of building components sensitive to differential settlement (plastic, masonry veneer, glass, etc.) should be prohibited at the edge of rock where there is an abrupt change in support characteristics.

8.7 Scarifying and Recompacting

Subgrade areas approved after proof-rolling should be scarified to a depth of at least 8 inches and soil moisture adjusted and compacted to comply with project specifications.

8.8 Treated Soils

Chemical stabilization is another alternate to utilize the on-site lean to fat and fat clays (CL-CH and CH) generated from undercutting procedures. It is recommended that chemically stabilized clays be placed in 6 to 9-inch lifts and compacted to specified densities. Use of approximately 6 percent hydrated lime or 15 percent Type C Flyash, by weight, should be anticipated. With CH or CL-CH clays chemically stabilized, it is considered applicable to place this material at all locations and elevations within the proposed development. Treated soils can be used in place of LVC material in all locations.

8.9 Fill Material Types

Fill Type[1]	USCS Classification	Acceptable Location for Placement
Low Volume Change (LVC) Engineered Fill[2]	Non-shaley CL[5], GC, or SC (LL < 45%)	All locations and elevations
On-Site Natural Soils	GC	All locations and elevations
	CL-CH[3], CH[3]	See Note 3
Potential Borrow Material	Non-shaley CL[5] or GC	All locations and elevations
	CL-CH[3], CH[3]	
Rock Fill[4]	GW	All locations and elevations

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris and contain maximum rock size of 4 to 6 in. Frozen material should not be used and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to its use.
2. Non-shaley, low plasticity cohesive soil or granular soil having at least 15% low plasticity fines.
3. CL-CH or CH clays with a Liquid Limit equal to or above 45% are considered suitable for use as controlled fill, only if the percentage of rock fragments exceeds 35% or if placed 2 feet below shallow foundations, pavements, or slab areas.
4. If rock fill will be utilized at the project site see Section 8.7.1.
5. Caution should be exercised when utilizing on-site lean clays as fill material. These soils are moisture sensitive and may not provide a stable subgrade even when properly compacted when soil moisture is above optimum.

8.9.1 Rock Fill

If rock is to be used as the primary filling medium, embankments should be constructed using rock having maximum dimensions in excess of 4 inches, but no greater than 8 inches. Rock material should be placed in horizontal layers having a thickness of approximately the maximum size of the larger rock comprising the lift, but not greater than 12 inches. Rocks or boulders too large to permit placing in a 12-inch thick lift should be reduced in size as necessary to permit placement or be bladed over the edge of the fill and not used in the compacted fill. Rock fill should not be dumped into place but should be distributed in horizontal lifts by blading and dozing in such a manner as to ensure proper placement into final position in the embankment. Finer material including rock fines and limited soil fines should be worked into the rock voids during this blading operation. Excessive soil and rock fine particles preventing interlock of cobble and boulder sized rock should be prohibited. Rock fill should be consolidated by a minimum of three (3) passes of a large diameter self-propelled vibratory compactor. Terminal fill slopes using rock may be constructed 1.5 horizontal to 1 vertical for fill height of 15 feet or less. The testing of rock fill quality should include the requirements that a representative of the Geotechnical Engineer be present daily, but not necessarily continuously during the placement of the fill to observe the placement of rock fill in order to determine fill quality and to observe that the contractors work sequence is in compliance with this specification. Progress reports indicative of the quality of the fill should be made at regular intervals to the Owner. If improper placement procedures are observed during the placement of the fill the Geotechnical Engineer should inform the Contractor, and no additional fill should be permitted on the affected area until the condition causing the low densities has been corrected and the fill has been reworked to obtain sufficient density.

8.10 Acceptable LVC Material

LVC material is recommended below floor slabs, footings and pavements. Potential sources of LVC material are as follows:

- Import from an off-site borrow area;
- Aggregate baserock, if containing at least 15% low plasticity fines, i.e. percent passing No. 200 Sieve; and
- Chemical stabilization is another alternate to utilize the on-site CL-CH or CH clays generated from undercutting procedures. It is recommended that chemically stabilized shaley clays be placed in 6 to 9-inch lifts and compacted to specified densities. Use of approximately 6 percent hydrated lime or 15 percent Type C Flyash, by weight, should be anticipated. With CL-CH or CH clays chemically stabilized, it is considered applicable to place this material at all locations and elevations within the proposed building footprint or pavement/sidewalk areas.

8.11 Compaction Requirements

Item	Description
Subgrade Scarification Depth	At least 8 inches
Fill Lift Thickness	8-inch (loose)
Compaction Requirements[1]	95% Standard Proctor Density (ASTM D-698)
Moisture Content	• ± 2% optimum moisture for CL, SC, or GC soil types; or • 0 to 4% above optimum for CL-CH or CH soil types
Recommended Testing Frequency	• One (1) Field Density (compaction) test for each 2,500 sq. ft. of fill within building areas; • One (1) Field Density (compaction) test for each 5,000 sq. ft. of fill within paving areas; and • A minimum of three (3) tests per lift.
1. We recommend that engineered fill (including scarified compacted subgrade) be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.	

8.12 Landscaping & Site Drainage

Discharge from roof downspouts should be collected and diverted well away from the building perimeter and incorporated into the design plans. Rapid, efficient runoff away from the building should also be provided. In addition, landscaping requiring frequent watering should be prohibited adjacent to building foundations.

In addition, provisions should be implemented to reduce the potential for large fluctuations in moisture within the subgrade soils adjacent to the structure. Ponding of surface water immediately adjacent to the structures and pavements can significantly increase subgrade moisture and may result in undesirable subgrade movement. As previously mentioned, careful consideration should be given to the landscaping and drainage elements to be installed at the project site adjacent to building and pavement areas. **Trees and some large bushes can draw significant moisture from the subgrade soils, resulting in shrinkage and subsequent foundation/pavement movement.**

8.13 Earthwork Construction Considerations

Once grading and filling operations have been completed, the moisture within the subgrade should be maintained and soils not be allowed to dry and desiccate prior to construction of floor slabs, footings or pavements. Grading of the site should be performed in such a manner so that ponding of surface water on prepared subgrade or in excavations is avoided. During construction, if the prepared subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be scarified or removed, moisture conditioned and recompacted prior to floor slab or pavement construction.

8.14 Excavations

Based upon the subsurface conditions encountered during this investigation, the on-site soils typically classify as Type C in accordance with OSHA regulations. Temporary excavations in soils classifying as Type C with a total height of less than 20 feet should be cut no steeper than 1.5H:1V in accordance with OSHA guidelines. If stable limestone bedrock is encountered in excavations, the bedrock may be cut to near vertical sidewalls. Deep excavations are not anticipated for this Project. Confirmation of soil classification during construction, as well as construction safety (including shoring, if required), is the responsibility of the contractor.

9.0 FOUNDATIONS

9.1 Building Foundations

Based upon the subsurface conditions encountered near the proposed building and anticipated site grading, footings for the proposed building are recommended to bear in new controlled LVC fill materials. If shallow rock is encountered the shallow rock should be over excavated and replaced to provide a cushion as described in Section 8.6. If undocumented fill material is encountered within footing excavations, all undocumented fill should be undercut to natural soils, then replaced with controlled fill. The top 2 ft immediately below the footing should consist of LVC material. Please refer to the section below for recommendations regarding shallow foundations.

