

SUBSURFACE EXPLORATION

Powwow Grounds Masterplan for Comanche Nation
Oklahoma, OK 73527

PROJECT NO. 2530-0249

September 19, 2025

Comanche Nation
584 N W Bingo Road
Lawton, OK 73507

Attn: Mr. Louie McCarthy
Director

Re: Subsurface Exploration
Powwow Grounds Masterplan for Comanche Nation
16193 OK-115 Cache
Oklahoma, OK 73527

Dear Mr. McCarthy:

Standard Engineering & Field Services, LLC (Standard) is pleased to present the report covering the subsurface exploration for the subject project. This study was authorized by the "Notice to Proceed, issued via the e-mail containing the Purchase Order (PO #327541)", dated March 27, 2025.

Standard conducted a geotechnical investigation at the site of the new Powwow Grounds Masterplan for Comanche Nation project in Cache, OK. This report contains the detailed results of the geotechnical investigation, including foundation recommendations, pavement recommendations and construction considerations.

The subsurface soils consist of approximately 5 to 25 feet of clay with various amounts of sand, sand with various amounts of clay, and silt over very weathered shale, poorly cemented clayey sandstone, and clayey sandstone rock. and exhibit low to high plastic characteristics. The estimated potential vertical rise of the soil is 2.8 inches.

Foundation recommendations include: (1) Shallow Footings, (2) Drilled Pier Foundation

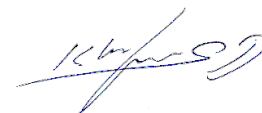
We trust that the results and recommendations contained herein will permit adequate economical design and construction of the proposed structure. Unless you specify otherwise, we will keep samples obtained from these borings in our Oklahoma City laboratory for the next thirty (30) days.

We appreciate the opportunity to assist on this project. Please call on us if we can be of further service.

Respectfully submitted,
STANDARD ENGINEERING & FIELD SERVICES, LLC



Venkata Reddy Kallam
Geotechnical Consultant



Roy Khalife, P.E.
Geotechnical Engineer

Project No. 2530-0249
Account No. 0230COM01

SUBSURFACE EXPLORATION

Powwow Grounds Masterplan for Comanche Nation
16193 OK-115 Cache
Oklahoma, OK 73527

PROJECT NO. 2530-0249

PREPARED FOR

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PREPARED BY

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Reviewed By:



Roy Khalife, P.E.
Geotechnical Engineer

I certify my e-signature for the study entitled "Subsurface Exploration."

Dated 9/19/2025

September 19, 2025

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Section 1

INTRODUCTION

1.1 Authorization

This report presents the results of a subsurface exploration performed by Standard Engineering & Field Services, LLC (Standard) in accordance with the proposal (P-2025-064) prepared for Mr. Louie McCarthy, dated March 19th, 2025, and identified as Standard's project number 2530-0249. This geotechnical study was authorized by the "Notice to Proceed, issued via an e-mail containing the Purchase Order (PO #327541)", dated March 27th, 2025.

1.2 Purpose and Scope

A geotechnical investigation was performed for the purpose of (1) determining the subsurface conditions, (2) evaluating the bearing capacity and plasticity characteristics of the soils, and (3) making recommendations concerning the earthwork, pavement recommendations, and foundation systems for the masterplan grounds.

Forty Three (43) exploratory borings (Hotel Building Borings (B-1 to B-5), Multipurpose Facility Building Borings (B-6 to B-10), Powwow Arbor Borings (S-1 to S-4), Carnival Area Borings (E-1 to E-4), and Pavement Borings (P-1 to P-25)) were drilled to a depth 5 to 25 feet. The boring depths and types of testing were performed according to the scope of work proposed by Standard and accepted by Mr. McCarthy. Narrative descriptions of our findings and recommendations are contained in the body of this report. A site and boring location plan, the boring logs, the soil profile, and a summary sheet of laboratory test results are included in the Appendices of this report.

1.3 Project Location and Description

It is understood that the Powwow Grounds Masterplan for Comanche Nation is proposed to be constructed at 16193 OK-115 Cache in Oklahoma, OK 73527. Maximum column loads for the proposed masterplan grounds are unknown while we are preparing this geotechnical report. The project involves the construction of a Powwow Arbor, Multi-Purpose Facility (estimated 30,625 SF), Hotel (estimated 41,424 SF), Carnival Area, Rodeo Area, Indian Church, Campground, Restrooms and Showers, RV Park, Parking and Roads, Utilities, Landscaping and other Miscellaneous Structures.

If the project is not as described or has changed, Standard must be notified in order to reevaluate the recommendations for the project.

Section 2

FIELD EXPLORATION

2.1 Drilling Information

The field exploration work was performed between the 13th of July, 2025 and 13th of August, 2025. Conditions at the site were investigated with Forty-Three (43) borings at the locations indicated on the site and boring location plan, included in Appendix "A." The boring surface elevations were measured with respect to a Temporary Benchmark (TBM) established at the Top nut of an existing fire hydrant (34.64322°, -98.63362°). The Temporary Benchmark (TBM) location is also shown in the site and boring location plan in Appendix "A." Boring surface elevations, rounded to the nearest foot, are reported on the individual boring logs, included in Appendix "A."

The benchmark has an elevation 100 feet. Boring depths were 5 to 25 feet within the masterplan grounds footprint. For accurate sampling, cuttings were observed continuously during drilling with specific samples being taken at distinct lithologic changes. The equipment used, field tests performed, and soil samples taken are discussed below.

2.2 Equipment Used

Forty-Three (43) borings were drilled with a truck-mounted CME-55, CME 75, and track-mounted D-50 rotary drilling unit equipped with 4" solid flight augers (SFA). Standard penetration tests (SPT) used a 1.375" ID split spoon sampler driven by an automatic hammer utilizing a 140 lb. weight falling 30 inches.

2.3 Testing and Sampling Performed

Standard penetration tests were performed in order to estimate the shear strengths of the soils in their natural state. The test was conducted as specified by ASTM D1586, "Penetration Test and Split-Barrel Sampling of Soils." The in-situ bearing strength is related to the N-value from this test. "N" is the number of blows required to drive a split-spoon sampler twelve inches, after a 6-inch seating, into undisturbed soil. The soil samples recovered in the split-spoon barrel were removed from the sample tool in the field, visually classified, and labeled according to boring number and depth. Results of the standard penetration tests are denoted at their respective depths on the boring logs.

Thin-walled tube samples were collected as specified by ASTM D1587, "Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes."

Depths of individual split spoon (standard penetration tests), thin-walled tube, and grab samples are indicated on the boring logs included in Appendix "B." All samples were labeled

and sealed in water tight, protective containers and returned to the laboratory for further evaluation and testing.

2.4 Subsurface Conditions

The soils encountered consist of clay with various amounts of sand, sand with various amounts of clay, and silt over very weathered shale, poorly cemented clayey sandstone, and clayey sandstone rock.. The cohesive soils were found to be stiff to hard in consistency and the cohesionless soils were found to have loose to very dense relative density. Rock materials (i.e., defined by standard penetration test refusal) were encountered in the indicated borings at the relative elevation shown in the following table:

Table 1: Relative Elevation of Rock Material

Boring No.	Surface Elevation (feet)	Rock Depth (feet)	Rock Elevation (feet)	Rock Material
B-1	96.0	15.5	80.5	Clayey sandstone
B-2	94.0	16.0	78.0	Clayey sandstone
B-3	95.0	15.0	80.0	Clayey sandstone
B-4	97.0	15.0	82.0	Clayey sandstone
B-5	98.0	15.0	83.0	Clayey sandstone
B-6	100.0	15.0	85.0	Clayey sandstone
B-7	99.0	13.0	86.0	Clayey sandstone
B-8	100.0	15.0	85.0	Clayey sandstone
B-9	100.0	15.0	85.0	Clayey sandstone
B-10	100.0	10.0	90.0	Clayey sandstone
E-1	111.0	2.0	109.0	Clayey Sandstone
E-2	102.0	4.0	98.0	Clayey Sandstone
E-3	103.0	7.5	95.5	Clayey Sandstone
E-4	106.0	10.5	95.5	Clayey Sandstone
P-23	111.0	5.5	105.5	Clayey Sandstone
S-1	97.0	21.0	76.0	Clayey Sandstone
S-2	97.0	20.0	77.0	Clayey Sandstone
S-3	97.0	16.0	81.0	Clayey Sandstone
S-4	98.0	20.5	77.5	Clayey Sandstone

*Below current grade

2.5 Groundwater

During drilling and at completion of drilling operations, groundwater was encountered in the indicated borings at a depth shown in the relative elevation of groundwater table. Presence of

water should be anticipated in any excavation. Water travelling through soil (subsurface water) is often unpredictable and may be present at shallow depths. Due to the seasonal changes in groundwater and the unpredictable nature of groundwater paths, groundwater levels will fluctuate. Therefore, it is necessary during construction to be observant for groundwater seepage in excavations in order to assess the situation and make necessary changes. We cannot assume responsibility for difficulties experienced during construction or for future operational problems due to elevation or volume of water encountered.

Table 2: Relative Elevation of Groundwater

Boring No.	Surface Elevation (feet)	Depth While Drilling (feet)	Depth After Drilling (feet)	Depth At 24 Hour (feet)	Elevation (feet)
B-1	96.0	21.0	-	-	75.0
		-	23.0	-	73.0
		-	-	*NA	*NA
B-5	98.0	Dry	-	-	Dry
		-	24.6	-	73.4
		-	-	15.0	83.0
B-6	100.0	Dry	-	-	Dry
		-	Dry	-	Dry
		-	-	15.5	84.5
B-8	100.0	21.0	-	-	79.0
		-	24.0	-	76.0
		-	-	11.0	89.0
B-9	100.0	Dry	-	-	Dry
		-	Dry	-	Dry
		-	-	23.5	76.5
B-10	100.0	21.0	-	-	79.0
		-	24.0	-	76.0
		-	-	12.0	88.0
S-1	97.0	13.0	-	-	84.0
		-	Dry	-	Dry
		-	-	*NA	*NA
S-2	97.0	14.0	-	-	83.0
		-	Dry	-	Dry
		-	-	*NA	*NA
S-3	97.0	14.0	-	-	83.0
		-	19.0	-	79.0

		-	-	*NA	*NA
S-4	98.0	13.0	-	-	85.0
		-	17.6	-	80.4
		-	-	*NA	*NA

*Below current grade

* Note: 24-hour readings were not performed (*NA)

Section 3

LABORATORY TESTING

Laboratory testing was performed in order to determine the plasticity characteristics of the subsurface materials as well as confirm the soil classifications.

3.1 Tests Performed

- Moisture content tests were performed on split spoon, thin-walled tube, and bag samples, in accordance with ASTM D2216, to determine the in-situ moisture conditions.
- Density tests were performed on intact split spoon, and thin-walled tube samples in accordance with ASTM D7263 Method A.
- Atterberg limits tests were performed on split spoon, thin-walled tube, and bag samples to determine the plasticity characteristics and swell potential of the soil. The tests were performed in accordance with ASTM D4318.
- Sieve analyses were performed on split spoon, thin-walled tube, and bag samples, in accordance with ASTM D2487, for aid in soil classification. These soils were classified according to the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Officials (AASHTO) soil classification system.
- Soluble sulfate content tests were performed on composite soil samples in accordance with OHDL-49. The test results are summarized under Laboratory Testing Results in Section 4 of this report.
- Unconfined compressive strength tests were conducted on thin-walled tube soil samples in accordance with ASTM D2166. The unconfined compressive strength as determined by this test, along with the results of the standard penetration test, is used to estimate the in-situ shear strength of the various soils encountered. The graphs in Appendix "D" depict the behavior of the tested soil under compression without confinement. The unconfined compressive strengths of the soils samples are presented on the boring logs and in the "Summary of Laboratory Test Results" table in Appendix "D."

3.2 Laboratory Summary

General descriptions of the encountered soils together with visual and laboratory classifications and numerical values of the test results are on the boring logs and soil profile included in Appendix "B." A "Summary of Test Results" is included in Appendix "D."

Section 4

ENGINEERING EVALUATION AND RECOMMENDATIONS

4.1 Soil Conditions

A geotechnical concern at this site is the presence of expansive soils. The soils encountered in this investigation consist of clay with various amounts of sand, sand with various amounts of clay, and silt over very weathered shale, poorly cemented clayey sandstone, and clayey sandstone rock. The cohesive soils were found to be stiff to hard in consistency and the cohesionless soils were found to have loose to very dense relative density. These near surface soils exhibit low to high plastic characteristics. Rock materials (i.e., defined by standard penetration test refusal) were encountered in the borings. The plasticity characteristics of the soils encountered indicate that these soils are active for consideration of soil expansion on foundation design. The plasticity index (PI) of a soil indicates a soil's potential to shrink or swell with changes in its moisture content. The near-surface soils at this site generally display high plasticity characteristics and were found in a slightly moist to very moist condition. Atterberg limits test results indicate that on-site plastic soils have PI's up to 48. These soils should be considered active and should be expected to undergo significant volume change upon moisture variation.

These soils are expected to undergo expansion upon moisture increase and, conversely, contraction upon moisture decrease. Oklahoma is well known for its heaving clays and the foundation problems associated with soil expansion and uplift pressures. These soil characteristics accompanied with the seasonal variability in soil moisture content caused by the regional climatic conditions often result in foundation and structural damage. Accordingly, the swelling characteristic of the soil is a primary concern and the Potential Vertical Rise (PVR) becomes an important factor in the foundation design of the proposed masterplan grounds.

The maximum PVR value computed for this site is 2.8 inches. The procedure used to predict the PVR was developed by Standard Testing based on AASHTO test method T258 and modified to incorporate our experience with actual Oklahoma soils. The displacement associated with the PVR is a relatively long-term effect, associated with significant moisture changes in the soil, and applies to free surface conditions. A maximum PVR of 0.75 inch or less is generally considered tolerable for most structures. These soils should be removed from underneath the slabs and replaced with inert fill as specified in the Earthwork Recommendations Section of this report.

4.2 Existing Site Conditions



Figure 1: Google Earth Aerial View, June 2015



Figure 2: Google Earth Aerial View, August 2025

Based on aerial imagery available from Google Earth®, and firsthand experience from our drilling crew, the project site consists of a largely empty lot of land. The character of the site has remained largely unchanged in the past 10 years. The site was predominantly undeveloped in 2015, characterized by native vegetation, scattered tree growth, and adjacent agricultural fields. By 2025, significant changes are evident, including construction at the southeast corner associated with the Comanche Cache Casino building, grading activities, soil stockpiles, and cleared areas near the developed portion. In addition, the southeast portion of the site previously contained a detention pond which appears to have been backfilled in a timeframe between 2020 and 2022, we were not provided with compaction test results documenting the compaction effort for the pond backfill. The site is underlain in certain areas by filled soil, which appears to have been placed during previous grading activities associated with road construction. The remainder of the site remains covered with natural vegetation and undeveloped land. Drilling operations encountered existing 6 to 7 inches concrete pavement and underlying 3 inches aggregate fill at the ground surface prior to advancing into native soils.

If undocumented fill or debris are encountered during construction, fill materials and any debris should be removed and replaced with inert fill as described in the Earthwork Recommendations section of this report. A representative of Standard should observe the exposed grade in these areas following over-excavation and prior to placement of new fill when applicable.

4.3 Laboratory Testing Results

Soluble Sulfate Test Results

The soluble sulfate results are included in the following table:

Table 3: Soluble Sulfate Test Results

Boring No.	Sample I.D.	Depth (feet)	Sulfate Content (ppm)
B-1 to B-5	Comp. 1	3.0-5.0	52
B-6 to B-10	Comp. 2	3.0-5.0	1198
S-1 to S-4	Comp. 3	3.0-5.0	50
E-2 to E-4	Comp. 4	3.0-5.0	37
E-1	Comp. 5	3.0-5.0	116

The results of the sulfate and chloride content test indicate that Type I/II or IL cement may be used for concrete, and the sulfate levels are negligible in affecting lime stabilization of the soil. According to the National Lime Association’s publication entitled “Technical Memorandum: Guidelines for Stabilization of Soils Containing Sulfates,” which can be found on their website at www.lime.org/documents/publications/free_downloads/technical-memorandum.pdf, “If the

total level of soluble sulfates is below 0.3%, or 3,000 parts per million (ppm), by weight of soil, then lime stabilization should not be of significant concern. The potential for a harmful reaction is low.”

Unconfined Compressive Strength of Soil Test Results

Unconfined compressive strength tests were conducted on thin-walled tube soil samples in accordance with ASTM D2166 testing method. The results are presented in the following table and are also presented in Appendix “D.”

Table 4: Unconfined Compressive Strength Test Results

Boring No.	Depth (feet)	Moisture Content (%)	Dry Density (pcf)	Undrained Shear Strength C_u (psf)	Strain at Max. Stress (%)
B-5	3.0-5.0	14.9	110.7	7804	7.0
B-6	3.0-5.0	17.3	102.1	5353	1.6
S-4	3.0-5.0	11.9	96.6	349	1.5

4.4 Seismic Site Class

Based on the results of our investigation, this site is classified as Seismic Site Class C. This recommendation is based on the criteria given in Table 1.5-2 of the ASCE/SEI 7-22, entitled "Site Class Definitions." The following are approximate mapped and design spectral acceleration parameters:

- Assumed Risk Category = III
- The Approximate Mapped Spectral Acceleration for Short Periods, $S_s=0.51$
- The Approximate Mapped Spectral Acceleration for a 1-Second Period, $S_1=0.12$
- The Approximate Design Spectral Response Acceleration at Short Period, $S_{ds}=0.32$
- The Approximate Design Spectral Response Acceleration at 1-Second, Period, $S_{d1}=0.1$

4.5 Geological Information

The “Engineering Classification of Geologic Materials, Division Seven” Research and Development Division of the Oklahoma Highway Department, 1969, indicates that the project site is located over the Addington Unit (Pad). This geologic information is described therein as follows:

Addington Unit (Pad):

The Addington Unit consists primarily of brilliant red to vermilion shale and sandy shale, with subordinate mudstone and occasional thin beds of sandstone. A persistent sandstone bed, locally referred to as the “Asphaltum Sandstone,” marks the base of the unit and varies from about 10 to 50 feet in thickness, generally thickest in Carter County and thinning westward. The formation is generally soft, though the sandstone beds are moderately firm, and the shale exhibits a platy to blocky structure when weathered. Thickness of the Addington Unit averages about 150 feet, although erosion has locally removed portions of the upper strata.

The unit outcrops extensively throughout Division Seven, including Comanche, Cotton, Stephens, Jefferson, Love, and Carter Counties. Topography over the unit is generally near-level to gently rolling prairie; however, locally dissected slopes and cultivated upland surfaces are common where erosion has modified the landscape.

4.6 Rock Rippability

Due to the close proximity of hard soil material and bedrock to the surface, which was encountered in the borings, excavation may encounter some difficulties. Experience has indicated that rock formations which can be penetrated with flight augers can sometimes be excavated using heavy duty construction equipment such as large backhoes with rock teeth or ripper-equipped dozers. Excavation in rock formations, which cannot be penetrated with flight augers, is usually much more difficult and often requires the use of other techniques such as pneumatic breakers or blasting.

Based on the borings, it appears that some excavations may extend into hard soil. Rippability of the hard soil will vary, and the use of jackhammers and other rock excavation equipment and/or methods may be required to reach the design excavation depths. Hard soil may be encountered at shallower depths at locations not explored by our borings and therefore we recommend that budgeting for appropriate ripping equipment be accounted for during the bidding process on this project.

Based on the Twelfth Edition from the Handbook of Ripping by Caterpillar, it is estimated that the shear wave velocity of the existing bedrock does not exceed 3,000 ft/sec. Therefore, based on the manual, the bedrock on the site is rippable using a D8R Ripper model or greater.

4.7 Earthwork Recommendations

Building Pad Construction

At the location of the Hotel and Multipurpose Building, and in the event that any buildings are planned at the locations of borings E-2 to E-4, a critical geotechnical consideration at this site

is the swelling soils. If slab-on-grade construction is to be used for the building floor at this site, construction of an inert fill building pad is advisable. The inert fill building pad should extend a minimum of 5 feet outside of the building footprint in all directions. The amount of ground surface movement that can be tolerated by the structure should be evaluated by the designer (a value of 0.75 inch or less may be used for most structures) and the corresponding amount of removal and replacement or over ground fill should be performed as indicated in the following options:

Option 1: Cut and Fill

- Remove the required amount of existing soil (see following table) and replace that soil with inert fill, meeting all requirements given herein,

Table 5: Cut and Fill Building Pad Requirements

Depth of Removal and Replacement Soil (feet)*	Estimated Potential Vertical Rise (PVR) (inches)
0.0	2.8
2.0	1.9
4.0	1.2
6.0	0.7

*Below existing site grade

or

Option 2: Fill Only

- Place the required amount or more of inert fill (see following table), meeting all requirements given herein, over the native soils.

