Report of Subsurface Exploration
and Geotechnical Evaluation
West 530 Roadway Improvements
Pryor, Oklahoma

Building & Earth Project No.: TU220100

Prepared For:
Childers Architect

July 1, 2022

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

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Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Avenue
Tulsa, OK 74112
Ph: (918) 439-9005
www.BuildingAndEarth.com

July 1, 2022

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

Attention: Mr. J. Breck Childers, AIA

Subject: Report of Subsurface Exploration and Geotechnical Evaluation
West 530 Roadway Improvements
Pryor, Oklahoma
Building & Earth Project No: TU220100

Dear Mr. Childers:

Building & Earth Sciences, Inc. has completed the authorized subsurface exploration and geotechnical engineering evaluation for the above referenced project in Pryor, Oklahoma.

The purpose of this exploration and evaluation was to determine general subsurface conditions at the site and to address applicable geotechnical aspects of the proposed pavement construction. The recommendations in this report are based on a physical reconnaissance of the site and observation and classification of samples obtained from eight (8) test borings and five (5) hand auger borings. Confirmation of the anticipated subsurface conditions during construction is an essential part of geotechnical services.

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

Respectfully Submitted,
BUILDING & EARTH SCIENCES, INC.
Certificate of Authorization #3975, Expires 6/30/2024

M. Dharmateja

MARCO V.
VICENTE SILVESTRE
PE21903
7/1/2022

Dharmateja Maganti, E.I.T.
Project Manager

Marco V. Vicente Silvestre, P.G., P.E.
Regional Vice President - Principal
OK 21903

Cc: Mr. Danny Baldwin, P.E., LEED GA – Principal; Wallace Design Collective

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1.0 PROJECT & SITE DESCRIPTION

We understand the project site is located at the South 432 Road and West 530 Road intersection going 0.5 miles west along West 530 Road in Pryor, Oklahoma. The aerial image with boring locations is shown in the following figure. Photographs depicting the current site conditions are presented on the following pages.

Figure 1: Google Earth dated July 2015

Based on information provided to our office, we understand that a new three lane roadway comprised of either asphalt or concrete is planned to replace the existing roadway with concrete curb and gutter. The planned roadway improvements are understood to be part of future residential and commercial developments.

The following documents were provided to our office to aid with preparing this report.

- Typical Roadway Sections for E530 Roadway, prepared by Cyntergy, dated 1/24/2020

At the time of our site reconnaissance, the ground surface was covered with asphaltic concrete pavement to the east of boring P-05. The west section of the existing roadway, west of boring P-04, was covered with graded crushed aggregate. The areas to the north and south of the existing roadway was covered with grass and topsoil. Overhead utilities were noted to the north and south of the existing roadway.

To the east of boring P-06, an existing creek crossing was noted at the time of our subsurface exploration. Historic aerial images indicated that multiple streams were noted to the north and east of existing roadway. Figure 2 below shows the Google Earth aerial image dated 1995.

Figure 2: Google Earth dated February 1995

Historical aerial images also indicated that a pond once existed in area of boring P-03, between 1968 and 1980. The pond appears to have been backfilled sometime prior to 1980. Soft soils encountered in boring P-03 at a depth of about 8.5 feet are likely associated with the referenced pond.

Figure 3: East end of the existing roadway, facing west

Figure 4: West section of the existing roadway, facing east

Figure 5: Area of boring SB-04, facing east

2.0 SCOPE OF SERVICES

The authorized subsurface exploration was performed on May 6, 2022, in conformance with our proposal TU24140, dated April 25, 2022. Notice to proceed was provided by signing and returning the proposal on April 28, 2022.

The purpose of the geotechnical exploration was to determine general subsurface conditions and to gather data on which to base a geotechnical evaluation with respect to the proposed pavement reconstruction. The information gathered from the exploration was evaluated to determine if any special pavement subgrade preparation procedures will be required during the earthwork phase of the project.

The borings were drilled with an ATV-mounted Diedrich D-50 drill rig equipped with solid flight augers and an automatic hammer.

Following completion of the subsurface exploration, representatives of Building & Earth visited the project site again on June 15, 2022, to perform five (5) additional hand auger borings within the grass shoulders to the north and south of the existing roadway. Dynamic Cone Penetration (DCP) testing was performed in the hand auger borings to estimate the in-place soil consistency.

The boring locations were determined in the field by a representative of our staff using handheld GPS equipment. As such, the boring locations shown on the Boring Location Plan attached to this report should be considered approximate.