9.2 Shallow Foundation Design Recommendations

Description	Column (Spread Footing)	Wall (Continuous Footing)
Net allowable bearing pressure[1]	LVC Fill: 2,500 psf	LVC Fill: 2,000 psf
Minimum dimensions	2.5 feet	1.5 feet
Minimum embedment below finished grade for frost protection and variation in soil moisture[2] (footings on soil)	2 feet	2 feet
Estimated total settlement[3]	1 inch or less	1 inch or less
Allowable passive pressure[4]	600 psf	600 psf
Coefficient of sliding friction[5]	0.4 (controlled fill)	0.4 (controlled fill)

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. The recommended pressure considers all unsuitable and/or soft or loose soils, if encountered, are undercut and replaced with tested and approved new engineered fill. Footing excavations should be free of loose and disturbed material, debris, and water when concrete is placed. A factor of safety value of 3 has been applied to these values.
2. For perimeter footings and footings beneath unheated areas.
3. The foundation movement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations.
4. Allowable passive pressure value considers a factor of safety of about 2. Passive pressure value applies to undisturbed native clay or properly compacted fill. If formed footings are constructed, the space between the formed side of a footing and excavation sidewall should be cleaned of all loose material, debris, and water and backfilled with tested and approved fill compacted to at least 95% of the material's Standard Proctor dry density. Passive resistance should be neglected for the upper 2 feet of the soil below the final adjacent grade due to strength loss from freeze/thaw and shrink/swell.
5. Coefficient of friction value is an ultimate value and does not contain a factor of safety.

Due to the low to moderate swell potential of the underlying lean to fat and fat clays present at the project site, it is recommended that the foundation size be designed to increase bearing pressures to the values presented in the table above to the extent reasonably possible. This increased bearing pressure should limit the swell potential of the underlying lean to fat and fat clays.

9.3 Uplift

Resistance of shallow spread footings to uplift (U_p) may be based upon the dead weight of the concrete footing structure (W_C) and the weight of soil backfill contained in an inverted cone or pyramid directly above the footings (W_S). The following parameters may be used in design:

Description	Weights
Weight of Concrete (W_c)	150 pcf
Weight of Soil Resistance (W_s)	100 pcf
Weight for on-site soils placed in accordance with Section 8.0	

The base of the cone or pyramid should be the top of the footing and the pyramid or cone sides should form an angle of 30 degrees with the vertical. Allowable uplift capacity (U_p) should be computed as the lesser of the two (2) equations listed below:

$$U_P = (W_S/2.0) + (W_C/1.25) \text{ or } U_P = (W_S + W_C)/1.5$$

10.0 SEISMIC CONSIDERATIONS

Code Used	Site Classification
2015 International Building Code (IBC)[1]	C
1. In general accordance with the *2015 International Building Code*, Section 1613	

11.0 FLOOR SLABS

A slab-on-fill floor system is considered appropriate at the site based upon subsurface conditions encountered and future site grading. Listed below are key considerations for design purposes of the floor slab.

- Subgrade containing lean to fat or fat clays (CL-CH or CH) in the floor slab areas should be over excavated and replaced as described in Section 8.5;
- Subgrade materials containing undocumented fills in the areas of the floor slabs should be proof-rolled prior to placement of controlled fill. Areas not passing the proof rolled should be treated as noted in Section 8.4;
- Prior to placement of **controlled** fill, if any, natural soils or approved existing fill should be scarified, moisture content adjusted and re-compacted in accordance with Section 8 of this report; and
- Prior to slab placement, soil moisture should be adjusted and maintained within the parameters specified in Section 8 of this report.

Placement of 4 or more inches of compacted free-draining granular base course below slabs that are not below grade is recommended to limit moisture rise through slabs and to improve slab support, particularly at joints. An impervious moisture barrier consisting of 6-mil plastic sheeting or equivalent should be provided in accordance with the 2012 IBC. Use of a 10-mil vapor barrier is recommended below all slab areas with an intended use sensitive to slab moisture.

12.0 PAVEMENT

Pavement subgrades should be prepared in accordance with Section 8 of this report. **It is considered essential that moisture content be adjusted and maintained above optimum for all exposed CL-CH and CH clays to limit the potential for shrink/swell. Additionally, it is recommended that a minimum of 1-foot of LVC material be established beneath pavements.** It is anticipated that any new pavements associated with this project will be constructed of either an asphaltic concrete wearing surface placed over a base or a rigid Portland Cement Concrete pavement over a granular base.

12.1 Flexible Pavement

If asphaltic paving is selected, the aggregate base may be a granular compacted crushed limestone with a gradation and quality conforming to the requirements of the Oklahoma Department of Transportation (ODOT), Standard Specification 703.01 for Type A aggregate. The maximum lift thickness for the granular base is 4 in. Granular base thicknesses in excess of 4 in. should be placed in multiple lifts with each lift being of approximately equal thickness. The granular base should be compacted to at least 100% of Standard Proctor Compaction (ASTM D-698).

Asphaltic concrete, both base and surface, should conform to the applicable requirements of ODOT Standard Specification 708. Asphaltic concrete should be compacted to 92 to 96% of Maximum Theoretical Gravity (ASTM D-2041). Substitution of an appropriate Superpave Mix Design, SP 190C or SP 250C, can be used in place of the bituminous base. SP 190C or SP 125C may be used for the surface. All bituminous mix designs should have been prepared or verified within 6 months of the date of placement on the project.

12.2 Rigid Pavement

If rigid concrete paving is selected, a minimum 4-in. thickness granular base compacted to 100% of Standard Proctor should be placed on the prepared subgrade. The Portland Cement Concrete (PCC) mix should have a minimum 28-day compressive strength of 4000 pounds per square inch (psi). Concrete should be placed at a low slump (1 to 3 inch) and have an entrained air content of 5 to 7%. If an increased slump is desired, use of Super Plasticizer is recommended.

12.3 Pavement Thickness

A pavement thickness would best be computed if traffic frequencies and wheel loadings were provided to us, but a typical pavement design for this type of development would generally generate a Structural Number of 3.0 to 3.5 within heavy duty areas and 2.4 to 2.6 within light duty areas, depending on the subgrade conditions. The following table presents corresponding typical flexible and rigid pavement thickness using the general Structural Numbers.

Pavement Type	Anticipated Traffic Frequency	Asphaltic Surface (in.)	Asphaltic Base (in.)	Concrete Thickness (in.)	Aggregate Base (in.)
Flexible Pavement	Heavy Duty	3.0	4.0	-	6.0
	Heavy Duty w/ Tensar TX5 Geogrid*	3.0	3.0	-	6.0
	Light Duty	2.0	2.0	-	6.0
	Light Duty w/ Tensar TX5 Geogrid*	3.0	-	-	6.0
Rigid Pavement	Heavy Duty	-	-	7.0	4.0
	Light Duty	-	-	5.0	4.0
*Geogrid to consist of Tensar TX5, installed below aggregate baserock section per manufacturer's recommendations.					

As mentioned above, a more accurate pavement thickness can be computed if anticipated traffic frequencies and wheel loadings are provided to PPI. The above thicknesses are considered approximate since actual pavement loading has not been provided.

13.0 CONSTRUCTION OBSERVATION & TESTING

The construction process is an integral design component with respect to the geotechnical aspects of a project. Since geotechnical engineering is influenced by variable depositional and weathering processes and because we sample only a small portion of the soils affecting the performance of the Tag Office, unanticipated or changed conditions can be disclosed during grading. Proper geotechnical observation and testing during construction is imperative to allow the Geotechnical Engineer the opportunity to evaluate assumptions made during the design process. Therefore, we recommend that PPI be kept apprised of design modifications and construction schedule of the proposed project to observe compliance with the design concepts and geotechnical recommendations, and to allow design changes in the event that subsurface conditions or methods of construction differ from those assumed while completing this study. We recommend that during construction all earthwork be monitored by a representative of PPI, including site preparation, placement of all engineered fill and trench backfill, and all foundation excavations as outlined below.