Table 6: Over Ground Inert Fill Building Pad Requirements

Depth of Over Ground Inert Fill Building Pad (feet)**	Estimated Potential Vertical Rise (PVR) (inches)
0.0	2.8
2.0	1.9
4.0	1.2
6.0	0.7

**Above existing site grade

Deep Fill Sections

It is recommended that any fill section under buildings or behind retaining walls above 5 feet in thickness be composed of no more than 5 feet of inert fill and the remaining section to be compacted ODOT Type A aggregate base in order to limit the consolidation settlement to approximately 1 inch. We recommend that the aggregate base be placed at the bottom of the fill section to provide improved structural capacity. The fill should be compacted to at least 95% of the Maximum Dry Density as determined using the Modified Proctor effort (ASTM D1557). If deep fill sections are to be composed of compressible materials such as cohesive inert fill, one of the following recommendations should be followed:

- Prior to placement of the fill section at its deepest section, settlement monitoring plates should be installed at several locations on top of subgrade and also settlement monuments should be installed on top of the fill section. Subgrade settlement and the self-consolidation of the fill section should be monitored using survey equipment at regular intervals (typically 30-day intervals under the supervision of the Geotechnical Engineer of Record). Once the full consolidation settlement of the fill section is complete, structure such as foundations and slabs-on-grade may be placed on top.
- Alternatively, and if the schedule does not allow for settlement monitoring, the full deep fill section may be composed of compacted ODOT Type A aggregate base compacted to 95% of the Modified Proctor effort (ASTM D1557).
- A Structural or elevated slab may also be and is recommended to be designed and constructed to span over any deep fill section that may potentially settle and therefore results in a gap underneath the slab.
- Plumbing and mechanical piping should be designed in such a way that they will not be affected by any movement of the deep fills or slabs above to prevent any damage to non-flexible piping.

Only low plasticity on-site soils or imported inert fill should be used for fill under structure. Inert fill should meet the following requirements:

Inert Fill Requirements

Amount finer than 2-inch sieve	100%
Amount finer than No. 200 Sieve	12% minimum and, if $PI \leq 7$, 60% maximum

Liquid Limit	35 maximum
Plasticity Index (PI)	5 to 15

Subgrade Preparation

The existing subgrade should be:

- Stripped of topsoil, vegetation, pavement, fills and any other deleterious materials,
- Over-excavated to the required depth to reduce PVR to a level appropriate for the structural system to be used referring to the cut and fill building pad requirements and overground inert fill building pad requirements tables and extended to at least five (5) feet beyond building footprint,
- Proofrolled, including removing and replacing any soft material which exhibits permanent subgrade deformation exceeding 0.5 inch when traversed by a loaded truck with a rear axle load of approximately 16,000 lbs./axle, and
- Tested for moisture and density and, if deficient, scarified to a depth of 8 inches, moisture conditioned and compacted to 95 percent or more of standard Proctor maximum dry density (ASTM D698).

When required during construction, removal of soft subgrade should not exceed a 3-foot depth below final top of subgrade elevation, nor extend below the static groundwater elevation. If such a depth is reached without encountering stable subgrade conditions, 3-inch diameter surge rock may be driven into the soft subgrade to provide a stable platform for construction equipment and then a minimum of 12 inches of ODOT Type A aggregate base should be placed in the bottom of the over-excavated area then suitable fill material placed and compacted to bring the subgrade to design elevation. In specific situations, geogrid may need to be placed on top of the subgrade, underneath the aggregate base material.

Compaction Requirements

All fill in the structural areas should be:

- Compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D698) at a moisture content within -2% to +2% of the optimum.
- Compacted to at least 95 percent of modified Proctor maximum dry density (ASTM D1557) at a moisture content near optimum for ODOT Type A aggregate base.
- Placed in lifts not to exceed eight (8) inches in compacted thickness.
- Tested for field density a minimum of three (3) times for each lift of fill at frequencies of every 1,500 sq. ft. in areas under structure and 2,500 sq. ft. in areas under pavement.

For utility trenches, test field density at frequencies of 100 linear foot of trench and at frequencies of 50 linear foot of any utility underneath pavement or other structure.

- Fill compacted with hand-operated equipment, i.e. small walk behind rollers, plate compactors etc. around and near pipelines, manholes etc. should be placed in lifts not to exceed four (4) inches in loose lift.

Moisture should be maintained up until the placement of concrete in structural areas to prevent shrinkage (and subsequent post-construction swell) of the soil.

Drainage

The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than six (6) inches vertical fall in the first ten (10) feet measured perpendicular to the face of each wall. Trees and large bushes for landscaping should not be permitted within this 10-foot zone adjacent to the building. General site slopes, drainage swales, or storm drains shall be constructed to provide 1.0 percent slope, or more, along drainage paths which serve to discharge storm water from the site. If surface soil should be left exposed (e.g., flower beds) near the structure foundation, then it is suggested that efforts be taken to maintain such areas at a constant moisture in order to avoid swell/shrinkage of the soil that will affect the foundation system.

If a non-expansive (inert fill) building pad is constructed such that it extends below the adjacent higher plasticity soils, the bottom of such excavation shall be cut at a slope of not less than 1.0 percent to provide a subsurface sump. Drainage shall be provided from this sump in the base of the non-expansive building pad by an underdrain with a slope of at least 1.0 percent discharging either to daylight or to a permanent, automated sump pump system. The underdrain at the sump shall extend below the excavation and shall consist of a perforated nonmetallic underdrain conduit (ODOT 726.02(b)6), 4.0 inches diameter or larger, wrapped in drainage geotextile (ODOT 712.03) and surrounded by at least 6 inches of coarse cover aggregate (ODOT 703.04) on all sides.

The underdrain system mentioned in the above paragraph can be waived if a clay cap is placed surrounding the building footprint and all utility line trenches sealed with a clay plug at the building perimeter.

Clay cap should be:

- Over-excavated at least one foot deep below final grade and be extended horizontally to at least five (5) feet beyond edge of the exterior wall;
- Placed with geofabric over the excavated subgrade soils;

- Backfilled with compacted CLAYS of PIs greater than twenty-five (25); and
- Sloped away from the building at a slope of not less than six (6) inches vertical fall in the first ten (10) feet.

On-site clays with PI’s greater than twenty-five may be used for the clay cap.

4.8 Foundation Recommendations

Considering the soils encountered and based on the test results of this exploration, the following foundation design parameters are recommended for the indicated foundation systems:

Footing Foundation System

Shallow foundations (e.g. spot or continuous cast-in-place concrete footings) may be used to support the new structures at this site. Footings must be placed a minimum of 2.0 feet below finished grade to provide adequate protection from frost action. Footings should have a width of at least 16 inches. The following table shows the allowable net bearing capacity pressure and the required bearing material requirements for the footings for each structure.

Table 7: Allowable Net Bearing Capacity

Structure	Bearing Material	Allowable Bearing Capacity (psf)
Hotel Building (B-1 to B-5)	Native Soils	3,000
	Compacted Inert Fills	2,000
	2.0 Feet of Properly Compacted ODOT Type A Aggregate Base	3,000
Multipurpose Facility (B-6 to B-10)	Native Soils	3,000
	Compacted Inert Fills	2,000
	2.0 Feet of Properly Compacted ODOT Type A Aggregate Base	3,000
Powwow Arbor (S-1 to S-4)	Native Soils	3,000
	Compacted Inert Fills	2,000
	2.0 Feet of Properly Compacted ODOT Type A Aggregate Base	3,000
Amphi Theatre (E-1)	Native Soils	3,000
	Compacted Inert Fills	2,000

	2.0 Feet of Properly Compacted ODOT Type A Aggregate Base	3,000
Carnival Area (E-2 to E-4)	Native Soils	3,000
	Compacted Inert Fills	2,000
	2.0 Feet of Properly Compacted ODOT Type A Aggregate Base	3,000

Continuous footings and spot footings are expected to undergo no more than 1.0 inch settlement when designed for the recommended bearing pressure when constructed on existing soil or no more than 5 feet of properly compacted inert fill. Standard Testing shall be provided with final grading plans and structural loads in order to re-evaluate our recommendations if deemed necessary.

Due to the variability of the subsurface conditions, it is imperative that any shallow footings be placed on similar materials to minimize the chances of differential settlement.

Subgrade Preparation within Footing Area

Due to the presence of very loose soils with low bearing capacities encountered in borings B-2, and P-24 near the shallow footing elevation in the boring, we recommend following steps if loose subgrade materials are encountered at the locations of the footings:

- Bearing Capacity should be verified by performing a Dynamic Cone Penetrometer (DCP) test or a Static Cone Penetrometer (SCP) at the bottom of the footings where soft/loose soils are encountered;
- If the DCP or SCP tests show the loose subgrade soils within the new footing area does not meet the specified bearing capacity, the loose subgrade soils should be over-excavated a minimum of 2 feet below bottom of new shallow footings;
- The exposed excavated soils should be compacted by using Jumping Jack or equivalent equipment,
- Either ODOT Type A aggregate base or inert fills or on-site low PI soils (PI between 5 and 15) should then be placed over up to the bottom of new footings.

Pier Foundation System

Structures may be designed to be supported by drilled cast-in-place concrete piers founded 3.0 feet or more below the depths indicated in the “Relative Elevation of Rock Materials” table

provided in Section 2.4 of this report. Using this type of foundation, each column is supported on a single drilled pier. Loads applied to the piers are transmitted to the rock partially through skin friction along the sides of the pier and partially through end bearing pressure.

All drilled piers should:

- Extend at least 2.0 feet or at least one (1) pier diameter, whichever is deeper, beyond the elevation indicated in the "Relative Elevation of Rock Material" table provided in Section 2.4 of this report,
- Have an aspect ratio (length/diameter) between three (3) and thirty (30),
- Have a spacing between individual piers of three diameters or more (clear spacing),
- Be adequately reinforced
- Have a diameter of at least 18 inches.

Piers may be proportioned using an allowable net end bearing capacity of 23,400 psf and an allowable skin friction capacity of 1,390 psf for that portion of the pier in direct contact with the Clayey Sandstone bedrock. The allowable net bearing capacity and allowable skin friction capacity both include a factor of safety of 3.0. Uplift of the piers can be resisted by using the same skin friction values plus for the pier weight (i.e. 150 pcf x Pier Area x length of Pier). Maximum service load vertical displacement of piers designed in this manner is expected to be on the order of 0.6% of the pier base diameter.

Drilled shafts may require casing or slurry-drilling methods. Concrete should be placed in pier holes as soon as practicable after completion of drilling to prevent weathering of the bearing stratum and relaxation of horizontal ground stresses.

If groundwater is encountered during pier excavation and cannot be dewatered, concrete may be placed by tremie-pipe method so as to assure no contamination of the fresh concrete by groundwater or drilling fluids. A sufficient head of plastic concrete should be maintained within the casing at all times during its extraction in order to overcome the hydrostatic groundwater pressure outside the casing.

4.9 Concrete Slabs

Concrete slabs-on-grade for floors should be supported on an inert fill pad in accordance with Tables 5&6 in Section 4.7 and should be constructed as follows:

- The subgrade, inert fill, and/or soil building pad should be prepared as described in the Earthwork Recommendations section of this report.
- Four (4) inches or more of granular base, meeting the following requirements, should be placed over the subgrade:

passing the 1.5 inches sieve.....100 %
 passing the #200 sieve.....15 % or less
 plasticity index.....6 or less

- At the time of concrete placement, the granular base should be moist, but free of any standing water.
- The concrete slab should be placed a minimum of four (4) inches thick in lightly loaded areas and up to six (6) inches thick in heavily loaded areas and should not be tied into the footings, stemwalls, or structural frame. If it is necessary to tie the concrete slab into the foundation walls, exterior walls, and/or pitwalls, the slab should be jointed no more than 10 to 15 feet from the point of the restraint (ACI 360R-10, Section 14.7). Other control joints should be provided, each way, at a spacing of 24 to 36 times the slab thickness but no more than 18 feet. Refer to ACI 360R-10, Section 6.1.3 and Figure 6.6 for additional guidance on joint spacing.

If floor coverings susceptible to moisture damage by moist floor conditions (capillary moisture) are to be used, a vapor retarder consisting of one or more polyethylene or polypropylene fabric reinforcement layers with one or more bonded polyethylene film layers, at least 10 mils in total thickness, should be placed below the slab. The vapor retarder should be lapped 6 inches and taped at joints and fitted around all service openings. Section 5.2.3.2 of ACI 302.1R-15 provides the most current industry recommendations for use and placement of vapor retarders. Figure 5.2.3.2, in ACI 302.1R-15, provides guidance for determining whether to place the vapor retarder above or below the "granular material" below the slab.

Concrete slabs can be designed using a modulus of subgrade reaction, k_s , of 140 pci for compacted inert fill described in the Earthwork Recommendations Section of this report or 110 pci for clayey native soil, 120 pci for silty-clayey sand soil, and 135 pci for clayey sand soil.

Elevated Structural Floor Slabs

Floor slabs may be constructed so as to be elevated at least four (4) inches from the natural ground surface to avoid contact with the swelling soils or non-engineered fills. This may best be accomplished by casting the concrete over cardboard carton forms or "void" boxes. Such floor slabs must be designed to span between supporting structural elements without the aid of soil support. These slabs are necessary when slabs at ground level should remain independent of soil movement. Slabs-on-carton forms are most commonly used when soils at the building site are expansive clays subject to significant movement as a result of moisture variation. They provide a more economical construction solution than conventional framing systems, which require a crawl space to remove forms. The cardboard carton forms deteriorate

in the months following construction, eventually leaving the desired void space below the slab and forcing the slab to span between supporting foundation elements.

If floor slabs are designed and constructed to be elevated in this manner and the foundation elements are designed to counteract the soil swelling pressures, then the inert fill subgrade provisions in the Earthwork Recommendations Section of this report may be waived. We recommend that the elevated floor slab be structurally connected to the foundation elements and grade beams. Construction of such slabs should follow ACI 318-19 Chapter 8 for two-way slabs especially when the slab is supporting or attached to partitions or other construction likely to be damaged by large deflections.

The minimum thickness of the slab should be determined in accordance with ACI 318-19 Table 8.3.1.1 (8.3.1.2 for 2-way slabs with beams spanning between supports on all sides). The minimum area of flexural reinforcement for the slab should be determined in accordance with ACI 318-19 section 8.6.1.2

Experience has shown that certain types of wet cardboard carton forms can fail locally under the weight of concrete and construction activities, resulting in a loss of part or all of the desired void space in the vicinity of the form failure. This failure can occur immediately or up to 30 or 45 minutes after strike-off. The latter type of failure, in addition to reducing desired void space, can result in a loss of local slab levelness. Forms that have been damaged by rain should be replaced or allowed to dry thoroughly, with their capacity verified, before concrete placement.

4.10 Grade Beams

Grade beams supported by shallow footings or pier foundation systems should be constructed so as to be elevated at least four (4) inches from the ground to avoid contact with the swelling soils. This may be best accomplished by casting the concrete over cardboard carton forms or “void” boxes.

4.11 Pavement Recommendations

Subgrade Preparation

Prior to the placement of fill or preparation of pavement subbase:

- The natural subgrade should be stripped of all topsoil, vegetation, pavement, fills and any other deleterious materials.
- The parking and drive areas should then be graded and shaped to facilitate drainage, with a minimum slope of 1/8 inch per foot.

- Next, the subgrade should be proofrolled, including removing and replacing any soft material which exhibits permanent subgrade deformation exceeding 0.5 inch when traversed by a loaded truck with a rear axle load of approximately 16,000 lbs./axle. Removal of soft subgrade should not exceed a 3-foot depth below final top of subgrade elevation, nor extend below the static groundwater elevation. If such a depth is reached without encountering stable subgrade conditions, 12 inches of ODOT Type A aggregate base should be placed in the bottom of the overexcavated area and suitable fill material placed and compacted to bring the subgrade to design elevation.
- It is recommended that the prepared subgrade and subbase extend a minimum of 2 feet outside the pavement edges.
- Once the subgrade has been satisfactorily proofrolled, the surface layer of the subgrade shall be scarified to a depth of 6 inches.

Pavement Sections

We estimate the CBR value of the near surface soils as 3.0 based on the paving borings. This would correspond to a modulus of subgrade reaction, k_s , of 110 pci, and a resilient modulus, M_r , of 4,500 psi.

Pavement sections were evaluated based on the AASHTO 1993 guidelines with the following assumptions. If traffic loads are greater than used in the analysis, Standard must be notified in order to reevaluate the recommendations.

- Design Period = 20 years
- Reliability Level = 85% (flexible and rigid)
- Initial Serviceability Index = 4.5 (flexible and rigid)
- Terminal Serviceability Index = 2.0 (flexible and rigid)
- Combined Standard Error (S_0) = 0.5 (flexible) and 0.4 (rigid)
- Light duty (car parking) total design ESALs (W_{18}) = 99,000 (flexible) and 150,000 (rigid)
- Heavy duty (truck parking) total design ESALs (W_{18}) = 348,000 (flexible) and 500,000 (rigid)

We recommend that the following pavement sections be used:

Table 8: Pavement Sections

Pavement Type	Light Duty (inches)	Heavy Duty (inches)
<u>Flexible Pavement</u>		

Surface Course (S4)	2.0	2.0
Intermediate Course (S3)	-	2.5
Base Course (S3)	3.0	2.5
Stabilized Subgrade* (Lime or Portland Cement)	8.0	8.0
<u>Rigid Pavement</u>		
Portland Cement Concrete	5.0	7.0
Stabilized Subgrade* (Lime or Portland Cement)	8.0	8.0

* Based on the presence of A-2-7, A-2-6, A-4, A-6, A-2-4, and A-7-6 near-surface soils across the site, ODOT OHD L-50 recommends Lime or Portland Cement stabilization, and a full mix design will be required for the treated subgrade mixture.

*In order to utilize Portland Cement, a mix design must be performed to ensure that the cement stabilizer sufficiently reduces the soil plasticity

Given the nature of the clay soils onsite, it is recommended to pretreat the existing soils with lime, then stabilized with Portland Cement to mitigate the risk of swelling in the clay soils.

All access lanes subject to delivery trucks, fuel truck, refuse pickup trucks, or fire trucks should consist of heavy-duty rigid pavement.

Materials and Construction

All materials and construction for base should be in accordance with the Oklahoma Department of Transportation (ODOT), "2019 Standard Specifications for Highway Construction," and the latest Special Provisions adopted by ODOT to supplement the Standard Specifications. ODOT Type "A" aggregate base should be compacted to not less than 95 percent standard Proctor maximum dry density (ASTM D698). Compacted/treated subgrade should be compacted to not less than 95% of the standard Proctor maximum dry density (ASTM D698) within -1 to +3 percentage points of the corresponding optimum moisture content. Compacted/treated subgrade should extend the full width of the pavement section (i.e., including curb and gutter).

Concrete for paving should have a modulus of rupture, M_r , of at least 550 psi (compressive strength of approximately 3,500 psi or more), should be air entrained with 4 to 7 percent air, should have a cementitious materials content of at least 564 pcy, and should have a maximum water to cementitious materials ratio of 0.45. The concrete mix design submittal should adequately address the criteria of ACI 301, section 4, including documentation of strength test results. Control joints should be saw cut at least one-eighth (0.125) inch wide and one-quarter of pavement thickness deep as soon as possible after concrete reaches final set (i.e., approximately 8 to 12 hours after placing the concrete), cleaned by high pressure air jet, and

sealed with a suitable pavement joint sealing material to prevent intrusion of surface water into the pavement base. Control joints should be spaced as indicated in the following table:

Table 9: Recommended Transverse Joint Spacings

Concrete Thickness (inches)	Maximum Joint Spacing (feet)
5.0	12.5
7.0	15.0

4.12 Stabilization Recommendations

Application of Chemical Stabilizer and Initial Mixing

Assuming a 5% Lime or 4% Portland Cement (PC) mixture by dry weight of soil, the application rate of the stabilizer is approximately 33 lbs/square yard and 26 lbs/square yard respectively.

Stabilizers must:

- Be applied so that it is uniformly mixed with the soil, the specified stabilizer content is obtained, and a sufficient quantity of Portland Cement treated soil is produced to construct the compacted Portland cement course conforming to the lines, grades, and cross section.
- Be spread only on areas where mixing operations can be completed during the same work shift or work day.
- Be applied as a slurry, and distributors are utilized in application of the slurry.
- Be applied by hand only if distributors are not able to access the area of application.
- Have no equipment pass over applied areas, except that used in spreading and mixing.
- Have adequate initial mixture to alleviate any dusting or wetting that may occur as a result of wind or inclement weather.

Water Application and Moist Mixing

Moisture content of the mixture must be determined prior to final mixing. Moisture in the mixture following final mixing shall not be less than the optimum moisture content (OMC), nor exceed the OMC by more than +2% of the optimum. Water must be added in increments as large as available equipment will permit; however, such increments of water shall be partially incorporated in the mix to avoid concentration of water near the surface of the mixture.

After the last increment of water has been added, continue mixing until water is uniformly distributed throughout the full depth of the mixture, including satisfactory moisture distribution along the edges of the cross section.

For cement stabilized soil, the mellowing requirement may be waived per the Geotechnical Engineer's permission.