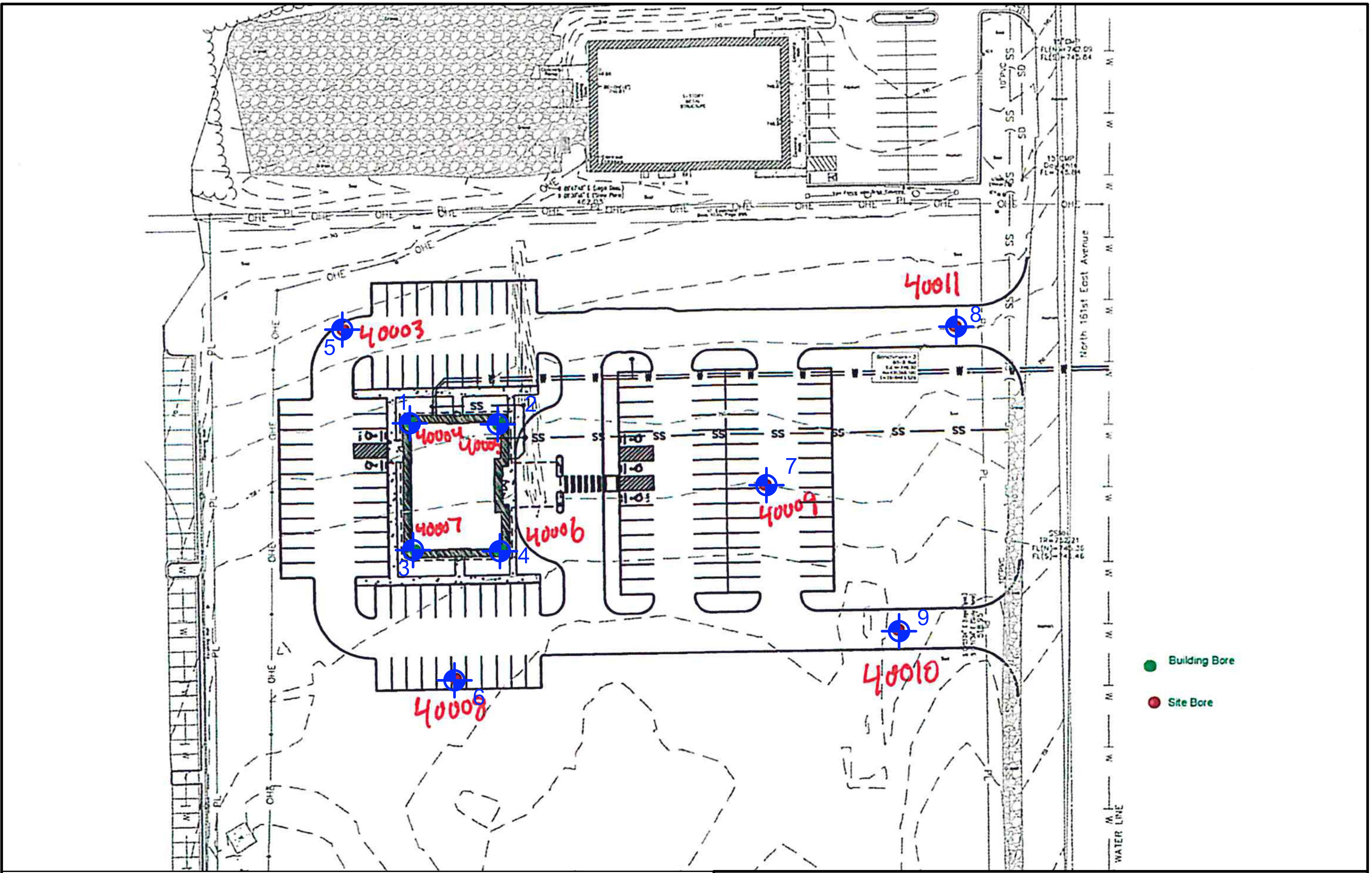
- An experienced Geotechnical Engineer or Engineering Technician of PPI should observe the subgrade throughout the proposed project site immediately following stripping to evaluate the native clay, identify areas requiring undercutting, and evaluate the suitability of the exposed surface for fill placement;
- An experienced Engineering Technician of PPI should monitor and test all fill placed within the building and pavement areas to determine whether the type of material, moisture content, and degree of compaction are within recommended limits;
- An experienced Technician or Engineer of PPI should observe and test all footing excavations. Where unsuitable bearing conditions are observed, remedial procedures can be established in the field to avoid construction delays; and
- The condition of the subgrade should be evaluated immediately prior to construction of the building floor slabs to determine whether the moisture content and relative density of the subgrade soils are as recommended.

14.0 REPORT LIMITATIONS

This report has been prepared in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area. Palmerton & Parrish, Inc. observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. Palmerton & Parrish's findings and conclusions must be considered not as scientific certainties, but as opinions based on our professional judgment concerning the significance of the data gathered during the course of this investigation. Other than this, no warranty is implied or intended.

APPENDIX I - FIGURES

S:_MASTER PROJECT FILE\2020\OK\C\Childers Architect-264572-Cherokee Nation Tag Office-Sub\Figures\264572-CAD.dwg



SCALE: 1" = 80'

LEGEND

⌖ Boring Location

NOTES

- Site Plan provided by the Client.
- Not intended for use in design.

Project: Cherokee Nation Tag Office - Catoosa, Oklahoma
Client: Childers Architecture

Boring Location Plan With Site Plan

DATE: March 25, 2020

Project Number: 264572

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 2

S:_MASTER PROJECT FILE\2020\OK\C\Childers Architect-264572-Cherokee Nation Tag Office-Sub\Figures\264572-CAD.dwg

SCALE: 1" = 80'

LEGEND

⊕ Boring Location

NOTES

- Aerial image from Google Earth Pro.
- Not intended for use in design.

Project: Cherokee Nation Tag Office - Catoosa, Oklahoma
Client: Childers Architecture

Boring Location Plan With Aerial Image

DATE: March 25, 2020

Project Number: 264572

PALMERTON & PARRISH, INC.
GEOTECHNICAL AND MATERIALS ENGINEERS/MATERIALS TESTING LABORATORIES/ENVIRONMENTAL SERVICES

FIGURE 1

APPENDIX II - BORING LOGS & KEY TO SYMBOLS

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GEOTECHNICAL BORING LOG

BORING NUMBER 1

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME New Cherokee Nation Tag Office

PROJECT NO. 264572

PROJECT LOCATION Catoosa, Oklahoma

DATE STARTED 3/12/20 **COMPLETED** 3/12/20

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER JS **DRILL RIG** 2008 CME 55

GROUND WATER LEVELS

HAMMER TYPE Auto

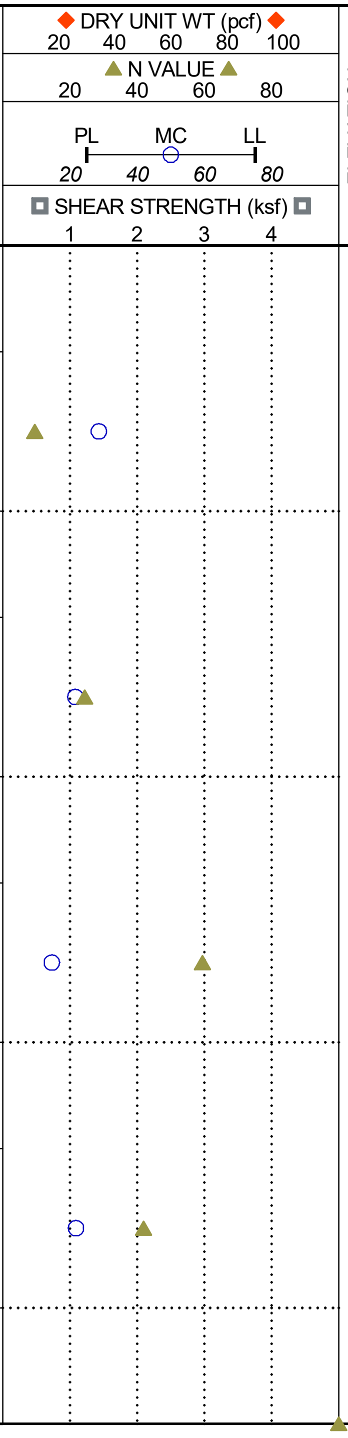
AT TIME OF DRILLING None

LOGGED BY WA **CHECKED BY** RTH

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.		Asphalt (5") 0.4 ft					
			Aggregate Baserock (8") 1.1 ft					
			FAT CLAY, Dark Gray, Moist, Stiff to Very Stiff (CH)	SPT 1		4-4-5 (9)	2.25	
2.5				SPT 2		5-9-15 (24)	3.25	
5.0			6.0 ft					
			SHALEY FAT CLAY, With Gravel and Sand, Gray and Brown, Moist, Hard (CH)	SPT 3		11-39-20 (59)	2.75	
7.5				SPT 4		8-23-19 (42)	4.5	
10.0			11.1 ft					
			Refusal at 11.1 feet. Bottom of borehole at 11.1 feet.	SPT 5		68/0"		



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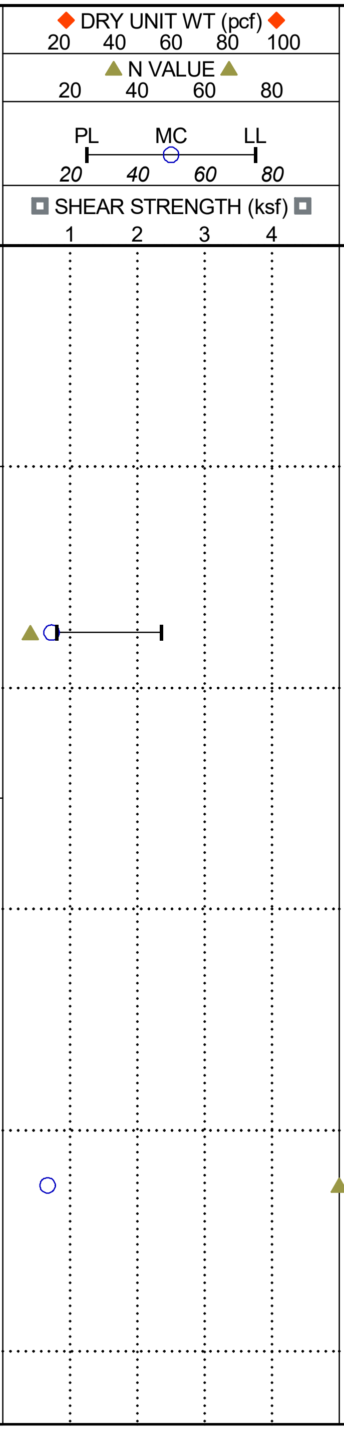
GEOTECHNICAL BORING LOG

BORING NUMBER 2

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME New Cherokee Nation Tag Office
PROJECT NO. 264572
PROJECT LOCATION Catoosa, Oklahoma
DATE STARTED 3/12/20
COMPLETED 3/12/20
SURFACE ELEVATION
BENCHMARK EL.
DRILLER JS
DRILL RIG 2008 CME 55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING 1.25 ft
LOGGED BY WA
CHECKED BY RTH
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		Asphalt (5") 0.4 ft					
			Aggregate Baserock (8") 1.1 ft					
1		∇	LEAN TO FAT CLAY, Dark Grayish Black, Moist, Medium Stiff (CL-CH) 2.0 ft	SPT 1		8-5-3 (8)	0.5	
2			CLAYEY GRAVEL, With Sand, Gray, Wet, Loose (GC)					
3								
4			- Very Dense Below 4' 4.8 ft	SPT 2		5-57-54 (111)		
5			LIMESTONE and SANDSTONE, Gray and Brown 5.3 ft					



Refusal at 5.3 feet.
Bottom of borehole at 5.3 feet.

BORING LOG - PPI - PPI STD TEMPLATE.GDT - 3/26/20 12:44 - S:_MASTER PROJECT FILE\2020\OK\C\CHILDERS ARCHITECT-264572-CHEROKEE NATION TAG OFFICE-SUB\BORING LOGS\264572-GINT.GPJ

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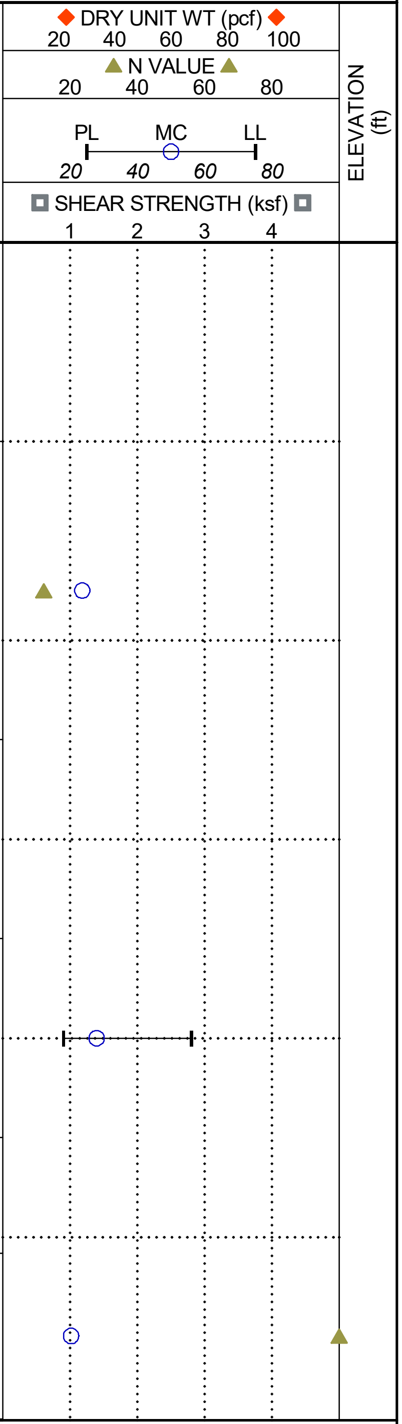
GEOTECHNICAL BORING LOG

BORING NUMBER 3

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME New Cherokee Nation Tag Office
PROJECT NO. 264572
PROJECT LOCATION Catoosa, Oklahoma
DATE STARTED 3/12/20 **COMPLETED** 3/12/20
SURFACE ELEVATION **BENCHMARK EL.**
DRILLER JS **DRILL RIG** 2008 CME 55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY WA **CHECKED BY** RTH
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System		SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)
0	CFA - 4.5" O.D.	Asphalt (5")	0.4 ft				
1		Aggregate Baserock (8")	1.1 ft				
2 3 4 5		FAT CLAY, Dark Grayish Black, Moist, Stiff (CH)	5.1 ft	SPT 1 ST 2	 83	4-5-7 (12) 	4 2.75
		LIMESTONE, Gray	5.9 ft	SPT 3		26-68/4"	4.5



Refusal at 5.9 feet.
Bottom of borehole at 5.9 feet.

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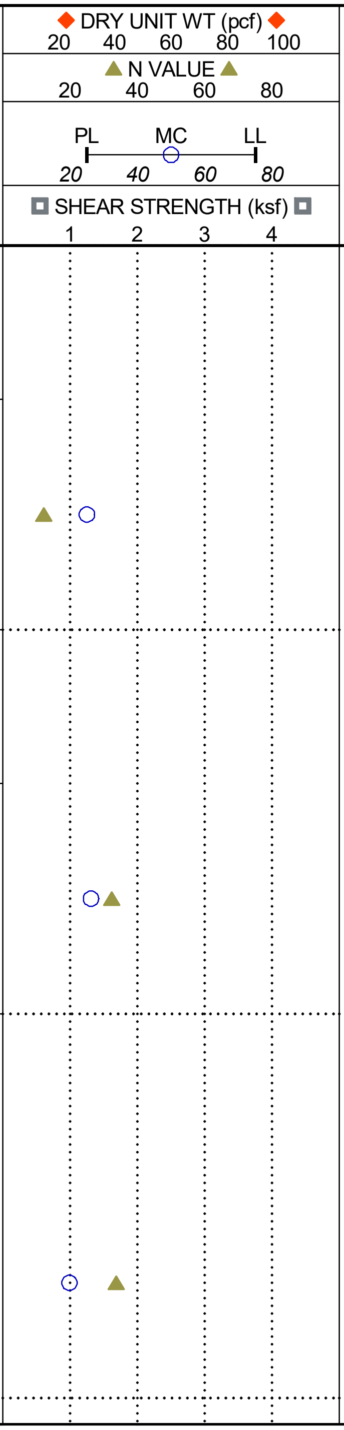
GEOTECHNICAL BORING LOG