4.13 Lateral Earth Pressure Parameters

Lateral earth pressure can be assumed to increase linearly with depth and may be represented as an equivalent fluid column equal to the effective unit weight of the soil times the appropriate coefficient of lateral earth pressure times the thickness of overlying soil at the depth in question. For consideration of lateral earth pressure, the effective unit weight of the soil is the weighted average, down to the depth in question, of the moist unit weight of the soil above the groundwater and the submerged unit weight of the soil below the groundwater. The following estimated parameters may be used for determining approximate lateral earth pressures for the retaining walls at this site:

Fat Clay

$\gamma =$	130 pcf	moist unit weight
$\phi =$	12°	angle of internal friction
$c =$	5,353 psf	apparent cohesion
$k_a =$	0.66	coefficient of active lateral pressure
$k_p =$	1.52	coefficient of passive lateral pressure
$k_0 =$	0.79	coefficient lateral earth pressure at rest

Lean Clay

$\gamma =$	125 pcf	moist unit weight
$\phi =$	20°	angle of internal friction
$c =$	2,000 psf	apparent cohesion
$k_a =$	0.49	coefficient of active lateral pressure
$k_p =$	2.04	coefficient of passive lateral pressure
$k_0 =$	0.66	coefficient lateral earth pressure at rest

Clayey Sand

$\gamma =$	120 pcf	moist unit weight
$\phi =$	28°	angle of internal friction
$c =$	349 psf	apparent cohesion
$k_a =$	0.36	coefficient of active lateral pressure
$k_p =$	2.77	coefficient of passive lateral pressure
$k_0 =$	0.53	coefficient lateral earth pressure at rest

Silty, Clayey Sand

$\gamma =$	110 pcf	moist unit weight
$\phi =$	25°	angle of internal friction
$c =$	500 psf	apparent cohesion
$k_a =$	0.41	coefficient of active lateral pressure
$k_p =$	2.46	coefficient of passive lateral pressure
$k_0 =$	0.58	coefficient of lateral earth pressure at rest

Sandstone

γ =	140 pcf	moist unit weight
ϕ =	35°	angle of internal friction
c =	8000 psf	apparent cohesion
k_a =	0.27	coefficient of active lateral pressure
k_p =	3.69	coefficient of passive lateral pressure
k_0 =	0.43	coefficient lateral earth pressure at rest

Inert Fill

γ =	110 pcf	moist unit weight
ϕ =	25°	angle of internal friction
c =	500 psf	apparent cohesion
k_a =	0.41	coefficient of active lateral pressure
k_p =	2.46	coefficient of passive lateral pressure
k_0 =	0.58	coefficient of lateral earth pressure at rest

The parameters for inert fill should be used only if the inert fill meets all requirements given in the Earthwork Recommendations Section of this report, testing has confirmed that the inert fill has an angle of internal friction of 25° or more, the slope of the native soil from the toe of the earth-retaining structure is no steeper than 1:1, and only inert fill is used in the backfill between the earth-retaining structure and the native soil slope. If these criteria are not met, then the appropriate parameters for the native soil should be used.

Note: P_{water} (Hydrostatic Pressure; psf) = 62.4 (pcf) x h (ft); h=depth below water level

Soil retaining structures (e.g. excavation pit for machine pad) will be subjected to horizontal loading due to lateral earth pressure. The magnitude of this lateral earth pressure depends on the natural and backfill soils, extent of the original excavation, and wall deflections (i.e., stiffness). The appropriate coefficient of lateral earth pressure will vary, based on these considerations, between the coefficient of active lateral earth pressure and the coefficient of lateral earth pressure at rest. Greater wall deflections result in the development of greater internal shear strength in the retained soil, thereby lowering the lateral pressure on the wall. Granular backfill and clay backfill require horizontal deflections of the top of the wall on the order of 0.2 percent and 2 percent, respectively, of the wall height to mobilize the full internal shear strength of the soil. Thus, at reasonably small wall deflections, a greater portion of the internal strength of granular backfill is mobilized reducing the lateral earth pressure on the wall for this type of material.

Retaining structures which are laterally supported and can be expected to undergo only a slight amount of deflection (i.e., less than 0.1 percent of wall height for granular soils or less than 1.0

percent of wall height for clay soils) should be designed for lateral loadings based on lateral earth pressure computed using the coefficient of lateral pressure at rest.

Retaining structures which can deflect sufficiently to mobilize the full active earth pressure condition should be designed for a smaller active lateral earth pressure computed using the coefficient of active lateral earth pressure. Walls designed for such loading must be detailed and specified such that (1) hydrostatic pressure cannot develop and (2) compaction effort used on backfill is required to achieve a minimum of 95 percent of Modified Proctor density.

If the slope of the undisturbed soil beyond the backfill behind retaining walls is steeper than the equivalent of a 1:1 slope measured from the base of the wall, then the active earth pressure should be based on the greater of the earth pressure value described above for backfill or the earth pressure computed based on the coefficient of lateral earth pressure at rest for the undisturbed soil.

A continuous back drain system should be installed at the heel of all walls to prevent water pressure build-up behind the walls. It is recommended that a free-draining, cohesionless material such as crushed stone having a gradation corresponding to ASTM C33, size 6, 7, or 67 be used to form a drainage blanket against the backside of the walls. The drainage blanket should have a minimum horizontal thickness of 12 inches and should extend from the bottom of the buried walls to within 18 inches of the finish ground surface. The crushed stone should be separated from soil surfaces by use of a fabric meeting the requirements of AASHTO M288 for a Class 2 subsurface drainage geotextile rated for soils with less than 50 percent passing the 0.075 mm sieve. A minimum 4 inch diameter, slotted or perforated, corrugated polyethylene pipe should be placed in the bottom of the drainage blanket to collect and transport groundwater to an appropriate point for disposal. Manufactured wall drain systems may be considered in lieu of the described gravel drainage blanket. With a drainage system in place, it is recommended that the buried walls be designed to resist lateral pressures equivalent to those produced by a fluid having a unit weight calculated from the parameters at the beginning of this section plus a uniform pressure equal to 40 percent of any anticipated surcharges adjacent to the walls.

Ultimate resistance to lateral sliding at the bottoms of footings may be calculated based on a coefficient of friction of 0.35. Sliding resistance may also include ultimate passive pressure against the front of the footings which can be calculated using an equivalent fluid unit weight in pcf in the table below. The designer may use the passive pressure in this zone only if there is a certainty of no loss of toe soil. If necessary, additional sliding stability may be derived from the use of a key embedded into soil beneath the base and utilizing the equivalent fluid unit

weight for passive lateral earth pressure seen in the table below. A factor of safety of at least 1.5 should be used with stability calculations involving lateral earth pressures. The safety factor should be computed as the sum of resisting forces or moments divided by the sum of driving forces or moments.

Table 10: Equivalent Fluid Pressure

Soil Type/ State	At Rest psf	Active psf	Passive psf
Fat Clay / Drained	103	85	198
Lean Clay / Drained	82	61	255
Clayey Sand / Drained	64	43	332
Silty, Clayey Sand / Drained	64	45	271
Sandstone/Drained	60	38	517
Inert Fill / Drained	64	45	271
Fat Clay / Undrained	116	107	165
Lean Clay / Undrained	104	93	190
Clayey Sand / Undrained	93	83	222
Silty, Clayey Sand / Undrained	90	82	180
Sandstone/Undrained	95	83	349
Inert Fill / Undrained	90	82	180

4.14 Excavation Requirements (OSHA Requirements)

Excavations adjacent to structures or public ways or to which personnel will enter which are more than 5 feet deep must be either supported (e.g., shoring or trench box) or laid back to a stable slope. If excavations less than 5 feet in depth appear to be unstable, they must also be shored or sloped sufficiently to protect the employees working within them. The recommended slopes provided herein on the Occupational Safety and Health Administration (OSHA) requirements and are intended for construction operations. Permanent slopes should not be constructed utilizing the slope angles described herein.

Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees involved in excavation work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavation begins. Existing underground utility lines shall also be protected during excavation. The excavation slopes specified herein have been determined to hold back the earth banks and not more than 2 feet of stockpiled soil within a distance of 5 feet from the edge of the excavation. Any excavated soil at the edge of the excavation must be stockpiled at a slope of 1.5 or more horizontal to 1.0 vertical. Additionally, no equipment should be allowed within 5 feet of the trench edge.

Someone capable of identifying existing and predictable hazards and who has the authorization to take prompt corrective measures (i.e., a "competent person") must inspect the excavations daily for any condition which may adversely affect the reliability and safety of the excavation. The excavations must also be inspected after each rainstorm or when any change in condition occurs that can increase the possibility of a cave-in or slide. If evidence of possible cave-ins or slides is apparent, all work in the excavation shall cease until the necessary precautions for sloping or bracing have been taken to safeguard the employees and the excavation. Any loose soil shall be scaled from the slope and removed from the excavation to protect workers against falling soil.

An adequate means of egress must be provided within 25 feet of lateral travel to any worker in all trench excavations 4 feet or more in depth. The means of egress may be a ladder or a ramp of stable soil having a slope which can be quickly traversed by personnel exiting the excavation under emergency conditions.

During excavation, the material encountered must be evaluated with respect to the soils encountered during the subsurface investigation as described on the boring logs. If material with different properties (e.g., fill soil, loose sand, etc.) is encountered, the recommendations given in this report may not be adequate to assure safe excavations.

Unless otherwise indicated all sloping requirements are given as a ratio of horizontal distance to vertical distance (i.e., H:V). OSHA soil classifications for the various soil and groundwater conditions encountered in the borings are indicated in the OSHA Soil Classification table:

Table 11: OSHA Soil Classification

Boring No.	Depth Range (feet)	Soil Description	OSHA Soil Type
All Borings	Surface to Top of Weathered shale	Clay Soils	Type B
All Borings	Surface to Top of Poorly Cemented Clayey Sandstone	Clayey Sandy Soils	Type C
All Borings	Surface to Top of Clayey Sandstone	Weathered Shale/Poorly Cemented Clayey Sandstone	Type A
All Borings	Below Groundwater	All Soils	Type C

Sloping requirements for excavation up to 20 feet in depth for the soils encountered are tabulated as follows:

Table 12: Maximum Allowable Slopes

OSHA Soil Type	Maximum Allowable Slopes (H:V)* for Excavations Less Than 20 Feet Deep**
A	¾:1 (53°)
B	1:1 (45°)
C	1.5:1 (34°)

* Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from horizontal. Angles are given to the nearest degree.

** Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer using the conditions unique to the specific excavation.

OSHA requires that all excavation slopes for any soil type overlying an exposed Type C soil follow Type C recommendations and for all Type A soils overlying an exposed Type B soil to follow Type B recommendations. All soils which are submerged are to be considered Type C.

All water should be continuously removed from the excavations to prevent softening and weakening of the excavation face. All excavations should be protected from rain and groundwater by surface diversion ditches or dikes and appropriate de-watering systems. Water shall be continuously removed to keep the water level below excavation depth. The groundwater levels shown on the boring logs represent its location on the day indicated. Groundwater levels will fluctuate with the seasons and may be encountered during construction at a level other than that shown on the boring logs. Workers should be prohibited from working in excavations where water has accumulated or is accumulating.

4.15 Construction Procedures and Considerations

If ground water is encountered during excavation of the footings and trenches, water should be removed from the excavation area and Standard should be contacted to verify to inspection the bearing soils and verify the recommended bearing capacity before the construction of the foundations is resumed.

Unless otherwise indicated all sloping requirements are given in horizontal: vertical. The OSHA Soil Classification for the soil and groundwater conditions encountered in the borings is a type B, C.

We recommend a slope no steeper than 1.5:1 for the subsurface conditions encountered. Sloping or benching for excavations greater than 20 feet deep shall be explicitly designed by a registered professional engineer.

The soils encountered are susceptible to rapid erosion from rainfall. Excavation slopes should be protected from erosion by some type of impermeable covering, such as plastic sheeting.

If space limitations prevent a 1.5:1 excavation side slope, use of shoring or sheet piles will be necessary.

Section 5

BASIS FOR RECOMMENDATIONS

5.1 General Comments

The recommendations and conclusions contained in this report are based on the borings drilled and tests performed. We would point out that there may be variations in material properties over the site and would caution that there may be unknown conditions in existence which differ seriously from those encountered by the test borings. Such conditions, if indeed they exist at all, cannot be, and have not been, accounted for in this report. Therefore, the descriptions, recommendations, and conclusions contained herein should be considered as generalized, applying only to the immediate vicinity of the borings.

5.2 Limitations

Since this report is being prepared in advance of much of the detailed design, the finalized soil and structure parameters (i.e., floor elevation, structural system and loading, vertical movement tolerance, etc.) may differ from the ones considered during the preparation of this report. If such a design variance is substantial, Standard would request the opportunity to review the plans and specifications of the proposed masterplan grounds for applicability to the soil conditions in this report, and assurance of consistency with its intent.

It is recommended that Standard be retained for testing and observation during earthwork and foundation construction phases, to help determine that the design requirements are fulfilled.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical practice.

APPENDIX A

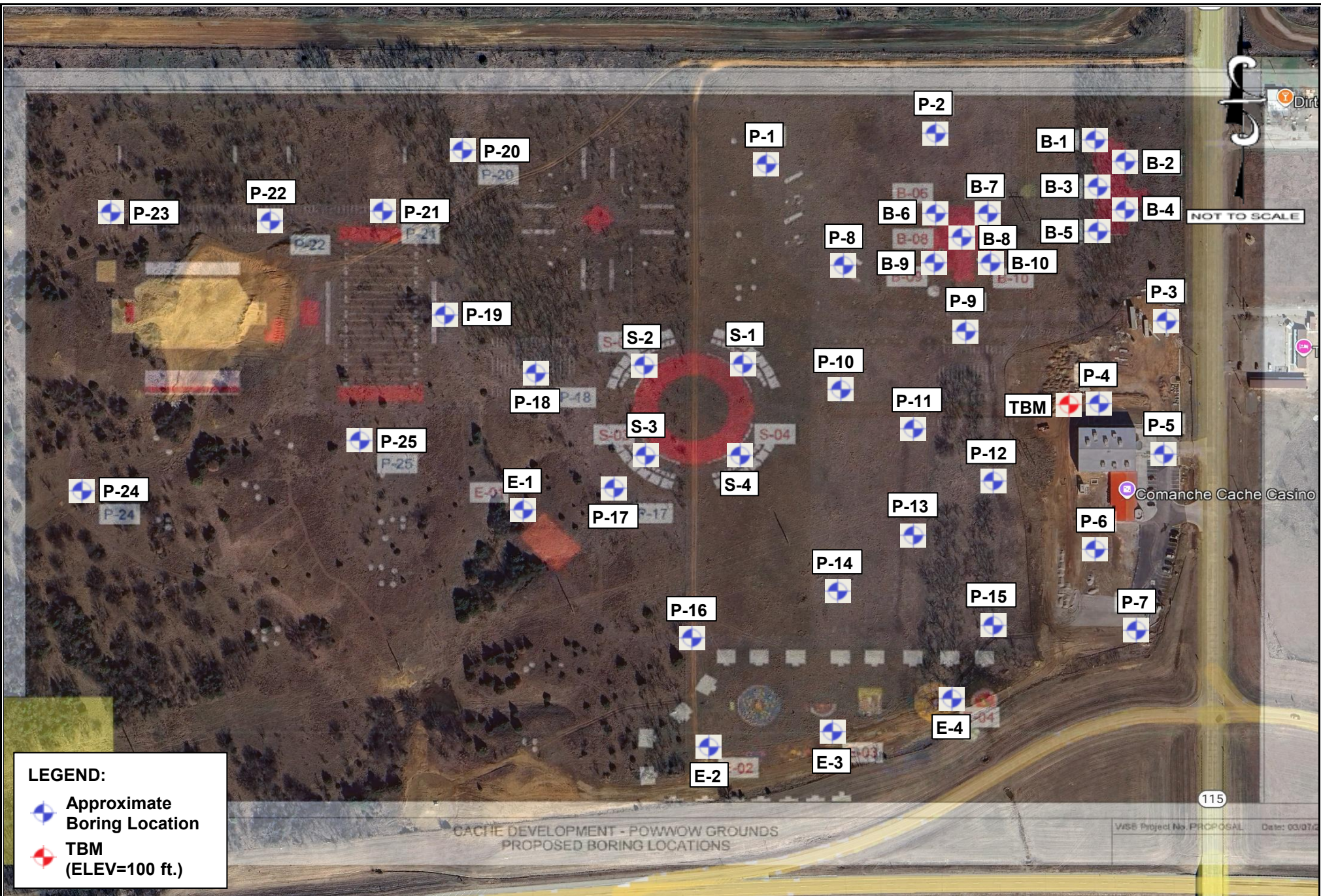
Vicinity Map Site and Boring Location Plan



Vicinity Map

Project Name: Powwow Grounds Masterplan
Project Location: 16193 OK-115, Cache, OK 73527
Project No.: 2530-0249

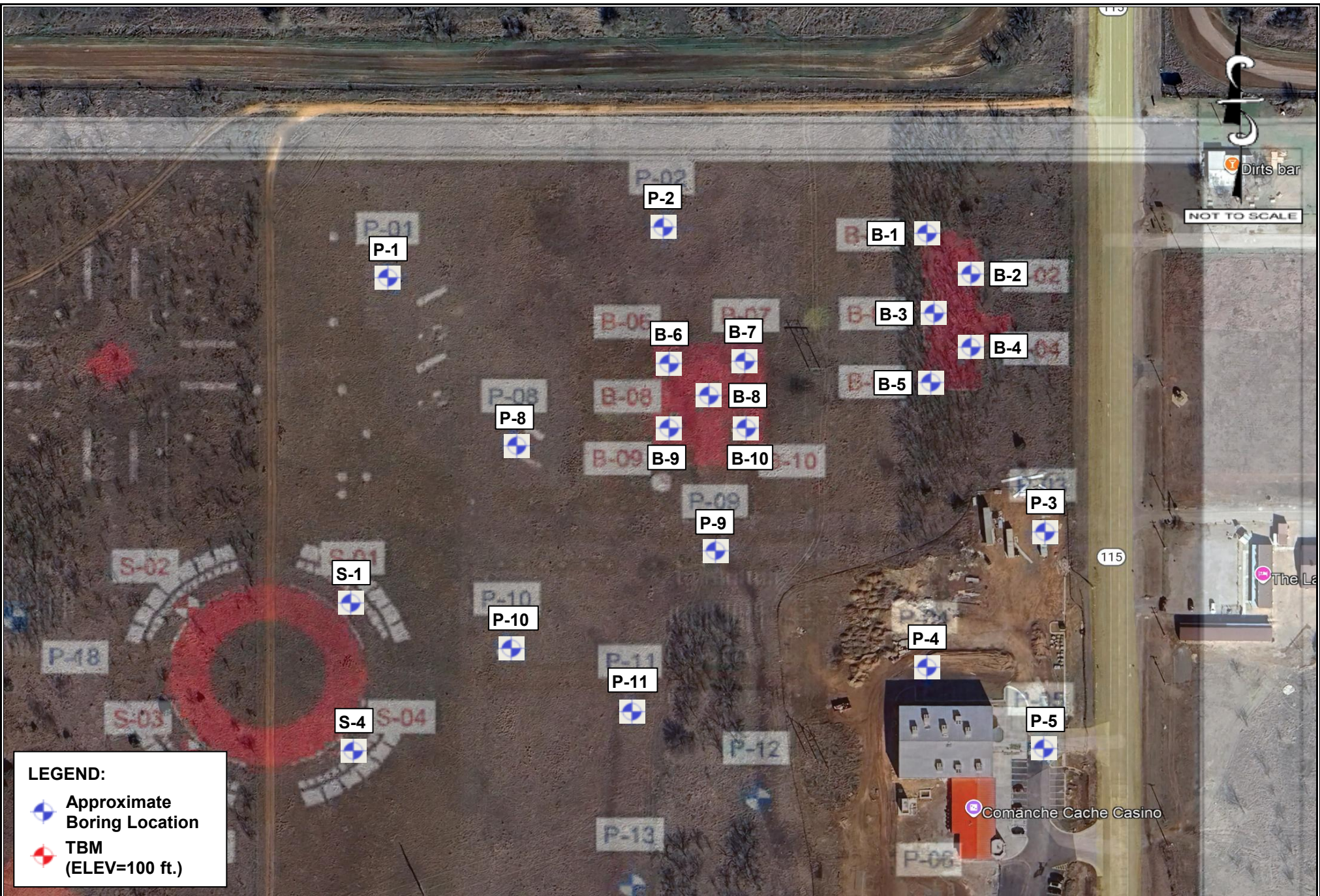




Site and Boring Location Plan

Project Name: Powwow Grounds Masterplan
 Project Location: 16193 OK-115, Cache, OK 73527
 Project No.: 2530-0249





Site and Boring Location Plan

Project Name: Powwow Grounds Masterplan
 Project Location: 16193 OK-115, Cache, OK 73527
 Project No.: 2530-0249