BORING NUMBER 4

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME New Cherokee Nation Tag Office
PROJECT NO. 264572
PROJECT LOCATION Catoosa, Oklahoma
DATE STARTED 3/12/20
COMPLETED 3/12/20
SURFACE ELEVATION
BENCHMARK EL.
DRILLER JS
DRILL RIG 2008 CME 55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY WA
CHECKED BY RTH
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0.0	CFA - 4.5" O.D.	Asphalt (5") 0.4 ft					
		Aggregate Baserock (8") 1.1 ft					
		FAT CLAY, Dark Grayish Black, Moist, Stiff to Hard (CH)	SPT 1		3-5-7 (12)	2.5	
2.5		4.0 ft					
		CLAYEY GRAVEL, With Sand, Gray & Dark Gray, Moist, Dense (GC)	SPT 2		7-18-15 (33)	2.5	
5.0							
			SPT 3		7-9-24 (33)		
7.5		7.7 ft					



Refusal at 7.7 feet.
Bottom of borehole at 7.7 feet.

PPI
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GEOTECHNICAL BORING LOG

BORING NUMBER 5

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME New Cherokee Nation Tag Office

PROJECT NO. 264572

PROJECT LOCATION Catoosa, Oklahoma

DATE STARTED 3/12/20 **COMPLETED** 3/12/20

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER JS **DRILL RIG** 2008 CME 55

GROUND WATER LEVELS

HAMMER TYPE Auto

AT TIME OF DRILLING None

LOGGED BY WA **CHECKED BY** RTH

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	◆ DRY UNIT WT (pcf) ◆ 20 40 60 80 100 ▲ N VALUE ▲ 20 40 60 80 PL MC LL 20 40 60 80 ▣ SHEAR STRENGTH (ksf) ▣ 1 2 3 4	ELEVATION (ft)
0	CFA - 4.5" O.D.		Asphalt (5") 0.4 ft						
			Aggregate Baserock (8") 1.1 ft						
1			FAT CLAY, Dark Gray to Gray, Moist, Stiff to Very Stiff (CH)	SPT 1		3-7-5 (12)	3.75		
4			- Gravel Layer Noted From 4' to 4.5' 5.0 ft	SPT 2		4-14-7 (21)	2.25		
5			Bottom of borehole at 5.0 feet.						

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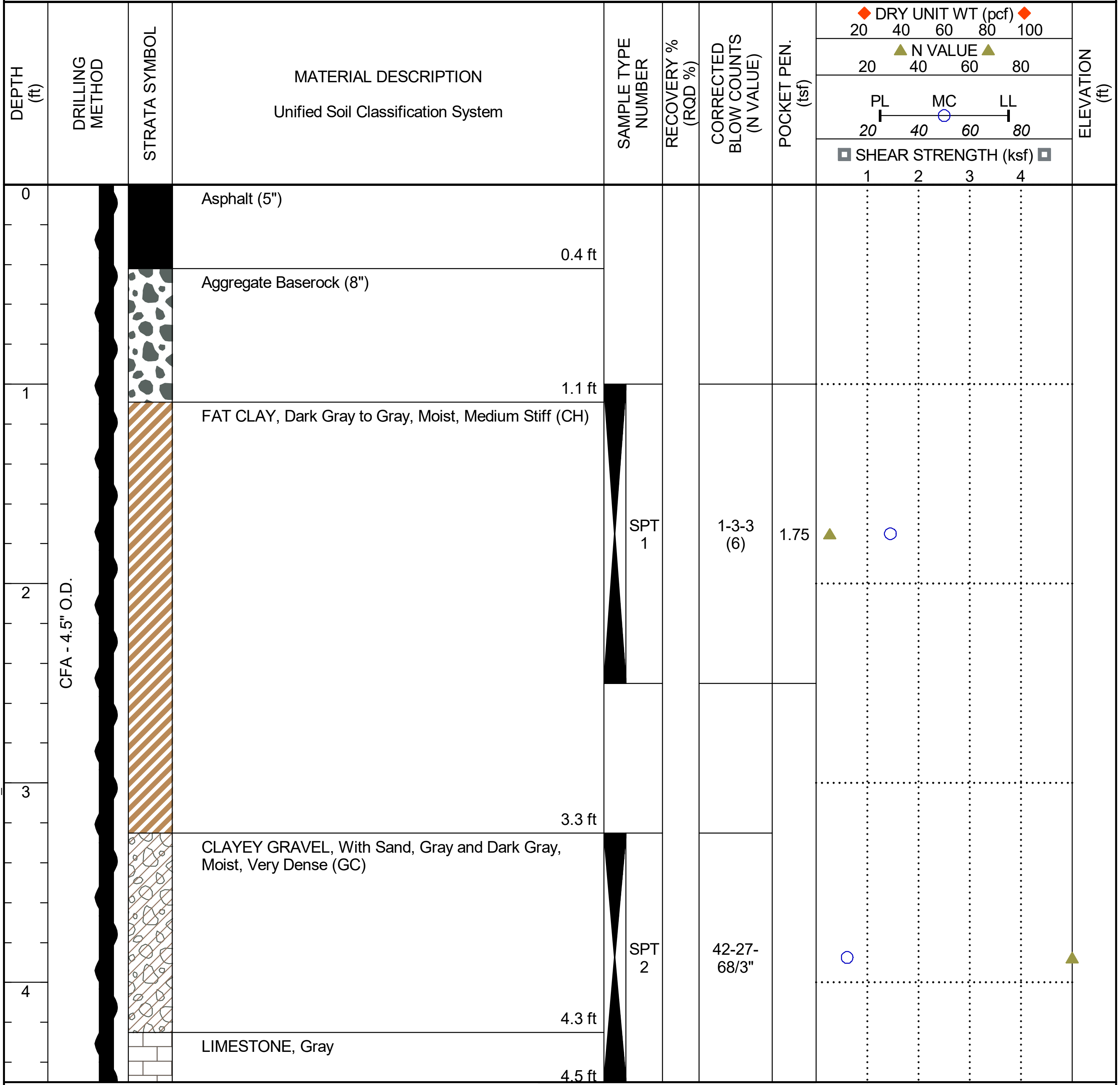
GEOTECHNICAL BORING LOG

BORING NUMBER 6

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME New Cherokee Nation Tag Office
PROJECT NO. 264572
PROJECT LOCATION Catoosa, Oklahoma
DATE STARTED 3/12/20
COMPLETED 3/12/20
SURFACE ELEVATION
BENCHMARK EL.
DRILLER JS
DRILL RIG 2008 CME 55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY WA
CHECKED BY RTH
AT END OF DRILLING
NOTES



DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		Asphalt (5") 0.4 ft					
			Aggregate Baserock (8") 1.1 ft					
1			FAT CLAY, Dark Gray to Gray, Moist, Medium Stiff (CH)	SPT 1		1-3-3 (6)	1.75	
2								
3			3.3 ft					
			CLAYEY GRAVEL, With Sand, Gray and Dark Gray, Moist, Very Dense (GC)	SPT 2		42-27-68/3"		
4			4.3 ft					
			LIMESTONE, Gray 4.5 ft					

Refusal at 4.5 feet.
Bottom of borehole at 4.5 feet.