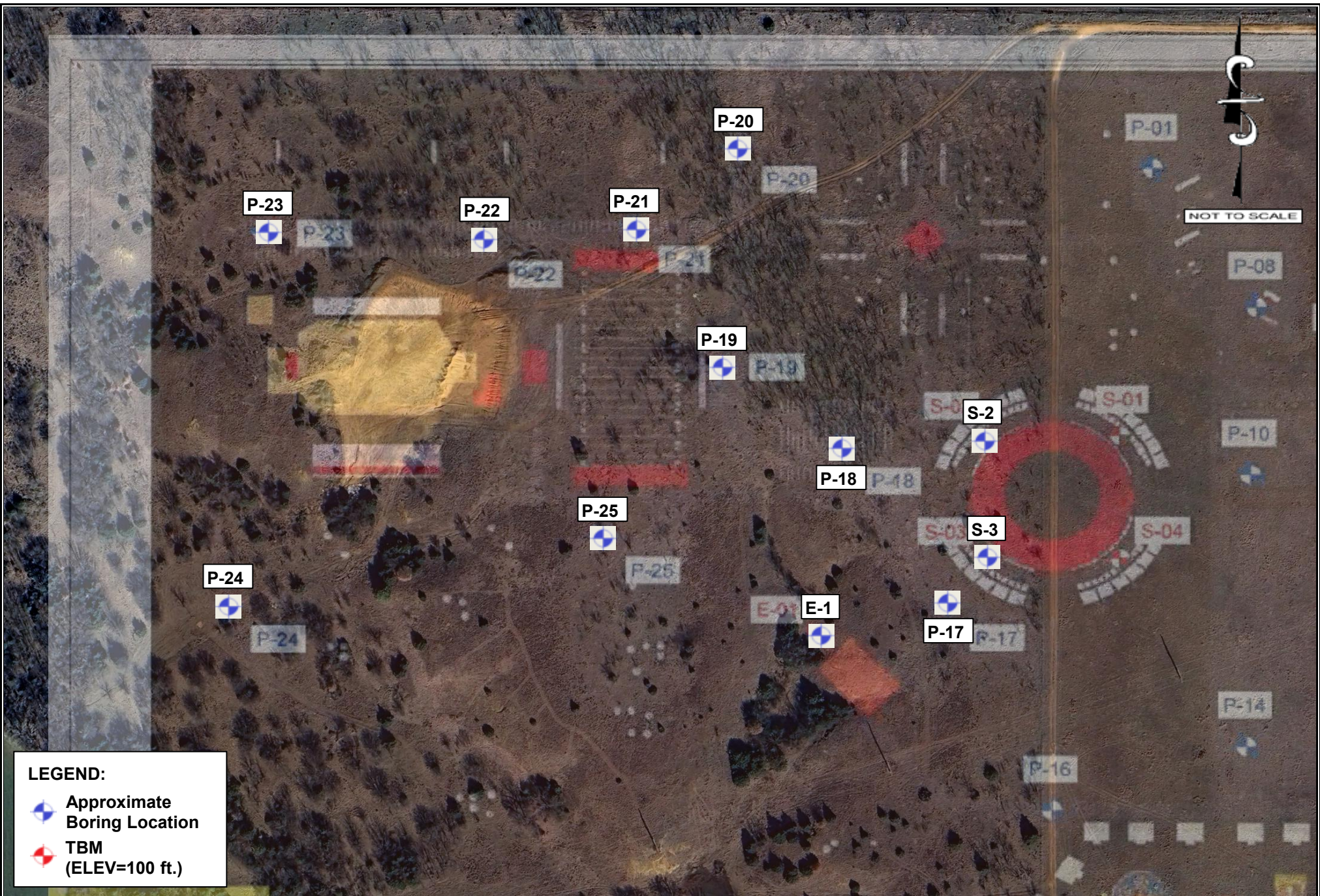




Site and Boring Location Plan

Project Name: Powwow Grounds Masterplan
 Project Location: 16193 OK-115, Cache, OK 73527
 Project No.: 2530-0249





Site and Boring Location Plan

Project Name: Powwow Grounds Masterplan
 Project Location: 16193 OK-115, Cache, OK 73527
 Project No.: 2530-0249



APPENDIX B

Boring Logs

Soil Profile

Definition of Descriptive Terms



BORING LOG B-1

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										
			MATERIAL DESCRIPTION											
0				(Tall Grass & 8" Topsoil)	Grab	A				5.5				
		SC		Brn. CLAYEY SAND V. Moist, Moderate Plasticity, V. Dense	SS	B	15-17-17 (34)		100	10.2			28.4	41-22-19
91				Med. Dense	SS	C	17-16-20 (36)		100	13.4				
7					SS	D	20-12-10 (22)		100	11.9				
					Grab	E				9.0				
84		SC		Reddish Brn. POORLY CEMENTED CLAYEY SANDSTONE V. Moist, Low Plasticity, V. Soft Rock	SS	F	10-15-21 (36)		100	13.8			22.2	32-19-13
14				(ROCK) Tan-Brn. CLAYEY SANDSTONE Soft Rock	SS	G	12-50/6.00"		100	13.1				
77				Grey Med. Hard Rock	HA	H	50/2.50"		100	8.6				
21					HA	I	50/2.50"		100	10.5				
70				Bottom of borehole at 25.2 feet										
28														
63														
35														
56														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		21'	GROUND ELEVATION: 96			DRILL START:	7/25/2025	LOGGER:	KS
AD		23'	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/25/2025	DRILLER:	RS
24 Hrs			GPS: 34.644883, -98.63354			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-2

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST											
MATERIAL DESCRIPTION															
0				(Tall Grass & 8" Topsoil)	Grab	A				5.2					
91				Brn. SILTY, CLAYEY SAND Med. Dense	SS	B	7-10-10 (20)		100	11.1					
					SS	C	8-6-5 (11)		100	8.6					
7		SC-SM		W/ GRAVEL V. Moist, Low Plasticity, Loose	SS	D	7-3-4 (7)		100	11.9			21.9	26-19-7	
84				Brn. to Reddish Brn. Med. Dense	Grab	E				15.2					
					SS	F	8-9-9 (18)		100	13.0					
14					SS	G	13-13-50/6.0"		100	14.3					
77				(ROCK) Brn. CLAYEY SANDSTONE Soft Rock	SS	H	50/5.00"		100	12.5					
21				Dk. Brn.	SS	I	40-50/3.50"		100	15.6					
70															
28				Bottom of borehole at 25.8 feet											
63															
35															
56															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 94			DRILL START:	7/28/2025	LOGGER:	RS
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/28/2025	DRILLER:	CC
24 Hrs			GPS: 34.644736, -98.63336			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-3

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS			SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST	RC											
			MATERIAL DESCRIPTION													
0			(Tall Grass & 8" Topsoil)			Grab	A				4.3					
91		SC	Brn. CLAYEY SAND Med. Dense V. Moist, Moderate Plasticity			SS	B	6-5-10 (15)		100	13.6					
7						SS	C	6-10-12 (22)		100	8.4			48.0	37-20-17	
84			Reddish Brn.			SS	D	10-8-10 (18)		100	10.5					
14						Grab	E				9.7					
84						SS	F	10-10-9 (19)		100	12.8					
77			(ROCK) Tan-Brn. CLAYEY SANDSTONE Med. Hard Rock			HA	G	50/2.50"		100	10.4					
21		CL	Dk. Brn. Soft Rock			SS	H	50/5.00"		100	12.2			61.2	33-17-16	
70			Reddish Brn. Hard Rock			SS	I	50/0.13"		100	6.6					
28			Bottom of borehole at 25.0 feet													
63																
35																
56																
42																

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 95			DRILL START:	7/28/2025	LOGGER:	RS
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/31/2025	DRILLER:	CC
24 Hrs			GPS: 34.644592, -98.63353			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-4

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS			SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST	RC											
			MATERIAL DESCRIPTION													
0			(Tall Grass & 8" Topsoil)			A				17.4						
			Dk. Brn. CLAYEY SAND			B	23-15-13									
			Brn.			C	14-10-9		100	7.9	121					
			Med. Dense			D	11-11-12		100	8.9				49.6	39-19-20	
			V. Moist, Moderate Plasticity			E										
91		SC	Reddish Brn.			F	11-11-11		100	12.8						
7						G	50/5.00"		100	13.1				24.7	25-20-5	
14		SC-SM	(ROCK) Tan-Brn. CLAYEY SANDSTONE			H	50/3.00"		100	9.9						
			V. Moist, Low Plasticity, Soft Rock			I	0.125/0.13"		100	7.0						
84			Reddish Brn.													
14			Bottom of borehole at 25.0 feet													
77																
21																
70																
28																
63																
35																
56																
42																

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 97			DRILL START:	8/4/2025	LOGGER:	BY
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/4/2025	DRILLER:	CSP
24 Hrs		Dry	GPS: 34.644449, -98.63336			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:	DRILL METHOD:	F.A.			



BORING LOG B-5

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS LL-PL-PI
			Grab	ST										
0 98														
	CH		(Tall Grass & 8" Topsoil)	⊗	A				15.2					
			Dk. Brn. FAT CLAY W/ SAND	⊗	B	8-8-7		100	14.6				79.8	63-21-42
			Sl. Moist, High Plasticity, Stiff	⊗	C			71	13.9		15609			
7 91			Grey.	⊗	D	8-10-12		100	14.9	112				
			V. Stiff	⊗	E									
			Brn.	⊗	F	27-15-18								
			Lt. Brn. VERY WEATHERED SHALE	⊗	G	50/3.50"		100	9.6					
14 84			V. Soft Rock	⊗	H	50/4.00"								
			(ROCK) Lt. Brn. CLAYEY SANDSTONE	⊗	I	23-50/3.00"		100	12.1					
			Soft Rock											
21 77			Med. Hard Rock											
			Bottom of borehole at 25.8 feet											
28 70														
35 63														
42 56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	▽	Dry	GROUND ELEVATION: 98			DRILL START:	8/4/2025	LOGGER:	BY
AD	▽	24'6"	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/4/2025	DRILLER:	CSP
24 Hrs	▽	15'	GPS: 34.644315, -98.63353			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs	▽		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-6

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▨ HA	LL-PL-PI										
MATERIAL DESCRIPTION														
0														
98					☒	A				15.4				
					☒	B	7-8-10 (18)		100	15.0	111			
					■	C			100	16.3	111	10706		
7		SC			☒	D	21-25-27 (52)		100	4.1			22.1	51-19-32
91					☒	E				11.1				
					☒	F	22-17-13 (30)		100	14.2				
14					☒	G	50/0.50"		100	6.5				
84					☒	H	50/2.00"		100					
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☒	Dry	GROUND ELEVATION: 100			DRILL START:	8/4/2025	LOGGER:	BY
AD	☒	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/4/2025	DRILLER:	CSP
24 Hrs	☒	15'5"	GPS: 34.644415, -98.63461			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs	☒		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-7

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS LL-PL-PI
			Grab	ST										
0														
98				⊗	A					18.2				
				⊗	B	6-7-14 (21)		100	11.2	116				
		SC	(Tall Grass & 8" Topsoil) Dk. Brn. CLAYEY SAND W/ GRAVEL Med. Dense	⊗	C	20-31-45 (76)		100	6.6				14.1	43-20-23
7			Moist, Moderate Plasticity, V. Soft Rock Soft Rock	⊗	D	50/5.75"		100	5.9					
91			Brn.	⊗	E				7.2	119				
				⊗	F	24-31-18 (49)		100	7.8					
14			(ROCK) Tan-Brn. CLAYEY SANDSTONE Hard Rock (Auger Refusal @ 13 Feet) Bottom of borehole at 13.0 feet	⊗	G	50/0.50"		100	13.8					
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☹	Dry	GROUND ELEVATION: 99			DRILL START:	8/4/2025	LOGGER:	BY
AD	☹	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/4/2025	DRILLER:	CSP
24 Hrs	☹	Dry	GPS: 34.644402, -98.63429			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs	☹		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-8

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			MATERIAL DESCRIPTION											
0				(Tall Grass & 8" Topsoil)	⊗	A				16.1				
98	CL			Dk. Brn. LEAN CLAY W/ SAND Lt. Brn. V. Stiff Moist, Moderate Plasticity	⊗	B	6-8-14 (22)		100	18.6	109			
						C		52	18.0		84.1	46-16-30		
7						D	5-11-18 (29)	100	11.5					
91						E			10.8					
				Lt. Brn. VERY WEATHERED SHALE V. Soft Rock	⊗	F	25-24-34 (58)		100	10.5				
14				(ROCK) Lt. Brn. CLAYEY SANDSTONE Med. Hard Rock	⊗	G	50/2.50"		100	12.0				
84				Soft Rock	⊗	H	50/4.00"		100	11.4				
21				Tan-Red.	⊗	I	50/3.50"		100	11.8				
77				Bottom of borehole at 25.3 feet										
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		21'	GROUND ELEVATION: 100			DRILL START:	8/5/2025	LOGGER:	RS/BY
AD		24'	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/5/2025	DRILLER:	CSP
24 Hrs		11'	GPS: 34.644276, -98.63445			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:	DRILL METHOD:	F.A.			



BORING LOG B-9

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST											
			MATERIAL DESCRIPTION												
0			(Tall Grass & 8" Topsoil)		Grab	A				17.2					
98		CH	Dk. Brn. FAT CLAY W/ SAND Sl. Moist, High Plasticity, Stiff		SS	B	3-5-10 (15)		100	11.2	115		79.8	58-19-39	
			Lt. Brn. VERY WEATHERED SHALE V. Soft Rock Brn.		SS	C	12-15-25 (40)		100	10.0					
7					SS	D	6-12-21 (33)		100	15.6	111				
91			Lt. Brn.		Grab	E				11.7					
					SS	F	20-28-30 (58)		100	12.9					
14					SS	G	50/4.00"		100	10.1					
84			(ROCK) Tan-Red. CLAYEY SANDSTONE Soft Rock		SS	H	28-50/3.75"		100	9.6					
21					SS	I	50/5.50"		100	11.9					
77			Bottom of borehole at 25.5 feet												
28															
70															
35															
63															
42															
56															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 100			DRILL START:	8/5/2025	LOGGER:	BY
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/5/2025	DRILLER:	CSP
24 Hrs		23'5"	GPS: 34.644147, -98.63462			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG B-10

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS LL-PL-PI
			Grab	ST										
0														
98					⊗	A				16.2				
					⊗	B	5-7-12		100	25.2	102			
					⊗	C	10-19-25 (19)		100	11.3				
7		SC			⊗	D	11-13-13 (44)		100	10.0	119		47.2	45-16-29
91					⊗	E				14.5				
					⊗	F	50/6.00"		100	11.4				
14														
84					⊗	G	14-28-50/3.00"		100	14.9				
21					⊗	H	50/5.50"		100	10.2				
77					⊗	I	50/5.00"		100	10.4				
28														
70														
35														
63														
42														
56														
			Bottom of borehole at 25.4 feet											

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		21'	GROUND ELEVATION: 100			DRILL START:	8/5/2025	LOGGER:	BY
AD		24'	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/5/2025	DRILLER:	CSP
24 Hrs		12'	GPS: 34.644143, -98.63430			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG E-1

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST											
			MATERIAL DESCRIPTION												
0				(Tall Grass & 8" Topsoil)	Grab	A				4.9					
		SC-SM		Brn. SILTY, CLAYEY SAND	SS	B	40-50/5.00"		100	8.6			27.1	25-20-5	
				(ROCK) Lt. Brn. CLAYEY SANDSTONE	SS	C	42-50/2.00"		100	9.9	114				
				V. Moist, Low Plasticity, Soft Rock											
				Hard Rock											
105				Brn.		D	50/4.00"		100	5.9					
7				Soft Rock											
						E				7.9					
				Lt. Brn.		F	50/4.00"		100	10.2					
98															
14				Hard Rock		G	50/2.00"		100						
				Bottom of borehole at 15.2 feet											
91															
21															
84															
28															
77															
35															
70															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 111			DRILL START:	8/11/2025	LOGGER:	CC
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/11/2025	DRILLER:	RS
24 Hrs			GPS: 34.642514, -98.63764			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG E-2

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST											
			MATERIAL DESCRIPTION												
0	(Tall Grass & 8" Topsoil)				Grab	A				12.1					
	Brn. CLAYEY SAND				ST	B	13-18-13		100	9.2					
98	Lt. Reddish Brn. POORLY CEMENTED CLAYEY SANDSTONE	SC			SS	C	13-39-50/3.00" (31)		100	9.1			26.9	37-20-17	
	V. Soft Rock				TC	D	50/5.00"		100	7.9					
7	(ROCK) Reddish Brn. CLAYEY SANDSTONE				HA	E	50/0.25"		100						
	Moist, Moderate Plasticity, Med. Hard Rock														
	Soft Rock														
	Hard Rock														
	(Auger Refusal @ 7.0 Feet)														
	Bottom of borehole at 7.0 feet														
14															
84															
21															
77															
28															
70															
35															
63															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☐	Dry	GROUND ELEVATION: 102			DRILL START:	8/12/2025	LOGGER:	RS
AD	☐	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/12/2025	DRILLER:	CC
24 Hrs	☐	Dry	GPS: 34.641025, -98.63629			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs	☐	Dry	STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG E-3

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS			SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST	RC										LL-PL-PI
			MATERIAL DESCRIPTION												
0															
	(Tall Grass & 8" Topsoil)														
	Brn. CLAYEY SAND					A				8.7					
	Reddish Brn. POORLY CEMENTED CLAYEY SANDSTONE					B	11-14-20		100	10.4				39.0	49-23-26
98						C	10-12-22		100	7.6					
	V. Moist, Moderate Plasticity, V. Soft Rock					D	18-14-16		100	6.5					
7															
	(ROCK) Reddish Brn. CLAYEY SANDSTONE					F	50/0.63"		100						
	Hard Rock														
	(Auger Refusal @ 7.5 Feet)														
	Bottom of borehole at 7.5 feet														
91															
14															
84															
21															
77															
28															
70															
35															
63															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☐	Dry	GROUND ELEVATION: 103			DRILL START:	8/12/2025	LOGGER:	RS
AD	☐	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/12/2025	DRILLER:	CC
24 Hrs	☐		GPS: 34.641143, -98.63538			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs	☐		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG E-4

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS
			Grab	ST											
			MATERIAL DESCRIPTION												
0				(Tall Grass & 8" Topsoil)	Grab	A				13.8					
105		CH		Brn. SANDY FAT CLAY Stiff V. Stiff Sl. Moist, High Plasticity, Stiff	SS	B	5-6-8 (14)		100	21.4	103				
						C	8-9-10 (19)		100	14.3	115				
7						D	5-6-7 (13)		100	17.4			52.3	60-22-38	
98						E				18.3					
				Reddish Brn.	Grab	F	25-50/6.00"		100	11.6					
14				(ROCK) Lt. Brn. CLAYEY SANDSTONE Soft Rock	SS	G	50/2.50"		100	11.4					
91															
				Med. Hard Rock Bottom of borehole at 15.2 feet											
21															
84															
28															
77															
35															
70															
42															
63															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 106			DRILL START:	8/13/2025	LOGGER:	RF
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/13/2025	DRILLER:	CC
24 Hrs			GPS: 34.641347, -98.63459			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



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BORING LOG P-1

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS	
			Grab	ST										RC	LL-PL-PI
			SS TC HA		MATERIAL DESCRIPTION										
0	98	CL		Brn. SANDY LEAN CLAY		×	A			11.1			68.6	37-19-18	
				Sl. Moist, Moderate Plasticity		⊗	B	16-17-18		100	14.9				
				Hard		×	C	(35)			13.2				
7	91			Brn. to Reddish Brn.		⊗	D	9-14-11		100	12.2				
		V. Stiff													
		Bottom of borehole at 6.5 feet													
14	84														
21	77														
28	70														
35	63														
42	56														

WATER LEVELS			ELEVATIONS / LOCATIONS		DRILLING			
WD		Dry	GROUND ELEVATION: 98		DRILL START:	7/29/2025	LOGGER:	JH
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/29/2025	DRILLER:	RF
24 Hrs			GPS: 34.644712, -98.63587		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:	DRILL METHOD:	F.A.		



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BORING LOG P-2

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS	
			Grab	ST										RC	LL-PL-PI
			Grab ST RC SS TC HA		MATERIAL DESCRIPTION										
0 98		CH	Dk. Brn. FAT CLAY W/ SAND			A				15.0					
			Sl. Moist, High Plasticity, V. Stiff			B	9-12-10 (22)		100	11.6			71.7	63-21-42	
			Brn.			C					11.9				
7 91			Bottom of borehole at 6.5 feet			D	11-13-17 (30)		100	12.5					
14 84															
21 77															
28 70															
35 63															
42 56															

WATER LEVELS		ELEVATIONS / LOCATIONS		DRILLING			
WD		GROUND ELEVATION: 99		DRILL START:	7/29/2025	LOGGER:	CB
AD		TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/29/2025	DRILLER:	RF
24 Hrs		GPS: 34.644896, -98.63469		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs		STA:	OFFSET:	DRILL METHOD:	F.A.		



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BORING LOG P-3

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
0														
		CH	(Sandy/Gravel)		A					5.1				
			Brn. FAT CLAY		B	5-10-16			100	14.0			91.1	58-20-38
91			Sl. Moist, High Plasticity, V. Stiff		C					13.6				
7			Reddish Brn. VERY WEATHERED SHALE		D	17-19-27			100	11.3				
			V. Soft Rock			(46)								
			Bottom of borehole at 6.5 feet											
84														
14														
77														
21														
70														
28														
63														
35														
56														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING				
WD		Dry	GROUND ELEVATION: 96			DRILL START:	7/28/2025	LOGGER:	CB	
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/28/2025	DRILLER:	RF	
24 Hrs			GPS: 34.643707, -98.63305			DRILL RIG:	CME 75	HOLE SIZE:	4"	
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.			



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BORING LOG P-4

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			MATERIAL DESCRIPTION											
0														
98		CH	(7" Concrete)			A				15.5				
			(3" Aggregate)			B	6-6-10		100	23.2			65.1	71-23-48
			Brn. SANDY FAT CLAY			C	(16)			18.5				
			Reddish Brn.			D	7-9-11		100	12.8				
			Moist, High Plasticity, V. Stiff				(20)							
7			Lt. Brn.											
			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 101			DRILL START:	8/1/2025	LOGGER:	JH
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/1/2025	DRILLER:	BH
24 Hrs			GPS: 34.643202, -98.63353			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



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BORING LOG P-5

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			▣ SS ▣ TC ▣ HA ▣ Grab ▣ ST ▣ RC		MATERIAL DESCRIPTION									
0														
98		SC	(6" Concrete)		▣	A				21.2				
			Brn. CLAYEY SAND		▣	B	6-9-10		100	18.6			44.1	61-24-37
			Reddish Brn.		▣	C	(19)			17.8				
			V. Moist, High Plasticity, Med. Dense		▣	D	6-6-10		100	22.8				
7			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 100			DRILL START:	8/13/2025	LOGGER:	RF
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/13/2025	DRILLER:	CC
24 Hrs			GPS: 34.642895, -98.63305			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



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BORING LOG P-6

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			MATERIAL DESCRIPTION											
0			(6" Concrete)		Grab	A				13.8				
98		CH	Brn. SANDY FAT CLAY Stiff Sl. Moist, High Plasticity		Grab	B	5-4-6 (10)		100	11.6				
					Grab	C			17.8		66.7	59-22-37		
7					Grab	D	5-5-10 (15)		100	20.5				
					Bottom of borehole at 6.5 feet									
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 101			DRILL START:	8/13/2025	LOGGER:	RF
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/13/2025	DRILLER:	CC
24 Hrs			GPS: 34.642269, -98.63352			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



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BORING LOG P-7

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			MATERIAL DESCRIPTION											
0			(7" Concrete)											
		CH	(3" Aggregate)		A					20.0			75.8	56-25-31
98			Brn. FAT CLAY W/ SAND		B	8-16-20		100	8.1					
			Sl. Moist, High Plasticity		C	(36)			15.5					
7			Brn. VERY WEATHERED SHALE		D	7-15-35		100	11.4					
			V. Soft Rock			(50)								
			Lt. Brn.											
			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 102			DRILL START:	8/1/2025	LOGGER:	JH
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/1/2025	DRILLER:	BH
24 Hrs			GPS: 34.641769, -98.63326			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



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BORING LOG P-8

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS	
			Grab	ST										RC	LL-PL-PI
0 98			Brn. CLAY W/ SAND Hard		⊗	A				5.1					
			⊗	B	21-22-21 (43)		100	11.3							
			⊗	C				7.1							
7 91			SC	Brn. to Reddish Brn. CLAYEY SAND V. Moist, Moderate Plasticity, Med. Dense Bottom of borehole at 6.5 feet	⊗	D	8-10-8 (18)		100	14.8				21.7	45-19-26
14 84															
21 77															
28 70															
35 63															
42 56															

WATER LEVELS			ELEVATIONS / LOCATIONS		DRILLING			
WD		Dry	GROUND ELEVATION: 99		DRILL START:	7/29/2025	LOGGER:	CB
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/29/2025	DRILLER:	RF
24 Hrs			GPS: 34.644051, -98.63533		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:	DRILL METHOD:	F.A.		



BORING LOG P-9

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
0														
98		CH	(Tall Grass & 8" Topsoil) Brn. FAT CLAY W/ SAND Dk. Brn. V. Stiff Sl. Moist, High Plasticity		A B C	6-8-13 (21)			15.0	21.1			74.9	59-22-37
7			Tan-Brn. VERY WEATHERED SHALE V. Soft Rock Bottom of borehole at 6.5 feet		D	21-26-20 (46)		100	6.1					
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING				
WD		Dry	GROUND ELEVATION: 101			DRILL START:	7/28/2025	LOGGER:	CB	
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/28/2025	DRILLER:	RF	
24 Hrs			GPS: 34.643631, -98.63446			DRILL RIG:	CME 75	HOLE SIZE:	4"	
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.			



BORING LOG P-10

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
0			Grab ST RC SS TC HA											
			MATERIAL DESCRIPTION											
0	(Tall Grass & 8" Topsoil)													
98	Brn. SANDY LEAN CLAY	CL			A				4.8				58.7	28-19-9
	Sl. Moist, Low Plasticity				B	14-12-13		100	14.8					
	Reddish Brn.				C	(25)			10.3					
	V. Stiff				D	7-8-8		100	15.2					
7			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS		DRILLING			
WD	☹	Dry	GROUND ELEVATION: 100		DRILL START:	7/28/2025	LOGGER:	RF
AD	☹	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/28/2025	DRILLER:	CB
24 Hrs	☹		GPS: 34.643279, -98.63535		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs	☹		STA:	OFFSET:	DRILL METHOD:	FA		



BORING LOG P-11

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS	
			Grab	ST										RC	LL-PL-PI
			MATERIAL DESCRIPTION												
0			(Tall Grass & 8" Topsoil)		⊗	A				5.4					
98		CH	Dk. Brn. SANDY FAT CLAY		⊗	B	5-8-15 (23)		100	10.2			68.0	66-23-43	
			Sl. Moist, High Plasticity, V. Stiff		⊗	C					11.4				
7			Dk. Reddish Brn.		⊗	D	7-11-18 (29)		100	9.8					
			Bottom of borehole at 6.5 feet												
91															
14															
84															
21															
77															
28															
70															
35															
63															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 102			DRILL START:	7/28/2025	LOGGER:	RF
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/28/2025	DRILLER:	CB
24 Hrs			GPS: 34.643039, -98.63482			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-12

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			⊠ Grab ■ ST ▨ RC ⊡ SS ▼ TC ▩ HA	LL-PL-PI										
MATERIAL DESCRIPTION														
0	(Tall Grass & 8" Topsoil)				⊠	A				13.7				
	Dk. Brn. CLAY W/ SAND				⊡	B	9-10-12 (22)		100	14.4				
98					⊠	C				16.1				
7	Dk. Brn. to Reddish Brn. POORLY CEMENTED CLAYEY SANDSTONE	SC			⊡	D	16-23-21 (44)		100	8.0			18.6	33-20-13
	Moist, Low Plasticity, V. Soft Rock													
	Bottom of borehole at 6.5 feet													
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☹	Dry	GROUND ELEVATION: 103			DRILL START:	7/28/2025	LOGGER:	RF
AD	☹	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/28/2025	DRILLER:	CB
24 Hrs	☹		GPS: 34.642697, -98.63427			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs	☹		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-13

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▨ HA	LL-PL-PI										
MATERIAL DESCRIPTION														
0	(Tall Grass & 8" Topsoil)													
	Dk. Brn. LEAN CLAY W/ SAND Sl. Moist, Moderate Plasticity V. Stiff	CL	☒		A					12.1			84.2	35-19-16
			☒		B	7-9-13 (22)		100	17.8					
98			☒		C				13.0					
7	Dk. Reddish Brn. VERY WEATHERED SHALE V. Soft Rock		☒		D	7-13-22 (35)		100	12.5					
	Bottom of borehole at 6.5 feet													
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS		ELEVATIONS / LOCATIONS		DRILLING			
WD	📏	GROUND ELEVATION: 103		DRILL START:	7/13/2025	LOGGER:	CC
AD	📏	TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/13/2025	DRILLER:	JH
24 Hrs	📏	GPS: 34.642366, -98.6348		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs	📏	STA:	OFFSET:	DRILL METHOD:	F.A.		



BORING LOG P-14

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS			SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST	RC										LL-PL-PI
			MATERIAL DESCRIPTION												
0			(Short Grass & 8" Topsoil)			⊗	A				5.9				
98	CL	CL	Brn. SANDY LEAN CLAY V. Stiff Sl. Moist, Moderate Plasticity			⊗	B	7-10-18 (28)		100	13.6				
7			V. Stiff			⊗	C				10.2			61.7	44-19-25
			Bottom of borehole at 6.5 feet			⊗	D	12-13-16 (29)		100	13.4				
91															
14															
84															
21															
77															
28															
70															
35															
63															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 102			DRILL START:	7/31/2025	LOGGER:	JH
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/31/2025	DRILLER:	RF
24 Hrs			GPS: 34.642013, -98.63537			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-15

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▨ HA	MATERIAL DESCRIPTION										LL-PL-PI
0														
105		CL	☒	■	A				5.9					
			☒	■	B	6-5-7 (12)		100	8.6				59.5	44-18-26
			☒	■	C				11.5					
7			☒	■	D	14-16-48 (64)		100	16.2					
98			Bottom of borehole at 6.5 feet											
14														
91														
21														
84														
28														
77														
35														
70														
42														
63														

WATER LEVELS		ELEVATIONS / LOCATIONS		DRILLING			
WD		GROUND ELEVATION: 106		DRILL START:	7/29/2025	LOGGER:	CC
AD		TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/29/2025	DRILLER:	RS
24 Hrs		GPS: 34.641812, -98.63426		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs		STA:	OFFSET:	DRILL METHOD:	F.A.		



BORING LOG P-16

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▩ HA	LL-PL-PI										
MATERIAL DESCRIPTION														
0				(Tall Grass & 8" Topsoil)	☒	A				4.7				
98	CH			Brn. SANDY FAT CLAY Sl. Moist, High Plasticity, V. Stiff	☒	B	6-7-11 (18)		100	18.0			60.2	63-23-40
					☒	C				13.7				
7				Brn. to Reddish Brn. VERY WEATHERED SHALE V. Soft Rock	☒	D	29-20-15 (35)		100	11.8				
91				Bottom of borehole at 6.5 feet										
14														
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☒	Dry	GROUND ELEVATION: 100			DRILL START:	7/31/2025	LOGGER:	JH
AD	☒	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/31/2025	DRILLER:	RF
24 Hrs	☒		GPS: 34.641717, -98.63638			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs	☒		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-17

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS LL-PL-PI
			Grab ST RC SS TC HA	MATERIAL DESCRIPTION										
0														
98		SC-SM	(Short Grass & 8" Topsoil) Tan-Brn. SILTY, CLAYEY SAND Moist, Low Plasticity			A			4.6				35.8	26-22-4
			Tan-Brn. POORLY CEMENTED CLAYEY SANDSTONE V. Soft Rock			B	13-19-24 (43)		100	12.3				
						C				5.4				
7						D	11-20-19 (39)		100	9.9				
91			Bottom of borehole at 6.5 feet											
14														
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS		ELEVATIONS / LOCATIONS		DRILLING			
WD		GROUND ELEVATION: 100		DRILL START:	7/31/2025	LOGGER:	JH
AD		TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	7/31/2025	DRILLER:	RF
24 Hrs		GPS: 34.642673, -98.63693		DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs		STA:	OFFSET:	DRILL METHOD:	F.A.		



BORING LOG P-18

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▩ HA	LL-PL-PI										
			MATERIAL DESCRIPTION											
0		SC	Brn. CLAYEY SAND Brn. to Reddish Brn. V. Moist, Moderate Plasticity, V. Dense Med. Dense		☒	A				12.1				
98					☒	B	19-18-20 (38)		100	10.2		37.9	45-25-20	
7					☒	C			10.9					
7					☒	D	11-10-11 (21)		100	23.5				
91			Bottom of borehole at 6.5 feet											
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☒	Dry	GROUND ELEVATION: 102			DRILL START:	7/31/2025	LOGGER:	JH
AD	☒	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/31/2025	DRILLER:	RF
24 Hrs	☒		GPS: 34.643404, -98.63749			DRILL RIG:	CME 75	HOLE SIZE:	
> 24 Hrs	☒		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-19

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			MATERIAL DESCRIPTION											
0				(Tall Grass & 8" Topsoil)	Grab	A				10.4				
98				Brn. SANDY LEAN CLAY	SS	B	12-16-20		100	14.0				
		CL		Brn. VERY WEATHERED SHALE	TC	C	(36)			9.8			61.4	48-19-29
				V. Soft Rock	HA	D	13-15-26		100	10.9				
7				Sl. Moist, Moderate Plasticity			(41)							
				Brn. to Reddish Brn.										
				Bottom of borehole at 6.5 feet										
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 100			DRILL START:	7/31/2025	LOGGER:	JH
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	7/31/2025	DRILLER:	RF
24 Hrs			GPS: 34.643775, -98.63812			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-20

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			⊠ Grab ■ ST ▨ RC ⊠ SS ▼ TC ▨ HA	MATERIAL DESCRIPTION										LL-PL-PI
0														
98				⊠	A					8.2				
				⊠	B	13-13-14 (27)		100	11.7					
		CH		⊠	C				11.2				66.9	56-21-35
7				⊠	D	11-15-28 (43)		100	8.4					
			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														
56														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 100			DRILL START:	8/1/2025	LOGGER:	JH
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/1/2025	DRILLER:	BH
24 Hrs			GPS: 34.644805, -98.63802			DRILL RIG:	CME 75	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-21

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS		
			Grab ST RC SS TC HA	LL-PL-PI												
			MATERIAL DESCRIPTION													
0				(Tall Weeds & 8" Topsoil)												
98		SC		Brn. CLAYEY SAND	A				6.4							
					Lt. Reddish Brn.	B	12-13-14		100	9.5						
					Med. Dense	C				7.5						
7					V. Moist, Moderate Plasticity, Med. Dense	D	12-8-7		100	9.1			40.9	40-19-21		
91			Bottom of borehole at 6.5 feet													
14																
84																
21																
77																
28																
70																
35																
63																
42																
56																

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 100			DRILL START:	8/11/2025	LOGGER:	RF
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/11/2025	DRILLER:	CC
24 Hrs			GPS: 34.644433, -98.63858			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-22

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▨ HA	LL-PL-PI										
			MATERIAL DESCRIPTION											
0			(Tall Weeds & 8" Topsoil)		☒	A				7.2				
98		SC	Brn. CLAYEY SAND Reddish Brn. V. Moist, Moderate Plasticity, Med. Dense Brn. Reddish Brn.		☒	B	9-9-9 (18)		100	11.3			28.7	44-21-23
7					☒	C				7.8				
					☒	D	10-10-10 (20)		100	10.4				
			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		Dry	GROUND ELEVATION: 101			DRILL START:	8/11/2025	LOGGER:	CC
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/11/2025	DRILLER:	RS
24 Hrs			GPS: 34.644360, -98.63937			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-23

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
			MATERIAL DESCRIPTION											
0	(Tall Weeds & 8" Topsoil)				Grab	A				6.4				
	Brn. CLAYEY SAND				SS	B	11-14-16		100	8.2				
	Lt. Brn.				ST	C	(30)			9.1				
	Med. Dense				RC	D	23-50/3.00"		100	11.1			23.8	41-18-23
	Brn.				HA									
105	(ROCK) Lt. Brn. CLAYEY SANDSTONE	SC												
7	V. Moist, Moderate Plasticity, Med. Hard													
	Rock													
	Bottom of borehole at 5.8 feet													
98														
14														
91														
21														
84														
28														
77														
35														
70														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☹	Dry	GROUND ELEVATION: 111			DRILL START:	8/11/2025	LOGGER:	RF
AD	☹	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/11/2025	DRILLER:	CC
24 Hrs	☹		GPS: 34.644411, -98.64052			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs	☹		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-24

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	-#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▨ HA	LL-PL-PI										
MATERIAL DESCRIPTION														
0				(Tall Weeds & 8" Topsoil)	☒	A				5.3				
133		SC-SM		Brn. SILTY, CLAYEY SAND	☒	B	3-3-4		100	11.5				
				Loose	☒	C	(7)				5.8		36.5	25-18-7
				Sl. Moist, Low Plasticity	☒	D	5-3-4		100	11.9				
7				Loose	☒		(7)							
			Bottom of borehole at 6.5 feet											
126														
14														
119														
21														
112														
28														
105														
35														
98														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD	☒	Dry	GROUND ELEVATION: 136			DRILL START:	8/11/2025	LOGGER:	RF
AD	☒	Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/11/2025	DRILLER:	CC
24 Hrs	☒		GPS: 34.642664, -98.64071			DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs	☒		STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG P-25

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS
			☒ Grab ■ ST ▨ RC ☒ SS ▼ TC ▨ HA	LL-PL-PI										
			MATERIAL DESCRIPTION											
0		CH	(Tall Grass & 8" Topsoil)											
98			Reddish Brn. SANDY FAT CLAY Sl. Moist, Moderate Plasticity											
7			Lt. Brn. VERY WEATHERED SHALE V. Soft Rock Reddish Brn.											
7			Bottom of borehole at 6.5 feet											
91														
14														
84														
21														
77														
28														
70														
35														
63														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS		DRILLING			
WD		Dry	GROUND ELEVATION: 101		DRILL START:	8/11/2025	LOGGER:	RF
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)		DRILLED END:	8/11/2025	DRILLER:	CC
24 Hrs		Dry	GPS: 34.642973, -98.63875		DRILL RIG:	D-50	HOLE SIZE:	4"
> 24 Hrs		Dry	STA:	OFFSET:	DRILL METHOD:	F.A.		



BORING LOG S-1

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS LL-PL-PI
			Grab	ST										
			MATERIAL DESCRIPTION											
0			(Tall Grass & 8" Topsoil)		Grab	A				5.5				
		SC	Brn. CLAYEY SAND Reddish Brn. Med. Dense V. Moist, Moderate Plasticity		SS	B	14-8-9 (17)		100	13.3	112			
					ST	C			58	11.2			47.3	43-19-24
7					SS	D	12-9-10 (19)		100	10.3				
			Reddish Brn.		Grab	E				9.2				
					SS	F	12-10-9 (19)		100	13.9				
14			Reddish Brn. POORLY CEMENTED CLAYEY SANDSTONE V. Soft Rock		SS	G	36-30-19 (49)		100	13.9				
21			(ROCK) Reddish Brn. CLAYEY SANDSTONE Soft Rock Bottom of borehole at 21.5 feet		SS	H	33-43-50/6.0"		100	13.1				
28														
35														
42														

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		13'	GROUND ELEVATION: 97			DRILL START:	8/6/2025	LOGGER:	BY
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/6/2025	DRILLER:	CSP
24 Hrs			GPS: 34.643467, -98.63603			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG S-2

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation

standardusa.com

DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS			SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST	RC										
			MATERIAL DESCRIPTION												
0			(Tall Grass & 8" Topsoil)			A				10.9					
		SC-SM	Brn. SILTY, CLAYEY SAND Lt. Brn. Moist, Low Plasticity, V. Dense Med. Dense Reddish Brn.			B	19-17-14 (31)		100	7.7				18.0	26-20-6
						C	15-13-9 (22)		100	8.4	116				
91						D	14-15-12 (27)		100	10.4					
7						E				11.4					
		SC	Reddish Brn. CLAYEY SAND W/ GRAVEL V. Moist, Moderate Plasticity, Loose			F	9-5-3 (8)		100	13.1				19.4	30-15-15
84						G	37-30-28 (58)		100	14.8					
14			Reddish Brn. POORLY CEMENTED CLAYEY SANDSTONE V. Soft Rock												
77			(ROCK) Dk. Reddish CLAYEY SANDSTONE Hard Rock Bottom of borehole at 20.2 feet			H	50/2.00"		100	15.6					
21															
70															
28															
63															
35															
56															
42															

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		14'	GROUND ELEVATION: 97			DRILL START:	8/6/2025	LOGGER:	BY
AD		Dry	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/6/2025	DRILLER:	CSP
24 Hrs			GPS: 34.643448, -98.63675			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG S-3

(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
 PROJECT NUMBER: 2530-0249
 PROJECT LOCATION: Cache, Oklahoma
 CLIENT: Comanche Nation

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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	LL-PL-PI	ATTERBERG LIMITS	
			Grab	ST												RC
			MATERIAL DESCRIPTION													
0				(Tall Grass & 8" Topsoil)	Grab	A				7.0						
96		SC		Brn. CLAYEY SAND	ST	B	11-10-13		100	7.9	116					
				Reddish Brn.	ST	C	15-16-22		100	5.0	116					
				Med. Dense	ST	D	15-12-22		100	3.7	132				25.5	31-16-15
				V. Dense	ST	E					10.6					
8				W/ GRAVEL	ST	F	10-9-9		100	15.6						
88				Sl. Moist, Moderate Plasticity, V. Dense	ST	G	28-36-50/3.50"		100	12.7						
16				(ROCK) Reddish Brn. CLAYEY SANDSTONE	ST	H	40-50/4.00"		100	17.4						
80				Soft Rock												
				Dk. Reddish												
				Bottom of borehole at 20.8 feet												
24																
72																
32																
64																
40																
56																
48																
48																

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		14'	GROUND ELEVATION: 97			DRILL START:	8/6/2025	LOGGER:	BY
AD		19'	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/6/2025	DRILLER:	CSP
24 Hrs			GPS: 34.642890, -98.63674			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