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GEOTECHNICAL BORING LOG

BORING NUMBER 7

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME New Cherokee Nation Tag Office

PROJECT NO. 264572

PROJECT LOCATION Catoosa, Oklahoma

DATE STARTED 3/12/20 **COMPLETED** 3/12/20

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER JS **DRILL RIG** 2008 CME 55

GROUND WATER LEVELS

HAMMER TYPE Auto

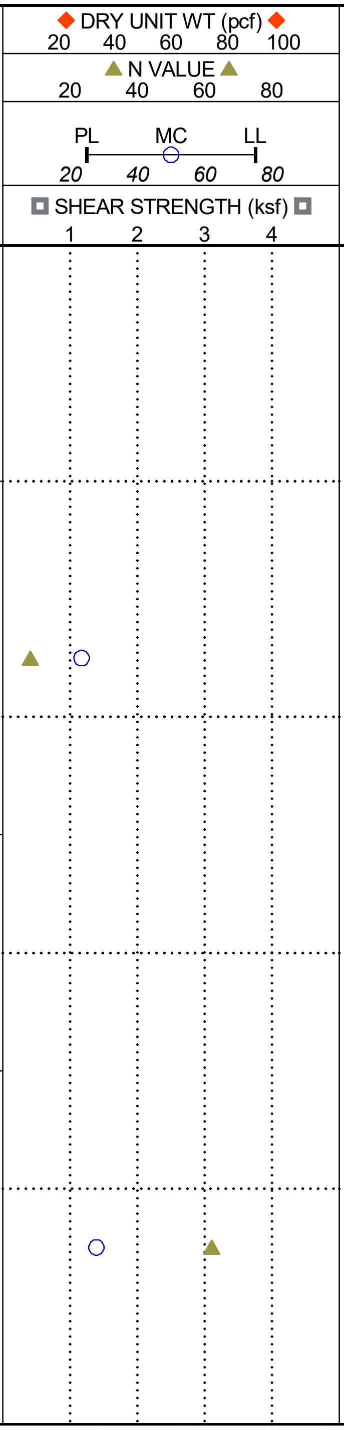
AT TIME OF DRILLING None

LOGGED BY WA **CHECKED BY** RTH

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		Asphalt (5") 0.4 ft					
			Aggregate Baserock (8") 1.1 ft					
1 2 3			POSSIBLE FILL: GRAVELLY LEAN TO FAT CLAY, Dark Gray, Moist, Medium Stiff (CL-CH) 3.3 ft	SPT 1		5-4-4 (8)	2.5	
4			FAT CLAY, Gray, Moist, Very Stiff to Very Hard (CH) 4.3 ft	SPT 2		8-5-57 (62)	2	
			CLAYEY GRAVEL, Gray & Dark Gray, Moist, Very Dense (GC) 5.0 ft					
5			Bottom of borehole at 5.0 feet.					



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GEOTECHNICAL BORING LOG

BORING NUMBER 8

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME New Cherokee Nation Tag Office

PROJECT NO. 264572

PROJECT LOCATION Catoosa, Oklahoma

DATE STARTED 3/12/20 **COMPLETED** 3/12/20

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER JS **DRILL RIG** 2008 CME 55

GROUND WATER LEVELS

HAMMER TYPE Auto

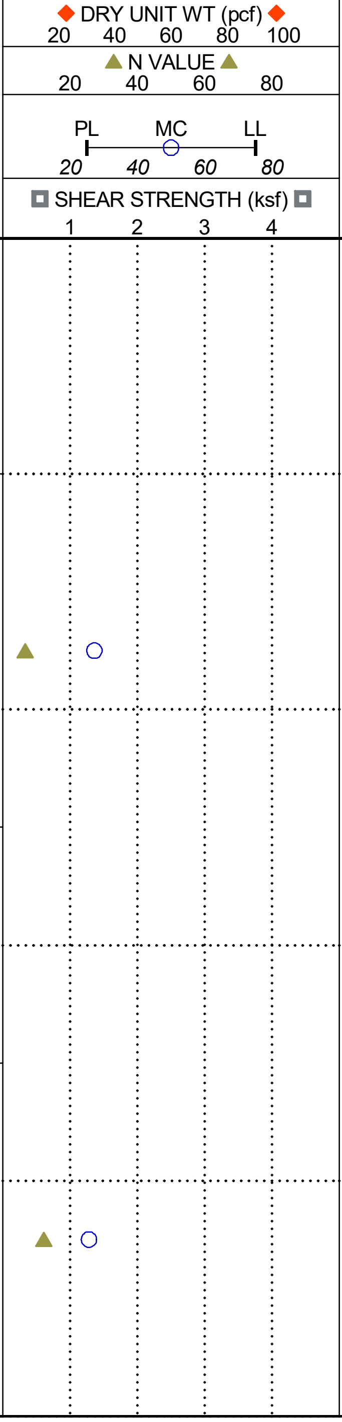
AT TIME OF DRILLING None

LOGGED BY WA **CHECKED BY** RTH

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.	■	Concrete (6") 0.4 ft					
		▨	POSSIBLE FILL: LEAN TO FAT CLAY, With Sand, Black, Moist, Medium Stiff (CL-CH) 3.0 ft	SPT 1		4-3-4 (7)	2.25	
3		▨	FAT CLAY, Trace Sand, Grayish Brown, Moist, Stiff (CH) 5.0 ft	SPT 2		4-5-7 (12)	3	
5			Bottom of borehole at 5.0 feet.					



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GEOTECHNICAL BORING LOG

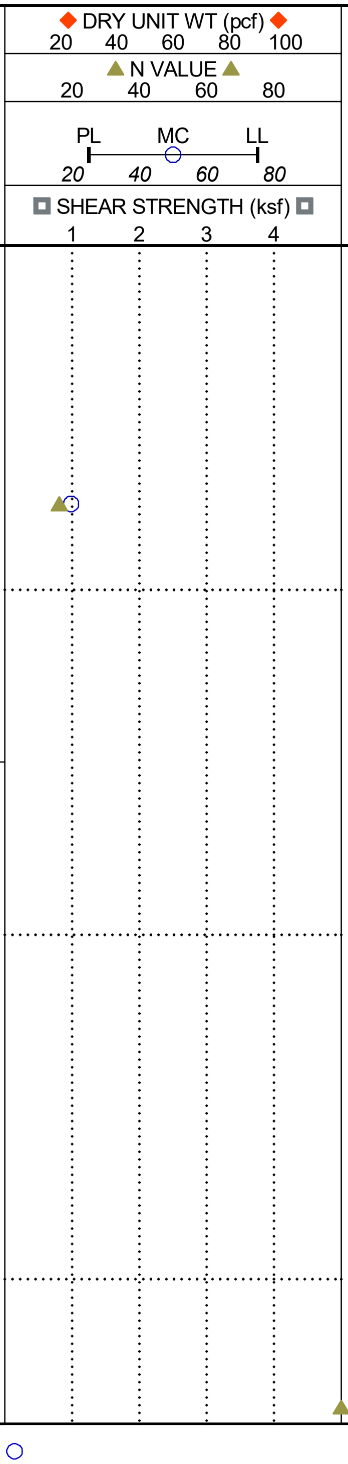
BORING NUMBER 9

PAGE 1 OF 1

CLIENT Childers Architect
PROJECT NAME New Cherokee Nation Tag Office
PROJECT NO. 264572
PROJECT LOCATION Catoosa, Oklahoma
DATE STARTED 3/12/20
COMPLETED 3/12/20
SURFACE ELEVATION
BENCHMARK EL.
DRILLER JS
DRILL RIG 2008 CME 55
GROUND WATER LEVELS
HAMMER TYPE Auto
AT TIME OF DRILLING None
LOGGED BY WA
CHECKED BY RTH
AT END OF DRILLING
NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	ELEVATION (ft)
0	CFA - 4.5" O.D.		TOPSOIL (3") 0.3 ft					
1 2 3			POSSIBLE FILL: LEAN TO FAT CLAY, With Gravel, Black, Moist, Very Stiff to Hard (CL-CH) 3.3 ft	SPT 1		4-4-12 (16)	2	
			LIMESTONE, Gray 3.4 ft	SPT 2		68/1"		

Refusal at 3.4 feet.
Bottom of borehole at 3.4 feet.