BORING LOG S-4

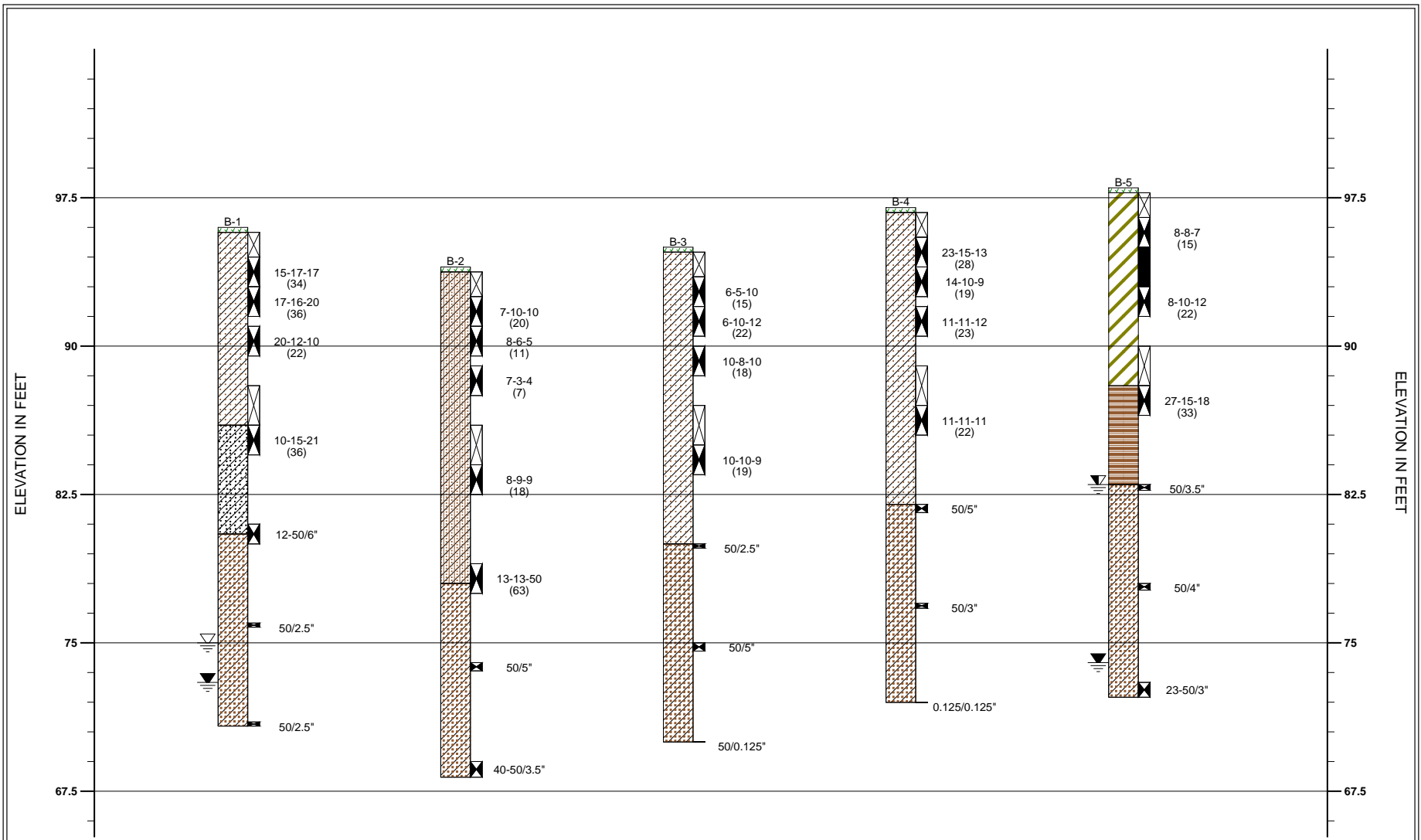
(1 of 1)

PROJECT NAME: Powwow Grounds Masterplan
PROJECT NUMBER: 2530-0249
PROJECT LOCATION: Cache, Oklahoma
CLIENT: Comanche Nation


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DEPTH (FT) ELEVATION (FT)	GRAPHIC LOG	USCS	SAMPLER SYMBOLS		SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS (N)	POCKET PENETROMETER (tsf)	RECOVERY % / RQD	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	UCS (psf)	#200 SIEVE (%)	ATTERBERG LIMITS
			Grab	ST										RC
					MATERIAL DESCRIPTION									
0	98													
			(Tall Grass & 8" Topsoil)		⊗	A				11.1				
			Brn. CLAYEY SAND		⊗	B	8-8-9		100	12.7	109			
			Reddish Brn.		⊗	C	(17)		100	11.9		697	36.7	41-18-23
			Med. Dense		⊗	D	8-8-8		100	12.4				
			V. Moist, Moderate Plasticity		⊗	E				11.2				
7	91		Reddish Brn.		⊗	F	14-14-14		100	12.4				
					⊗	G	16-17-16		100	13.2				
			Reddish Brn. POORLY CEMENTED		⊗	H	36-50/3.00"		100	9.8				
			CLAYEY SANDSTONE											
			V. Soft Rock											
14	84		(ROCK) Dk. Reddish CLAYEY											
			SANDSTONE											
			Med. Hard Rock											
			Bottom of borehole at 20.8 feet											
21	77													
28	70													
35	63													
42	56													

WATER LEVELS			ELEVATIONS / LOCATIONS			DRILLING			
WD		13'	GROUND ELEVATION: 98			DRILL START:	8/6/2025	LOGGER:	BY
AD		17'6"	TBM: Top nut of fire hydrant(ELEV=100ft)			DRILLED END:	8/6/2025	DRILLER:	CSP
24 Hrs			GPS: 34.642871, -98.63602			DRILL RIG:	CME 55	HOLE SIZE:	4"
> 24 Hrs			STA:	OFFSET:		DRILL METHOD:	F.A.		



- Topsoil
- Sandy Lean Clay
- Poorly Cemented Clayey Sandstone
- Clayey Sandstone
- Silty, Clayey Sand
- Fat Clay
- Weathered Shale



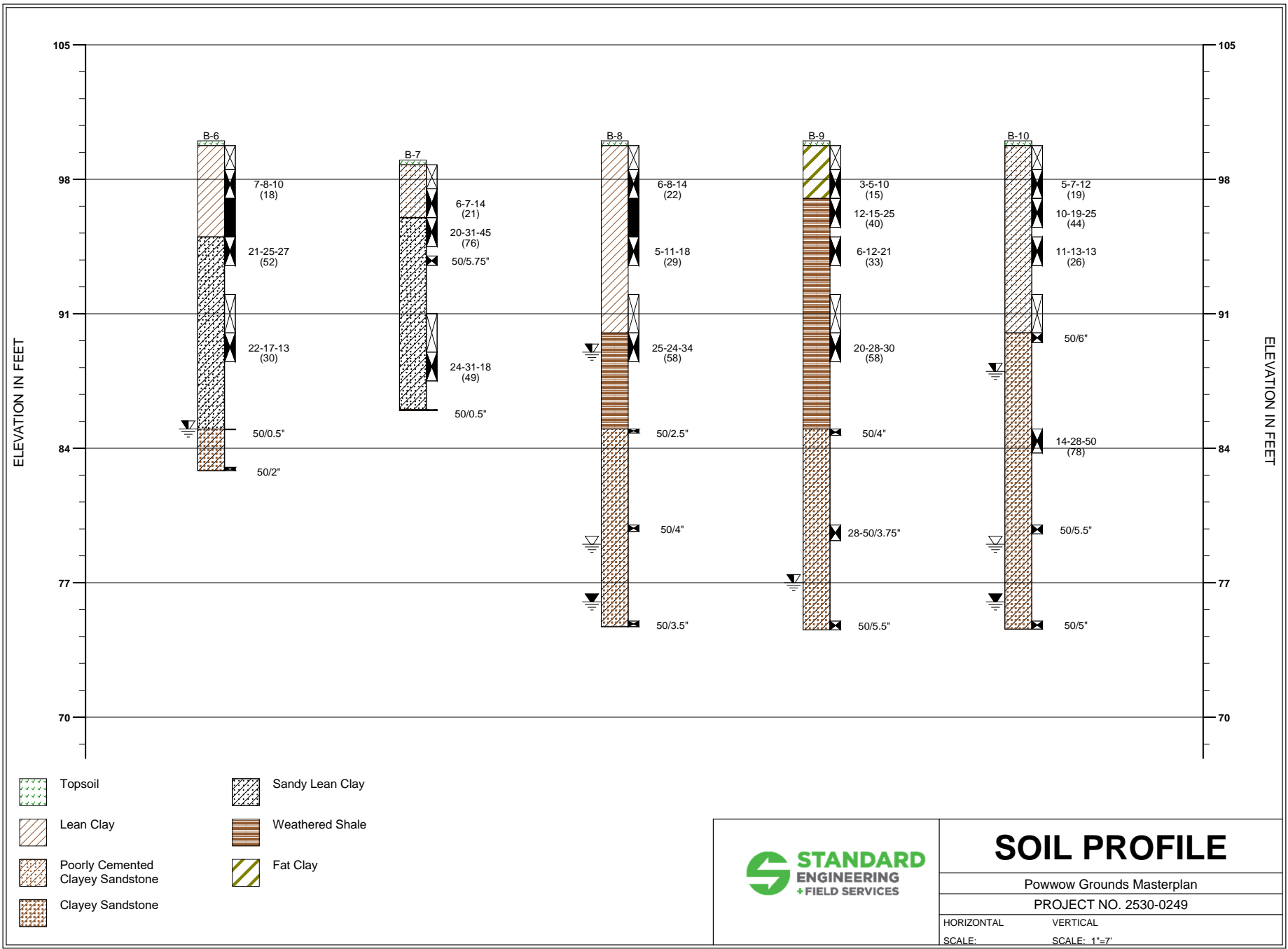
STANDARD
ENGINEERING
+ FIELD SERVICES

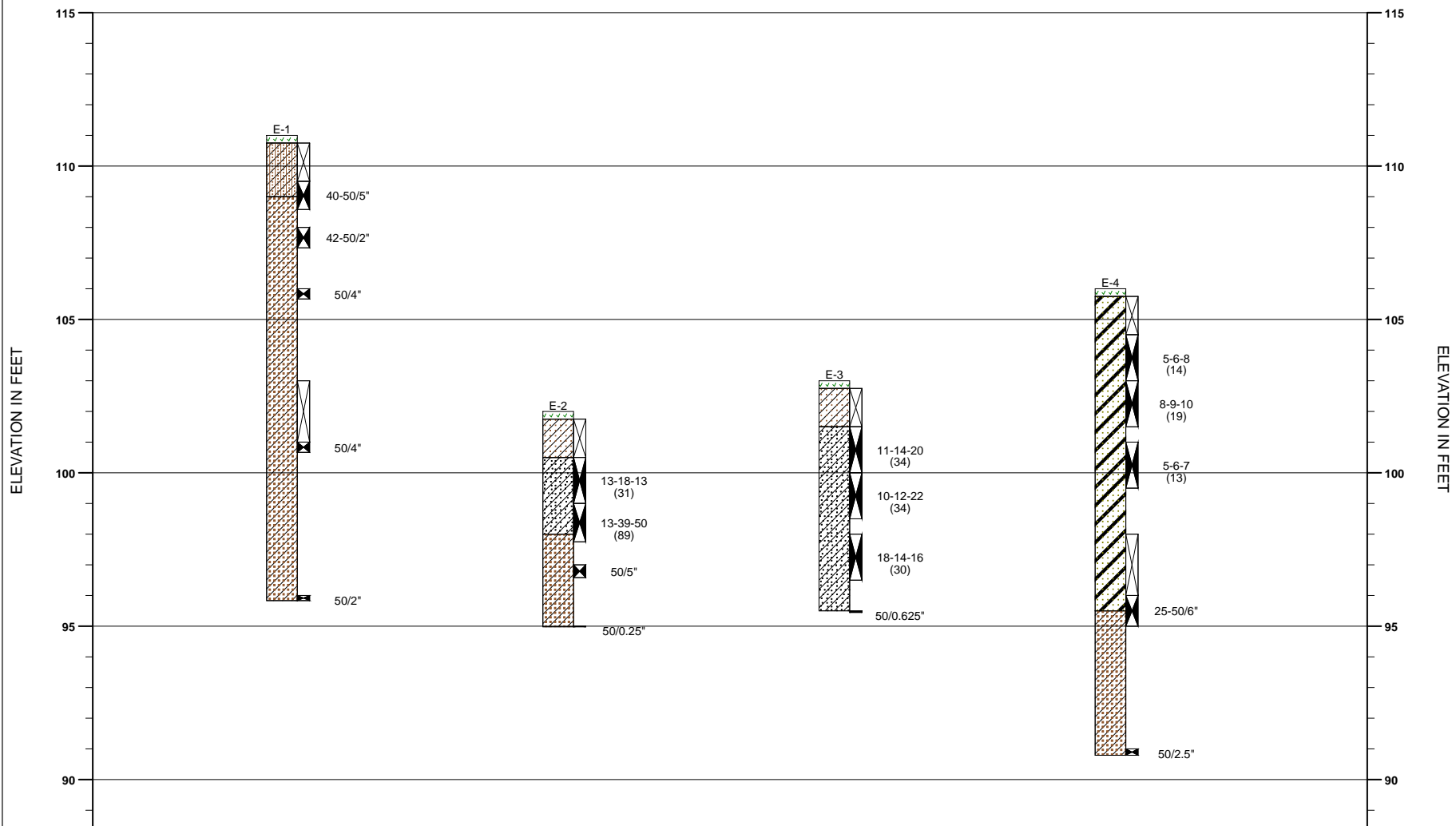
SOIL PROFILE







Powwow Grounds Masterplan

PROJECT NO. 2530-0249

HORIZONTAL	VERTICAL
SCALE:	SCALE: 1"=7.5'





-  Topsoil
-  Silty, Clayey Sand
-  Clayey Sandstone
-  Sandy Lean Clay
-  Poorly Cemented Clayey Sandstone
-  Sandy Fat Clay

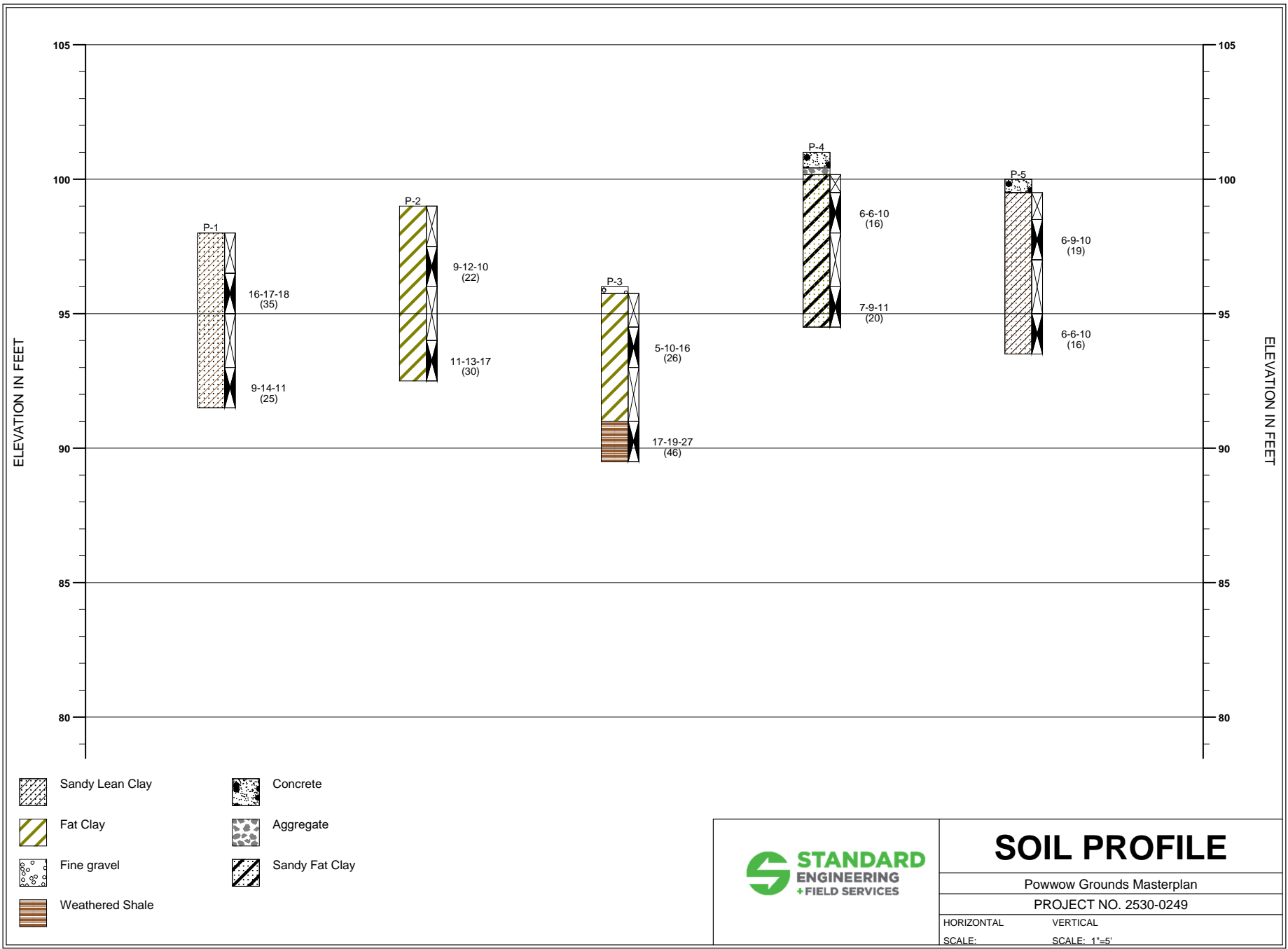









SOIL PROFILE

Powwow Grounds Masterplan

PROJECT NO. 2530-0249

HORIZONTAL SCALE: 1"=5'
 VERTICAL SCALE: 1"=5'



-  Sandy Lean Clay
-  Fat Clay
-  Fine gravel
-  Weathered Shale
-  Concrete
-  Aggregate
-  Sandy Fat Clay



SOIL PROFILE

Powwow Grounds Masterplan

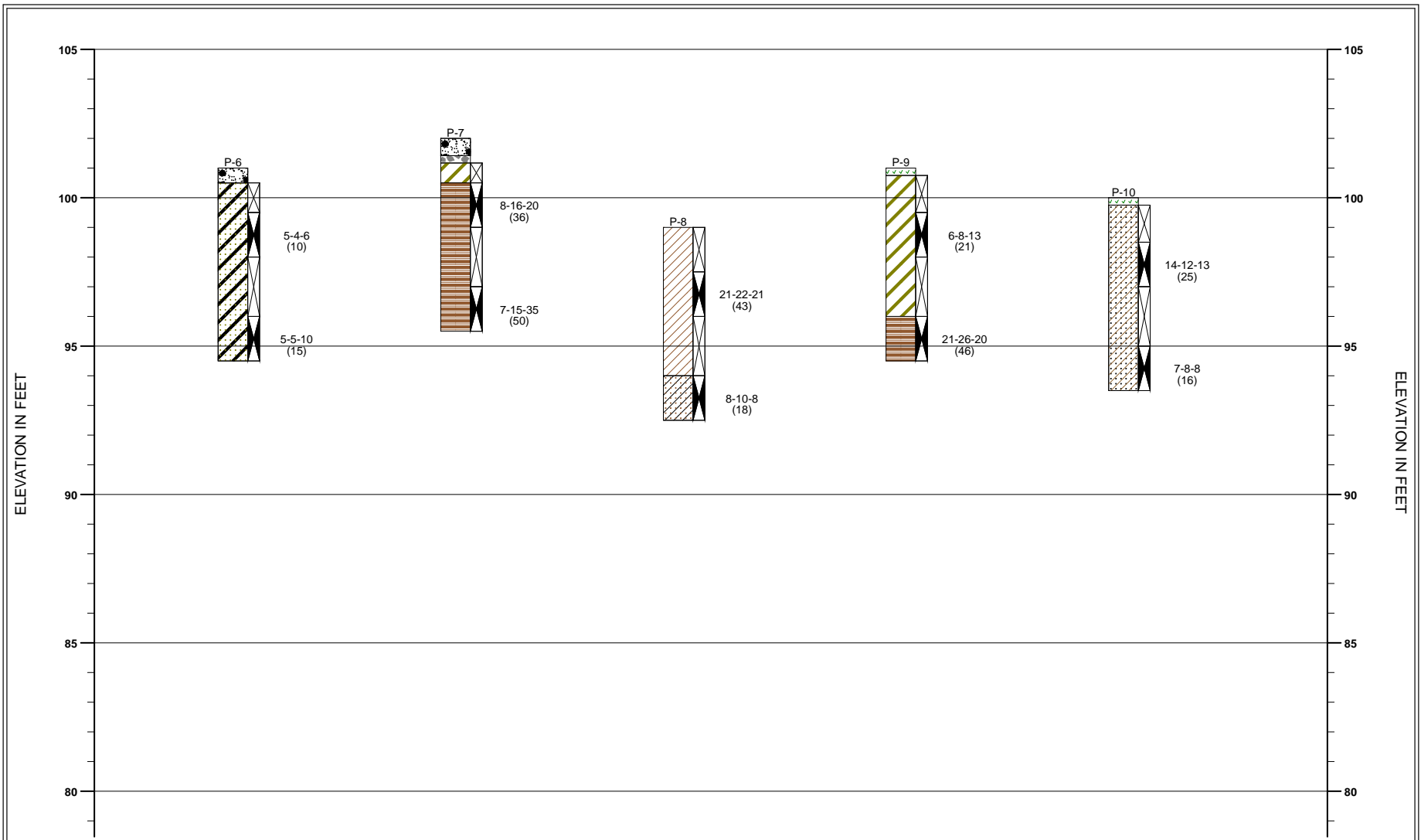
PROJECT NO. 2530-0249









HORIZONTAL


VERTICAL

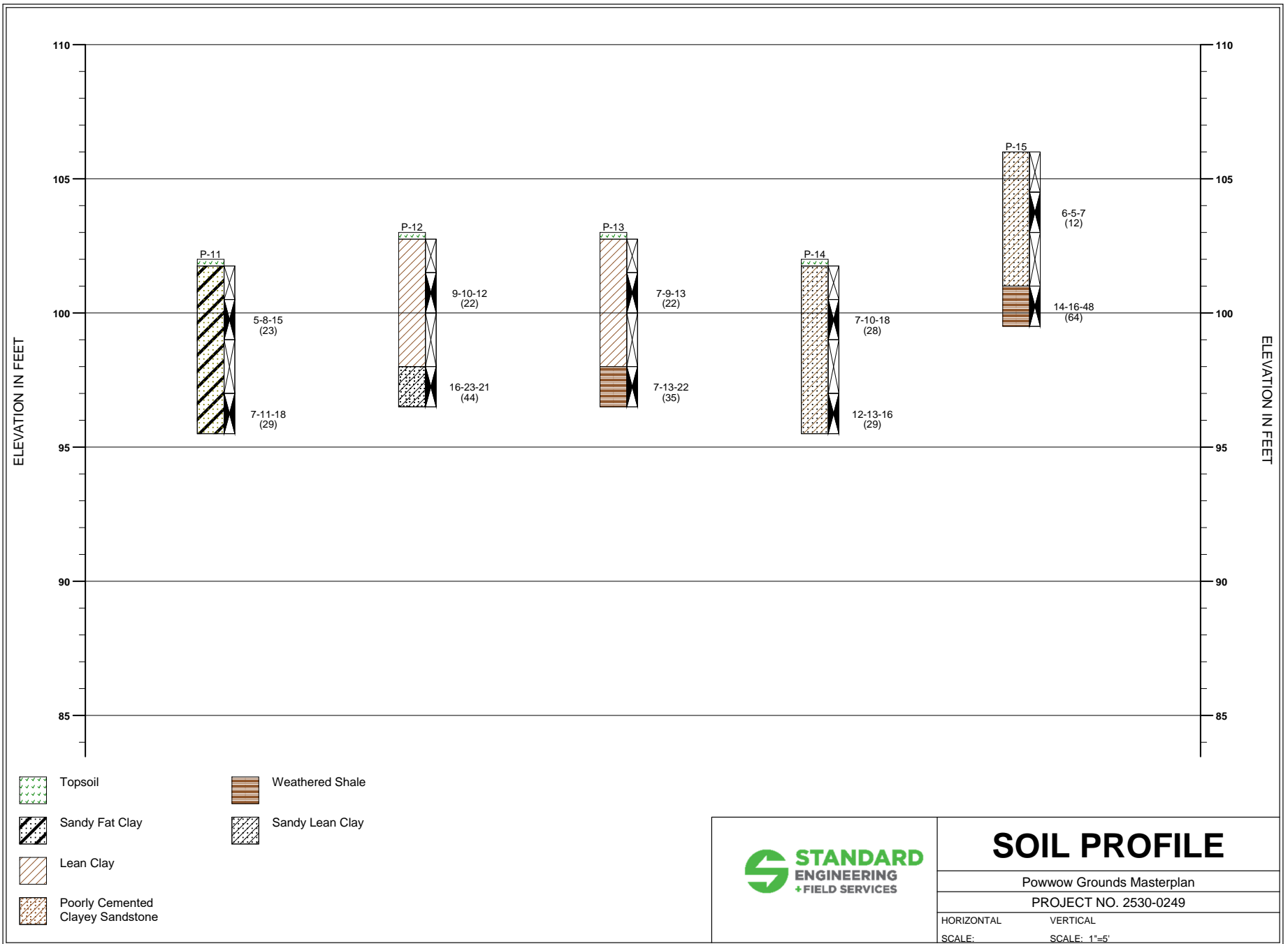
SCALE:

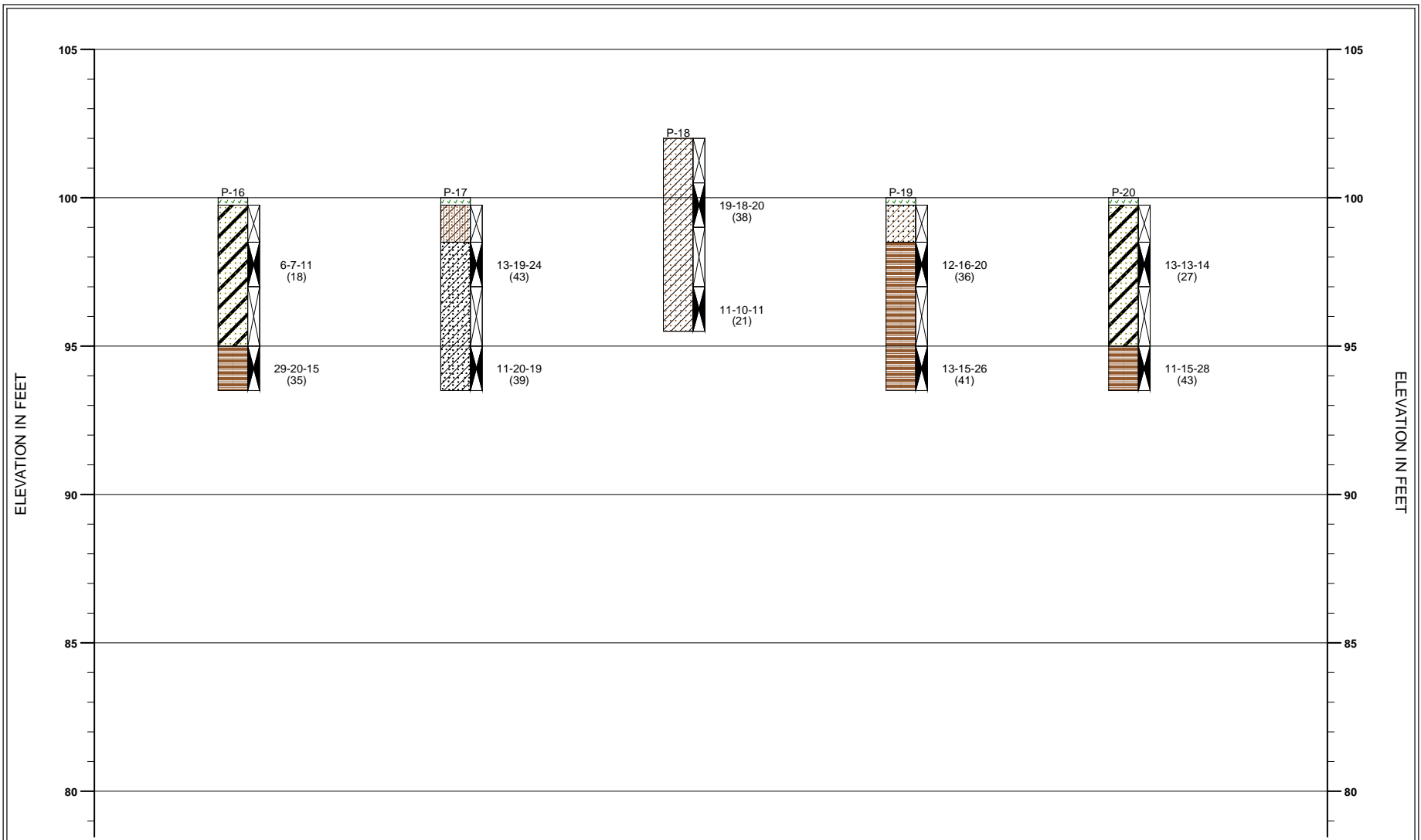
SCALE: 1"=5'




-  Concrete
-  Sandy Fat Clay
-  Aggregate
-  Fat Clay
-  Weathered Shale
-  Lean Clay
-  Sandy Lean Clay
-  Topsoil

	SOIL PROFILE
	Powwow Grounds Masterplan
	PROJECT NO. 2530-0249
HORIZONTAL	VERTICAL
SCALE:	SCALE: 1"=5'





- Topsoil
- Sandy Fat Clay
- Weathered Shale
- Silty, Clayey Sand
- Poorly Cemented Clayey Sandstone
- Sandy Lean Clay



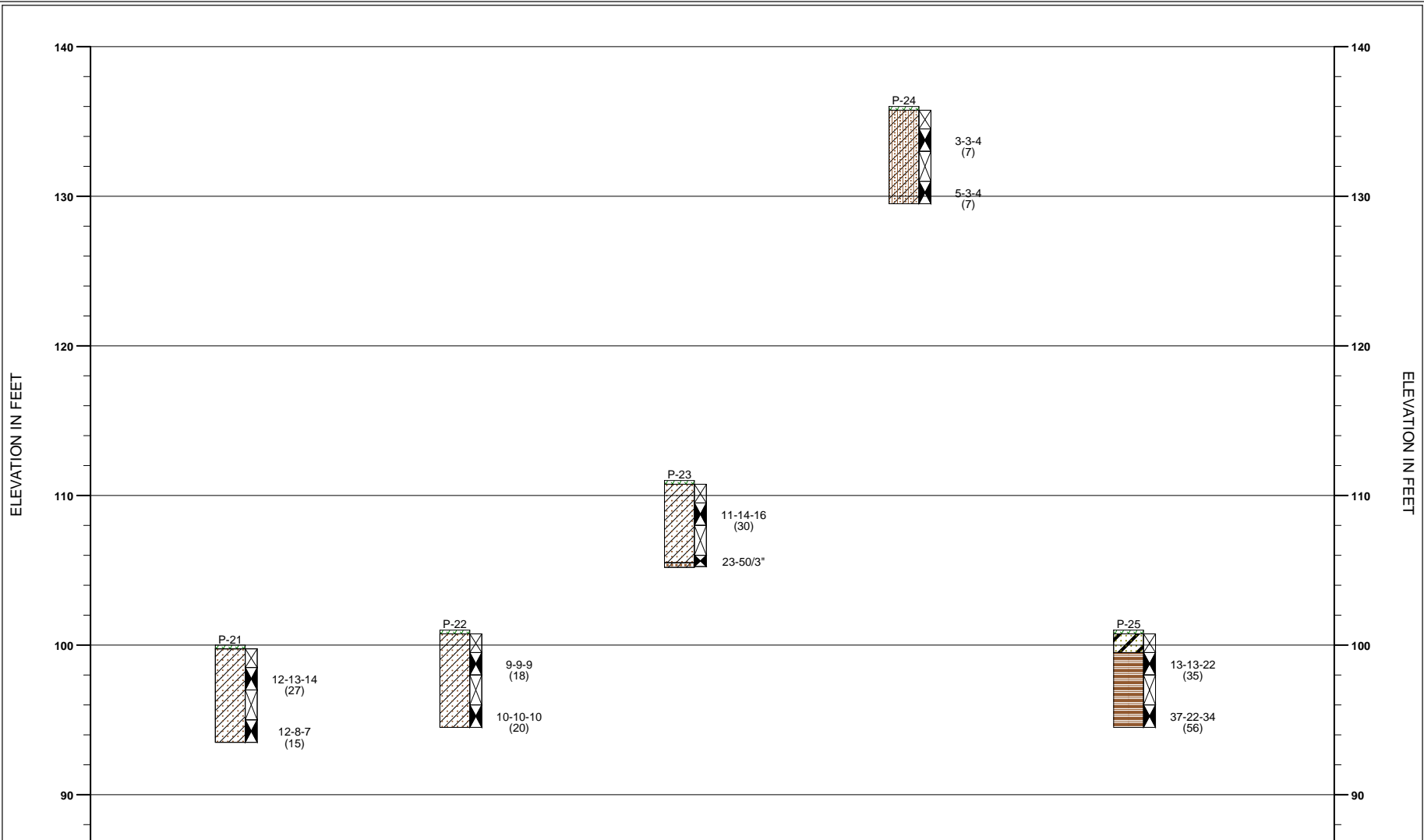
STANDARD
ENGINEERING
+ FIELD SERVICES

SOIL PROFILE


Powwow Grounds Masterplan

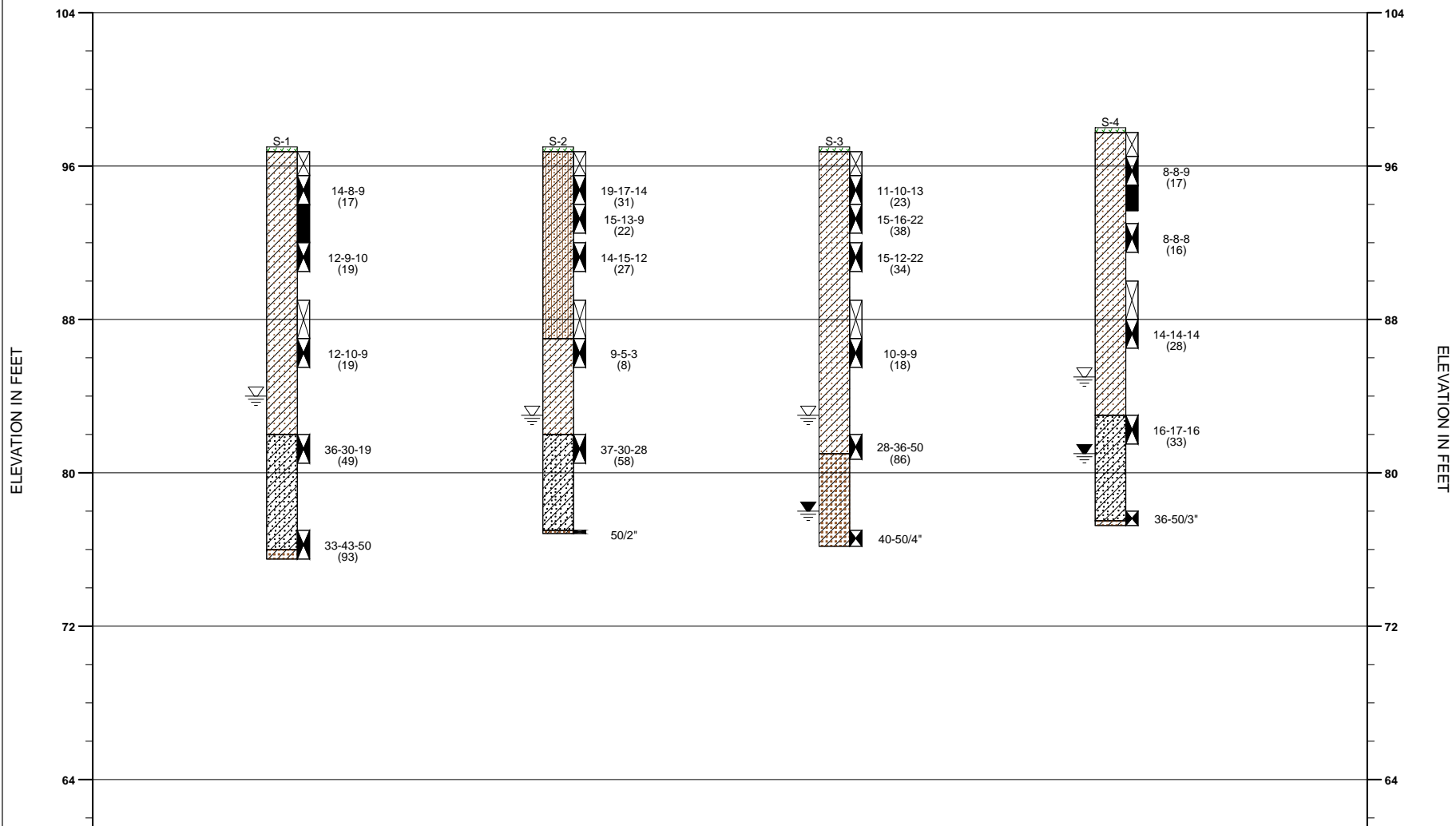
PROJECT NO. 2530-0249

HORIZONTAL	VERTICAL
SCALE:	SCALE: 1"=5'



-  Topsoil
-  Sandy Fat Clay
-  Sandy Lean Clay
-  Weathered Shale
-  Clayey Sandstone
-  Silty, Clayey Sand

	SOIL PROFILE
	Powwow Grounds Masterplan
	PROJECT NO. 2530-0249
HORIZONTAL	VERTICAL
SCALE:	SCALE: 1"=10'



- Topsoil
- Sandy Lean Clay
- Poorly Cemented Clayey Sandstone
- Clayey Sandstone
- Silty, Clayey Sand



SOIL PROFILE

Powwow Grounds Masterplan

PROJECT NO. 2530-0249

HORIZONTAL

VERTICAL

SCALE:

SCALE: 1"=8'

DEFINITION OF DESCRIPTIVE TERMS

Consistency of Cohesive Soils (at moisture content near plastic limit):

- Very Soft - Easily penetrated 4" to 6" by fist; tall core will sag under its own weight.
- Soft - Easily molded by fingers.
- Firm - Can be penetrated 2" to 3" by thumb with moderate effort, imprinted with fingers.
- Stiff - Readily indented by thumb but penetrated only with great effort.
- Very Stiff - Readily indented by thumbnail, imprinted very slightly with pressure from fingers.
- Hard - Indented with difficulty by thumbnail, cannot be imprinted with fingers.

Density of Cohesionless Soils:

- Very Loose - less than 4 SPT "N" value corrected for overburden.
- Loose - 5 to 10 SPT "N" value corrected for overburden.
- Medium Dense - 11 to 30 SPT "N" value corrected for overburden.
- Dense - 31 to 50 SPT "N" value corrected for overburden.
- Very Dense - 51 to 50/6" SPT "N" value corrected for overburden.
- Hard - less than 6" penetration in 50 SPT "N" blows corrected for overburden (cemented).

Hardness of Rock:

- Very Soft - can be scratched readily by fingernail
- Soft - can be grooved readily by knife or pick
- Medium - can be grooved 0.05" deep by firm pressure of knife
- Moderately Hard - can be scratched by knife
- Hard - can be scratched by knife or pick only with difficulty
- Very Hard - cannot be scratched by knife or sharp pick

Other Terms Descriptive of Consistency:

- Brittle - Ruptures with little deformation
- Friable - Crumbles or pulverizes easily.
- Elastic - Returns to original length after small deformation.
- Spongy - Is very porous, loose and elastic.
- Sticky - Adheres or sticks to tools or hands.

In-Situ Moisture Descriptions:

- Dry - powdery
- Slightly Moist - water not readily absorbed by paper
- Moist - water readily absorbed by paper
- Very Moist - water condenses on sample tray
- Wet - water drips from sample

Degree of Plasticity When Moist to Very Moist:

- Nonplastic - cannot be rolled into a ball
- Trace of Plasticity - can be rolled into a ball but not into a 1/8" thread
- Low Plasticity - barely holds its shape when rolled into a 1/8" thread
- Fairly Low Plasticity - 1/8" thread quickly ruptures when bent
- Medium Plasticity - 1/8" thread withstands considerable deformation without rupture.
- Fairly High Plasticity - difficult to rupture a 1/8" thread by bending.
- High Plasticity - can be kneaded without rupture; greasy texture.

Abbreviations:

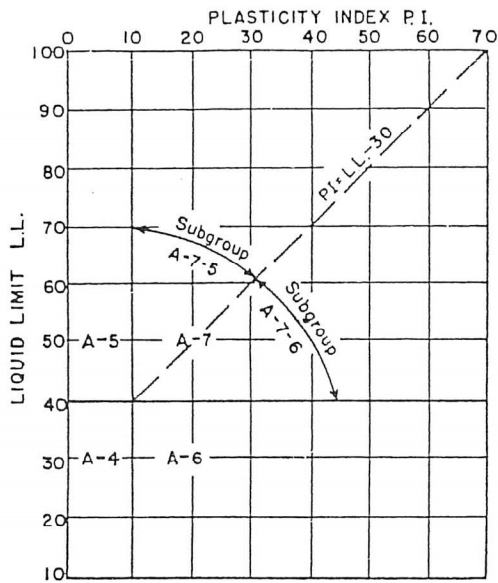
- | | | |
|----------------|---------------|--------------|
| V. - Very | Dk. - Dark | Blk. - Black |
| Tr. - Trace | Lt. - Light | Brn. - Brown |
| Fl. - Fairly | Med. - Medium | |
| Sl. - Slightly | | |

APPENDIX C

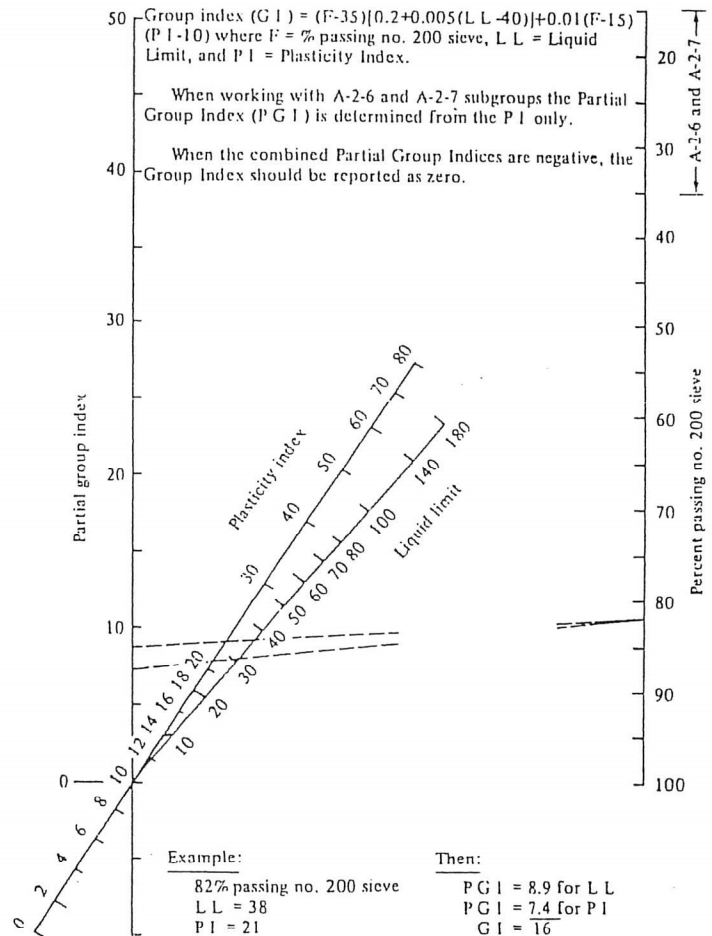
**AASHTO Soil Classification System
Unified Soil Classification System**

Soil Classification System — American Association of State Highway and Transportation Officials

The tables and charts given below are from AASHTO Designation: M 145-83, The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes. More detailed information as to the background and application of the system may be obtained from the report.