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GEOTECHNICAL BORING LOG

BORING NUMBER 3A

PAGE 1 OF 1

CLIENT Childers Architect

PROJECT NAME New Cherokee Nation Tag Office

PROJECT NO. 264572

PROJECT LOCATION Catoosa, Oklahoma

DATE STARTED 3/12/20 **COMPLETED** 3/12/20

SURFACE ELEVATION **BENCHMARK EL.**

DRILLER JS **DRILL RIG** 2008 CME 55

GROUND WATER LEVELS

HAMMER TYPE Auto

AT TIME OF DRILLING None

LOGGED BY WA **CHECKED BY** RTH

AT END OF DRILLING

NOTES

DEPTH (ft)	DRILLING METHOD	STRATA SYMBOL	MATERIAL DESCRIPTION Unified Soil Classification System	SAMPLE TYPE NUMBER	RECOVERY % (RQD %)	CORRECTED BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	◆ DRY UNIT WT (pcf) ◆ 20 40 60 80 100 ▲ N VALUE ▲ 20 40 60 80 PL MC LL 20 40 60 80 ▣ SHEAR STRENGTH (ksf) ▣ 1 2 3 4	ELEVATION (ft)
0	CFA - 4.5" O.D.		Asphalt (5") 0.4 ft						
			Aggregate Baserock (8") 1.1 ft						
1 2 3			FAT CLAY, Dark Grayish Black, Moist, 3.5 ft						
4			CLAYEY SAND, With Gravel, Gray, Moist, *Possible Sandstone* 4.3 ft						
			LIMESTONE 4.5 ft						

Refusal at 4.5 feet.
Bottom of borehole at 4.5 feet.

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KEY TO SYMBOLS

CLIENT Childers Architect
PROJECT NAME New Cherokee Nation Tag Office
PROJECT NO. 264572
PROJECT LOCATION Catoosa, Oklahoma

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

■ ASPHALT: Asphalt
▨ CH: USCS High Plasticity Clay
▧ CL-CH: USCS Low to High Plasticity Clay
▩ GC: USCS Clayey Gravel
▩ GW: USCS Well-graded Gravel
▦ LIMESTONE: Limestone
▨ SC: USCS Clayey Sand
▒ TOPSOIL: Topsoil
▦ WEATHERED LIMESTONE: Weathered Limestone

SAMPLER SYMBOLS

⧗ Standard Penetration Test
■ Shelby Tube

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
W - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)

TV - TORVANE
PID - PHOTOIONIZATION DETECTOR
UC - UNCONFINED COMPRESSION
ppm - PARTS PER MILLION
▽ Water Level at Time Drilling, or as Shown
▼ Water Level at End of Drilling, or as Shown
▼ Water Level After 24 Hours, or as Shown

KEY TO SYMBOLS - PPI STD TEMPLATE.GDT - 3/26/20 12:44 - S:_MASTER PROJECT FILE\2020\OK\C\CHILDERS ARCHITECT-264572-CHEROKEE NATION TAG OFFICE-SUB\BORING LOGS\264572-GINT.GPJ

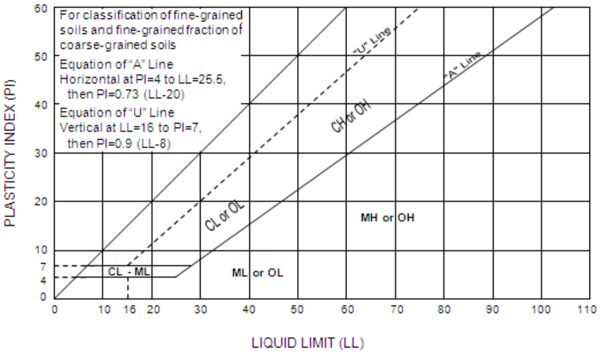
APPENDIX III - GENERAL NOTES

GENERAL NOTES

SOIL PROPERTIES & DESCRIPTIONS

COHESIVE SOILS

Consistency	Unconfined Compressive Strength (Qu)	Pocket Penetrometer Strength	N-Value
	(psf)	(tsf)	(blows/ft)
Very Soft	<500	<0.25	0-1
Soft	500-1000	0.25-0.50	2-4
Medium Stiff	1001-2000	0.50-1.00	5-8
Stiff	2001-4000	1.00-2.00	9-15
Very Stiff	4001-8000	2.00-4.00	16-30
Hard	>8000	>4.00	31-60
Very Hard			>60



Group Symbol	Group Name
CL –	Lean Clay
ML –	Silt
OL –	Organic Clay or Silt
CH –	Fat Clay
MH –	Elastic Silt
OH –	Organic Clay or Silt
PT –	Peat
CL-CH –	Lean to Fat Clay

Plasticity		Moisture	
Description	Liquid Limit (LL)	Descriptive Term	Guide
Lean	<45%	Dry	No indication of water
Lean to Fat	45-49%	Moist	Indication of water
Fat	≥50%	Wet	Visible water

Fine Grained Soil Sub Classification	Percent (by weight) of Total Sample
Terms: SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT	PRIMARY CONSTITUENT
Sandy, gravelly, abundant cobbles, abundant boulders	>30-50]
with sand, with gravel, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered sand, scattered gravel, scattered cobbles, scattered boulders	5-15]
a trace sand, a trace gravel, a few cobbles, a few boulders	<5]
The relationship of clay and silt constituents is based on plasticity and normally determined by performing index tests. Refined classifications are based on Atterberg Limits tests and the Plasticity Chart.	

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	N-VALUE
Very Loose	0-4
Loose	5-10
Medium Dense	11-24
Dense	25-50
Very Dense	≥51

MOISTURE CONDITION	
Descriptive Term	Guide
Dry	No indication of water
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table.

**GRAIN SIZE IDENTIFICATION		
Name	Size Limits	Familiar Example
Boulder	12 in. or more	Larger than basketball
Cobbles	3 in. to 12 in.	Grapefruit
Coarse Gravel	¾-in. to 3 in.	Orange or lemon
Fine Gravel	No. 4 sieve to ¾-in.	Grape or pea
Coarse Sand	No. 10 sieve to No. 4 sieve	Rock salt
Medium Sand	No. 40 sieve to No. 10 sieve	Sugar, table salt
Fine Sand*	No. 200 sieve to No. 40 sieve	Powdered sugar
Fines	Less than No. 200 sieve	
*Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8 inches.		

Coarse Grained Soil Sub Classification	Percent (by weight) of Total Sample
Terms: GRAVEL, SAND, COBBLES, BOULDERS	PRIMARY CONSTITUENT
Sandy, gravelly, abundant cobbles, abundant boulders	>30-50]
with gravel, with sand, with cobbles, with boulders	>15-30] – secondary coarse grained constituents
scattered gravel, scattered sand, scattered cobbles, scattered boulders	5-15]
a trace gravel, a trace sand, a few cobbles, a few boulders	<5]
Silty (MH & ML)*, clayey (CL & CH)*	<15]
(with silt, with clay)*	5-15] – secondary fine grained constituents
(trace silt, trace clay)*	<5]
*Index tests and/or plasticity tests are performed to determine whether the term "silt" or "clay" is used.	

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*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

GENERAL NOTES

BEDROCK PROPERTIES & DESCRIPTIONS

ROCK QUALITY DESIGNATION (RQD)

Description of Rock Quality	*RQD (%)
Very Poor	< 25
Poor	25-50
Fair	50-75
Good	75-90
Excellent	90-100

*RQD is defined as the total length of sound core pieces 4 in. or greater in length, expressed as a percentage of the total length cored. RQD provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

SCALE OF RELATIVE ROCK HARDNESS

Term	Field Identification	Approx. Unconfined Compressive Strength (tsf)
Extremely Soft	Can be indented by thumbnail	2.6-10
Very Soft	Can be peeled by pocket knife	10-50
Soft	Can be peeled with difficulty by pocket knife	50-260
Medium Hard	Can be grooved 2 mm deep by firm pressure of knife	260-520
Moderately Hard	Requires one hammer blow to fracture	520-1040
Hard	Can be scratched with knife or pick only with difficulty	1040-2610
Very Hard	Cannot be scratched by knife or sharp pick	>2610

DEGREE OF WEATHERING

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

GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS)

Description	Diameter (mm)	Field Identification
Very Coarse Grained	>4.76	Individual grains can easily be distinguished by eye.
Coarse Grained	2.0-4.76	
Medium Grained	0.42-2.0	Individual grains can be distinguished by eye.
Fine Grained	0.074-0.42	Individual grains can be distinguished by eye with difficulty.
Very Fine Grained	<0.074	Individual grains cannot be distinguished by unaided eye.