Liquid-limit and plasticity-index ranges for the A-4, A-5, A-6 and A-7 subgrade groups.



Group index chart

Classification of Soils and Soil-Aggregate Mixtures (with Suggested Subgroups)

General classification	Granular materials (35 per cent or less passing No. 200)						Silt-clay materials (More than 35 per cent passing No. 200)				
	A-1		A-3	A-2			A-4	A-5	A-6	A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7			A-7-5; A-7-6	
Sieve analysis: Per cent passing: No. 10 No. 40 No. 200	50 max. 30 max. 15 max.	— 50 max. 25 max.	— 51 min. 10 max.	— — 35 max.	— — 35 max.	— — 35 max.	— — 35 max.	— — 36 min.	— — 36 min.	— — 36 min.	— — 36 min.
Characteristics of fraction passing No. 40: Liquid limit Plasticity index	— 6 max.		— NP	40 max. 10 max.	41 min. 10 max.	40 max. 11 min.	41 min. 11 min.	40 max. 10 max.	41 min. 10 max.	40 max. 11 min.	41 min. 11 min.*
Usual types of significant constituent materials	Stone fragments, gravel and sand		Fine sand	Silty or clayey gravel and sand				Silty soils		Clayey soils	
General rating as subgrade	Excellent to good						Fair to poor				

*P.I. of A-7-5 subgroup is equal to or less than L.L. minus 30. P.I. of A-7-6 subgroup is greater than L.L. minus 30

UNIFIED SOIL CLASSIFICATION (Including Identification and Description)										
Major Divisions		Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 inches and basing fractions on estimated weights)	Information Required for Describing Soils	Laboratory Classification Criteria				
1	2	3	4	5	6	7				
Coarse-grained Soils More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in size may be used as equivalent to the No. 4 sieve size)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.	For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics Give typical name; indicate approximate percentages of sand and gravel, maximum size, angularity, surface condition, and hardness of the coarse grains, local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength, well compacted and moist in place; alluvial sand, (SM).	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for GW Atterberg limits below "A" line or PI less than 4 Atterberg limits above "A" line or PI greater than 7 Above "A" Line with PI between 4 and 7 are borderline cases requiring use of dual symbols				
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.						
		GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).						
		GC	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).						
		SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.						
		SP	Poorly-graded sands, gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.						
	Sands More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classification, the 1/4-in size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).	Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength, well compacted and moist in place; alluvial sand, (SM).	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 Not meeting all gradation requirements for SW Atterberg limits below "A" line or PI less than 4 Atterberg limits above "A" line or PI greater than 7 Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols			
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).					
			GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).					
		Gravels with Fines (Appreciable amount of fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.					
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.					
			GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).					
Fine-grained Soils More than half of material is smaller than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).	Give typical name, indicate degree and character of plasticity, amount and maximum size of coarse grains, color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. Example: Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).	Use grain-size curve in identifying the fractions as given under field identification Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% More than 12% 5% to 12%				
		SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).						
		GM	Silty gravels, gravel-sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).						
		GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.						
		GW	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.						
		SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.						
	Sils and Clays Liquid limit less than 50	Sils and Clays Liquid limit greater than 50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.			None to slight	Quick to slow	None	Comparing Soils of Equal Liquid Limit Toughness and Dry Strength Increase with Increasing Plasticity Index
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.			Medium to high	None to very slow	Medium	
			OL	Organic silts and organic silty clays of low plasticity.			Slight to medium	Slow	Slight	
			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.			Slight to medium	Slow to none	Slight to Medium	
			CH	Inorganic clays of high plasticity, fat clays.			High to very high	None	High	
			OH	Organic clays of medium to high plasticity, organic silts.			Medium to high	None to very slow	Slight to medium	
Highly Organic Soils		PI	Peat and other high organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.						

(1) **Boundary Classifications:** Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U.S. Standard

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (Reaction to shaking)
 After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky. Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat, which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and glass disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.
 Very fine clean sands give the quickest and most distinct reactions whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour show a moderately quick reaction.

Dry Strength (Crushing Characteristics)
 After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.
 High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty, whereas a typical silt has the smooth feel of flour.

Toughness (Consistency near plastic limit)
 After removing particles larger than the No. 40 sieve size, a specimen of soil about one-half inch cube in size is molded to the consistency of putty. If too dry, water must be added and if sticky, specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.
 After the thread crumbles, the pieces should be lumped together and slight kneading action continued until lump crumbles.
 The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.
 Highly organic clays have a very weak and spongy feel at the plastic limit.

APPENDIX D

Summary of Test Results



SUMMARY OF LABORATORY TEST RESULTS

Client: Comanche Nation

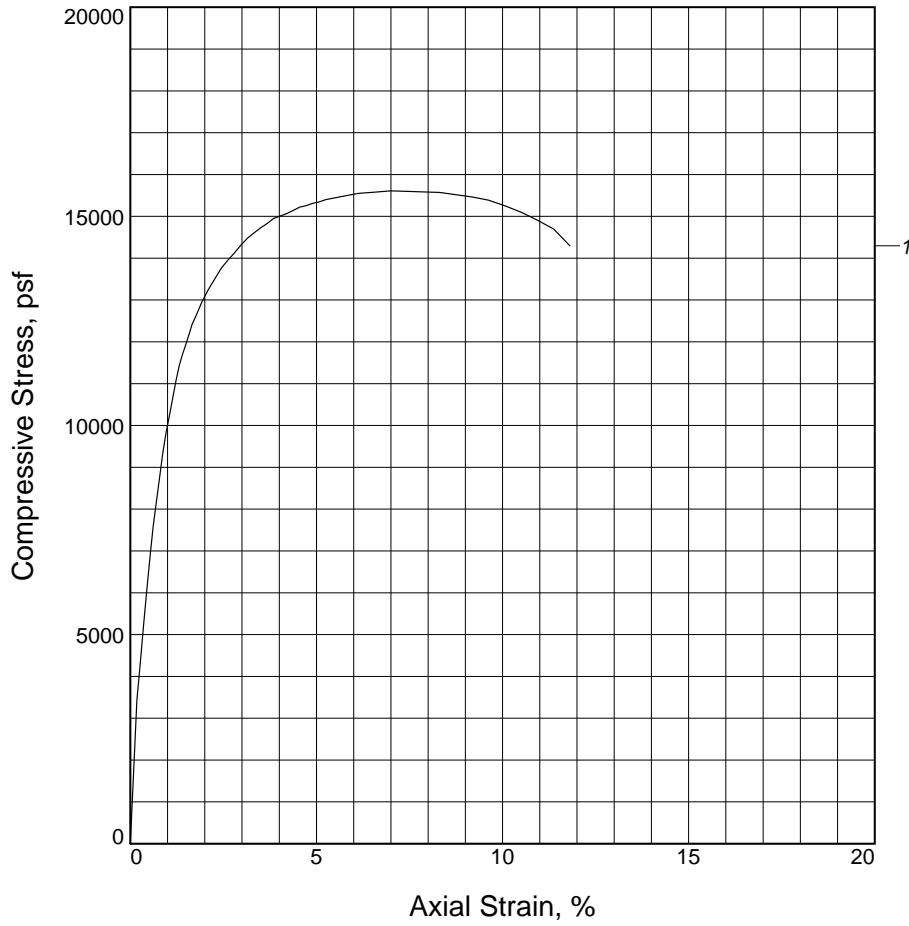
Date: 9/19/2025

Project: Powwow Grounds Masterplan

Project No.: 2530-0249

Boring No.	Sample No.	Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Atterberg Limits (% Moisture)			Sieve Analysis (% Passing)					Soil Classification		UCT		
					LL	PL	PI	#4	#10	#40	#100	#200	USCS	AASHTO	Stress (psf)	Strain (%)	
P-19	A	0.0-1.5	12.1														
	B	1.5-3.0	10.2		45	25	20	96	85	54	42	37.9	SC	A-7-6(3)			
	C	3.0-5.0	10.9														
	D	5.0-6.5	23.5														
P-20	A	0.3-1.5	10.4														
	B	1.5-3.0	14.0														
	C	3.0-5.0	9.8		48	19	29	100	97	79	63	61.4	CL	A-7-6(15)			
	D	5.0-6.5	10.9														
P-21	A	0.3-1.5	8.2														
	B	1.5-3.0	11.7														
	C	3.0-5.0	11.2		56	21	35	100	99	82	73	66.9	CH	A-7-6(22)			
	D	5.0-6.5	8.4														
P-22	A	0.3-1.5	6.4														
	B	1.5-3.0	9.5														
	C	3.0-5.0	7.5														
	D	5.0-6.5	9.1		40	19	21	96	84	58	46	40.9	SC	A-6(4)			
P-23	A	0.3-1.5	7.2														
	B	1.5-3.0	11.3		44	21	23	96	86	45	32	28.7	SC	A-2-7(2)			
	C	3.0-5.0	7.8														
	D	5.0-6.5	10.4														
P-23	A	0.3-1.5	6.4														
	B	1.5-3.0	8.2														
	C	3.0-5.0	9.1														
	D	5.0-5.8	11.1		41	18	23	94	84	55	33	23.8	SC	A-2-7(1)			

UNCONFINED COMPRESSION TEST



Stage	1		
Unconfined strength, psf	15609		
Undrained shear strength, psf	7804		
Failure strain, %	7.0		
Strain rate, in./min.	0.052		
Water content, %	14.9		
Wet density, pcf	127.3		
Dry density, pcf	110.7		
Saturation, %	83.3		
Void ratio	0.4656		
Specimen diameter, in.	2.88		
Specimen height, in.	5.72		
Height/diameter ratio	1.98		

Description:

LL =	PL =	PI =	Assumed GS= 2.6	Type:
------	------	------	-----------------	-------

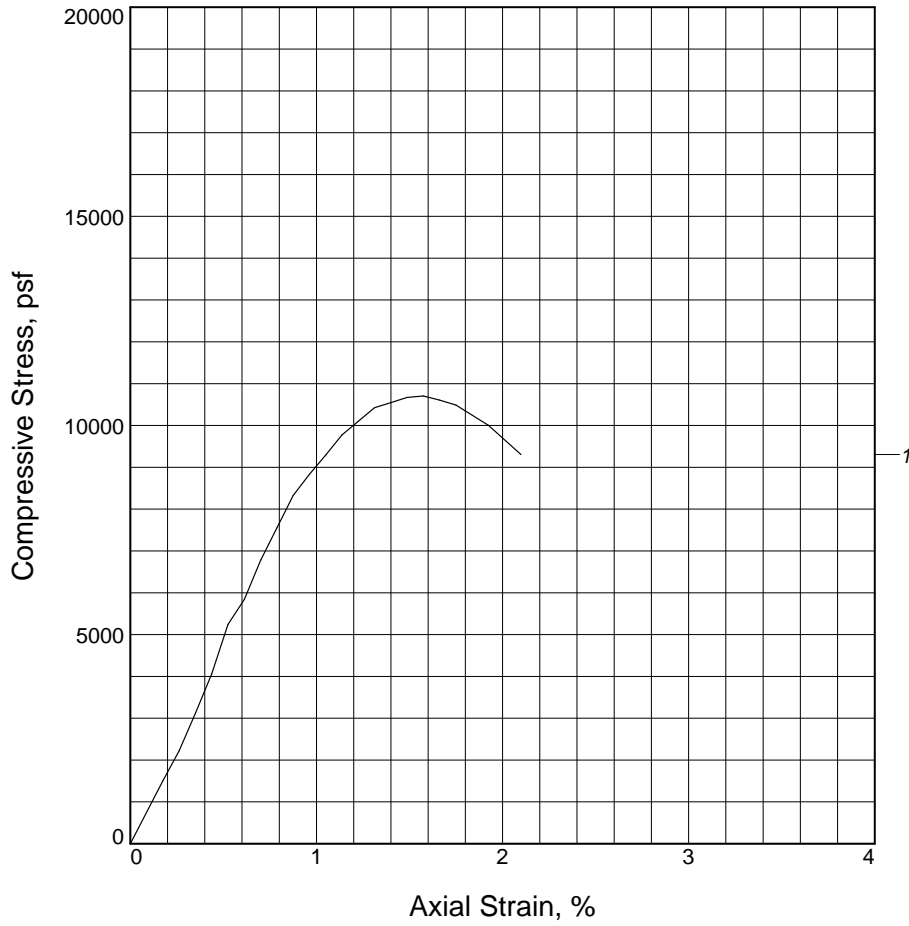
Project No.: 2530-0249
Date Sampled:
Remarks:

Client: Comanche Nation
Project: Powwow Grounds Masterplan
Source of Sample: B-5 **Depth:** 3
Sample Number: C

Figure _____



UNCONFINED COMPRESSION TEST



Stage	1		
Unconfined strength, psf	10706		
Undrained shear strength, psf	5353		
Failure strain, %	1.6		
Strain rate, in./min.	0.052		
Water content, %	17.3		
Wet density, pcf	119.7		
Dry density, pcf	102.1		
Saturation, %	76.1		
Void ratio	0.5905		
Specimen diameter, in.	2.85		
Specimen height, in.	5.72		
Height/diameter ratio	2.00		

Description:

LL =	PL =	PI =	Assumed GS= 2.6	Type:
------	------	------	-----------------	-------

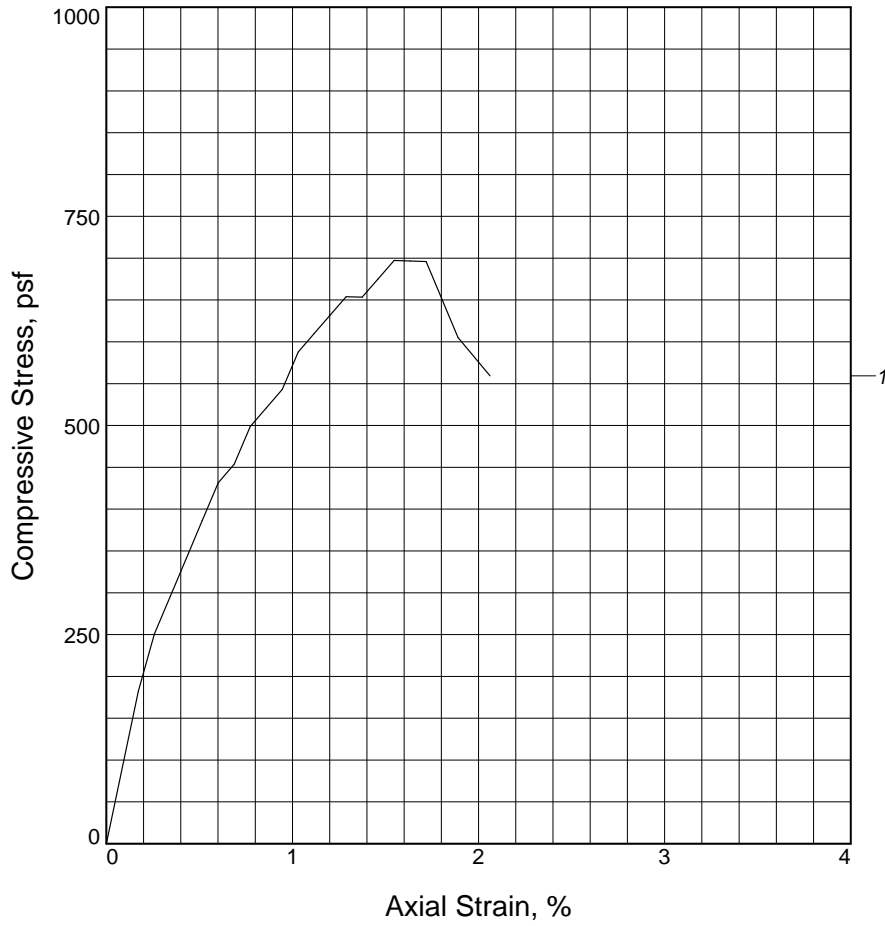
Project No.: 2530-0249
Date Sampled:
Remarks:

Client: Comanche Nation
Project: Powwow Grounds Masterplan
Source of Sample: B-6 **Depth:** 3
Sample Number: C

Figure _____



UNCONFINED COMPRESSION TEST



Stage	1			
Unconfined strength, psf	697			
Undrained shear strength, psf	349			
Failure strain, %	1.5			
Strain rate, in./min.	0.052			
Water content, %	11.9			
Wet density, pcf	108.1			
Dry density, pcf	96.6			
Saturation, %	45.6			
Void ratio	0.6802			
Specimen diameter, in.	2.83			
Specimen height, in.	5.82			
Height/diameter ratio	2.05			

Description: Sl. Moist, Moderate Plasticity

LL = 41 **PL = 18** **PI = 23** **Assumed GS= 2.6** **Type:**

Project No.: 2530-0249

Date Sampled:

Remarks:

Client: Comanche Nation

Project: Powwow Grounds Masterplan

Source of Sample: S-4 **Depth:** 3

Sample Number: C

Figure _____



Report On: Determining Soluble Sulfate Content in Soil (OHD-L49)

Project Name: Powwow Grounds

Boring No.: B-1 to B-5

File ID: _____

Sample No.: Comp. 1

Material: _____

Depth (ft): 3.0-5.0

Test Method: OHD L-49

Material Represented: _____

Mass of Air-Dried Sample Passing #10 Sieve (W_s): 5.08 g

Mass of Deionized Water Used in Slurry (W_w): 200.19 g

Average Colorimeter Reading (R): 1.33 ppm

Volume of Original Filtrate Used (V_f): N/A ml

Volume of Deionized Water Added to Filtrate (V_w): N/A ml

Colorimeter Reading on Diluted Filtrate (R_d): N/A ppm

$$C = [R * (W_w / W_s)] \text{ or } [R_d * (W_w / W_s) * (V_f + V_w) / V_f]$$

Sulfate Concentration in Air-Dry Soil, (C): 52 ppm

Report On: Determining Soluble Sulfate Content in Soil (OHD-L49)

Project Name: Powwow Grounds

Boring No.: B-6 to B-10

File ID: _____

Sample No.: Comp. 2

Material: _____

Depth (ft): 3.0-5.0

Test Method: OHD L-49

Material Represented: _____

Mass of Air-Dried Sample Passing #10 Sieve (W_s): 5.07 g

Mass of Deionized Water Used in Slurry (W_w): 200.23 g

Average Colorimeter Reading (R): 30.33 ppm

Volume of Original Filtrate Used (V_f): N/A ml

Volume of Deionized Water Added to Filtrate (V_w): N/A ml

Colorimeter Reading on Diluted Filtrate (R_d): N/A ppm

$$C = [R * (W_w / W_s)] \text{ or } [R_d * (W_w / W_s) * (V_f + V_w) / V_f]$$

Sulfate Concentration in Air-Dry Soil, (C): 1198 ppm

Report On: Determining Soluble Sulfate Content in Soil (OHD-L49)

Project Name: Powwow Grounds

Boring No.: S-1 to S-4

File ID: _____

Sample No.: Comp. 3

Material: _____

Depth (ft): 3.0-5.0

Test Method: OHD L-49

Material Represented: _____

Mass of Air-Dried Sample Passing #10 Sieve (W_s): 5.36 g

Mass of Deionized Water Used in Slurry (W_w): 200.46 g

Average Colorimeter Reading (R): 1.33 ppm

Volume of Original Filtrate Used (V_f): N/A ml

Volume of Deionized Water Added to Filtrate (V_w): N/A ml

Colorimeter Reading on Diluted Filtrate (R_d): N/A ppm

$$C = [R * (W_w / W_s)] \text{ or } [R_d * (W_w / W_s) * (V_f + V_w) / V_f]$$

Sulfate Concentration in Air-Dry Soil, (C): 50 ppm

Report On: Determining Soluble Sulfate Content in Soil (OHD-L49)

Project Name: Powwow Grounds

Boring No.: E-2 to E-4

File ID: _____

Sample No.: Comp. 4

Material: _____

Depth (ft): 3.0-5.0

Test Method: OHD L-49

Material Represented: _____

Mass of Air-Dried Sample Passing #10 Sieve (W_s): 5.46 g

Mass of Deionized Water Used in Slurry (W_w): 200.44 g

Average Colorimeter Reading (R): 1 ppm

Volume of Original Filtrate Used (V_f): N/A ml

Volume of Deionized Water Added to Filtrate (V_w): N/A ml

Colorimeter Reading on Diluted Filtrate (R_d): N/A ppm

$$C = [R * (W_w / W_s)] \text{ or } [R_d * (W_w / W_s) * (V_f + V_w) / V_f]$$

Sulfate Concentration in Air-Dry Soil, (C): 37 ppm

Report On: Determining Soluble Sulfate Content in Soil (OHD-L49)

Project Name: Powwow Grounds

Boring No.: E-1

File ID: _____

Sample No.: Comp. 5

Material: _____

Depth (ft): 3.0-5.0

Test Method: OHD L-49

Material Represented: _____

Mass of Air-Dried Sample Passing #10 Sieve (W_s): 5.17 g

Mass of Deionized Water Used in Slurry (W_w): 200.21 g

Average Colorimeter Reading (R): 3 ppm

Volume of Original Filtrate Used (V_f): N/A ml

Volume of Deionized Water Added to Filtrate (V_w): N/A ml

Colorimeter Reading on Diluted Filtrate (R_d): N/A ppm

$$C = [R * (W_w / W_s)] \text{ or } [R_d * (W_w / W_s) * (V_f + V_w) / V_f]$$

Sulfate Concentration in Air-Dry Soil, (C): 116 ppm