VOIDS

Pit	Voids barely seen with the naked eye to 6mm *1/4-inch)
Vug	Voids 6 to 50mm (1/4 to 2 inches) in diameter
Cavity	50 to 6000mm (2 to 24 inches) in diameter
Cave	> 600mm

BEDDING THCKNESS

Very Thick Bedded	> 3' Thick
Thick Bedded	1' to 3' Thick
Medium Bedded	4" to 1' Thick
Thin Bedded	1-1/4" to 4" Thick
Very Thin Bedded	½" to 1-1/4" Thick
Thickly Laminated	1/8" to ½" Thick
Thinly Laminated	1/8" or less (paper thin)

DRILLING NOTES

Drilling & Sampling Symbols

NQ – Rock Core (2-inch diameter)	CFA- Continuous Flight (Solid Stem) Auger	WB – Wash Bore or Mud Rotary
HQ – Rock Core (3-inch diameter)	SS – Split Spoon Sampler	TP – Test Pit
HSA – Hollow Stem Auger	ST – Shelby Tube	HA – Hand Auger

Soil Sample Types

Shelby Tube Samples: Relatively undisturbed soil samples were obtained from the borings using thin wall (Shelby) tube samplers pushed hydraulically into the soil in advance of drilling. This sampling, which is considered to be undisturbed, was performed in accordance with the requirements of ASTM D 1587. This type of sample is considered best for the testing of "in-situ" soil properties such as natural density and strength characteristics. The use of this sampling method is basically restricted to soil containing little to no chert fragments and to softer shale deposits.

Split Spoon Samples: The Standard Penetration Test is conducted in conjunction with the split-barrel sampling procedure. The "N" value corresponds to the number of blows required to drive the last 1 foot of an 18-inch long, 2-inch O.D. split-barrel sampler with a 140 lb. hammer falling a distance of 30 inches. The Standard Penetration Test is carried out according to ASTM D-1586.

Water Level Measurements

Water levels indicated on the boring logs are levels measured in the borings at the times indicated. In permeable materials, the indicated levels may reflect the location of groundwater. In low permeability soils, shallow groundwater may indicate a perched condition. Caution is merited when interpreting short-term water level readings from open bore holes. Accurate water levels are best determined from piezometers.

Automatic Hammer

Palmerton and Parrish, Inc.'s CME's are equipped with automatic hammers. The conventional method used to obtain disturbed soil samples used a safety hammer operated by company personnel with a cat head and rope. However, use of an automatic hammer allows a greater mechanical efficiency to be achieved in the field while performing a Standard Penetration resistance test based upon automatic hammer efficiencies calibrated using dynamic testing techniques.

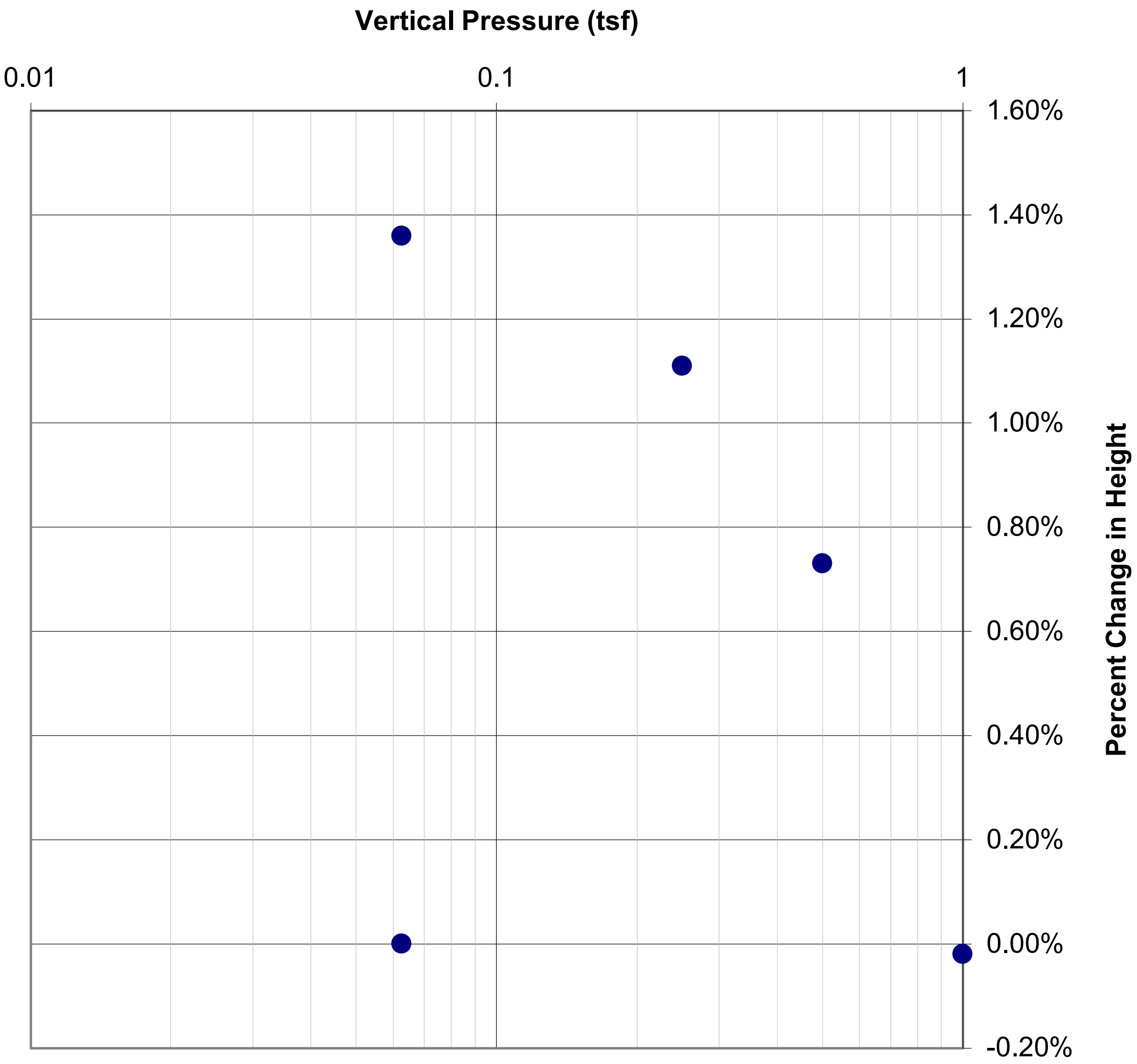
*Modified after Ref. ASTM D2487-93 & D2488-93
**Modified after Ref. Oregon DOT 1987 & FHWA 1997
***Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987

APPENDIX IV – SWELL TEST RESULTS

Palmerton & Parrish, Inc.
4168 W. Kearney St. - Springfield, MO 65803
Phone: (417) 864-6000 Fax: (417) 864-6004

Client:	**Childers Architect**	Dry Unit Wt lbs/cf	94.3	% Swell
Project:	**Cherokee Nation Tag Office**	Trimmings M%	27.9%	**1.36%**
Boring	**B-3**	Specimen M%	29.2%	
Depth	**3.5'-4.5'**	Liquid Limit	56	Swell Pressure (TSF)
Description:		Plastic Limit	18	**1.00 TSF**
		Plastic Index	36	

Swell Test Results



APPENDIX V - IMPORTANT INFORMATION REGARDING YOUR GEOTECHNICAL REPORT

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.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in 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.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives 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 this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- 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. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering 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 subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

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ASSOCIATION

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