The samples recovered during our site investigation were visually classified and specific samples were selected by the project engineer for laboratory analysis. The laboratory analysis consisted of:

Test	ASTM	No. of Tests
Natural Moisture Content	D2216	29
Atterberg Limits	D4318	5
Material Finer Than No. 200 Sieve by Washing	D1140	2

Table 1: Scope of Laboratory Tests

The results of the laboratory analysis are presented on the enclosed Boring Logs and in tabular form in the Appendix of this report. Descriptions of the laboratory tests that were performed are also included in the Appendix.

The information gathered from the exploration was evaluated to determine if any special subgrade preparation procedures will be required during the earthwork phase of the project and to establish minimum pavement sections for planned roadway reconstruction.

The results of the work are presented within this report that addresses:

- Summary of existing surface conditions.
- A description of the subsurface conditions encountered at the boring locations.
- A description of the groundwater conditions observed in the boreholes during drilling. Long-term monitoring was not included in our scope of work.
- Presentation of laboratory test results.
- Site preparation considerations including material types to be expected at the site, treatment of any encountered unsuitable soils, excavation considerations, and surface drainage.
- Recommended typical minimum flexible and rigid pavement sections based on assumed traffic loading conditions.

3.0 GEOTECHNICAL SITE CHARACTERIZATION

The following discussion is intended to create a general understanding of the site from a geotechnical engineering perspective. It is not intended to be a discussion covering all the potential geotechnical issues that may arise, nor to provide every possible interpretation of the conditions identified. The following conditions and subsequent recommendations assume that significant changes in subsurface conditions do not occur between boreholes. However, anomalous conditions can occur due to variations in existing fill or the geologic conditions at the site, and it will be necessary to evaluate the assumed conditions during site grading and pavement construction.

3.1 EXISTING SURFACE CONDITIONS

At the time of the subsurface exploration, the existing roadway was covered with asphaltic concrete pavement and graded crushed aggregate. The shoulders to the north and south of the existing roadway were covered with grass and topsoil.

The following table summarizes the topsoil, pavement, and aggregate base thicknesses at each boring location. The thicknesses of pavement were estimated by measuring sections exposed in the sidewalls of the boreholes. Pavement coring would be needed to obtain more accurate estimates of in-place asphaltic concrete thicknesses.

Boring/Core No.	Asphalt Thickness	Aggregate Base Thickness	Topsoil Thickness
P-01	6.75″	3″	N/A
P-02	5″	4″	N/A
P-03	7″	2″	N/A
P-04	7.5″	2″	N/A
P-05	Not encountered	2″	N/A
P-06	Not encountered	2.5″	N/A
P-07	Not encountered	4″	N/A
P-08	Not encountered	1.5″	N/A
SB-01	N/A	N/A	3″
SB-02	N/A	N/A	2.5″
SB-03	N/A	N/A	4″
SB-04	N/A	N/A	4.5″
SB-05	N/A	N/A	4.5″

Table 2: Summary of Approximate Topsoil, Asphalt Pavement and Aggregate Base Thicknesses

3.2 SUBSURFACE CONDITIONS

A generalized stratification summary has been prepared using data from the test borings and is presented in the table below. The stratification depicts the general soil and rock conditions and stratum types encountered during our field investigation.

Stratum No.	Typical Thickness	Description	Consistency/Rock Hardness	Lab Testing Data (5)
1 (1)	0.7 to 3.7′	**Existing Fill Materials:** Lean Clays and some Silty Sands (2) with sandstone fragments and cobbles Various shades and combinations of gray, brown, red, and yellow	Typically, stiff to very stiff In borings P-01, SB-01, and SB-02, silty sands exhibited a medium dense relative density	**Silty Sands:** Non Plastic *%Passing #200 Sieve: 21* *Moisture content: 13%* **Clay Soils:** *Atterberg Limits:* *LL = 24 to 29* *PI = 9 to 13* *%Passing #200 Sieve: 56* *Moisture content Range: 13 to 20%*

Stratum No.	Typical Thickness	Description	Consistency/Rock Hardness	Lab Testing Data (5)
2 (3)	5.5 to 9’	**Residuum:** Lean Clays (CL) and Lean to Fat Clays (CL-CH) with sandstone fragments, and ferrous staining Various shades and combinations of brown, red, gray, and yellow	Typically, stiff to very stiff Medium stiff clays were encountered in borings SB-04 and SB-05 below depths of about 1 to 1.5 feet In boring P-03, very soft clays were encountered at a depth of about 8.5 feet	*Atterberg Limits:* *LL = 46, PI = 27* *Moisture Contents:* *15 to 31%* *A moisture content of 44% was recorded in P-03 at 8.5 feet*
3 (4)	Termination Layer	**Atoka Formation:** Highly weathered sandstone with interbedded clay and Sandstone Various shades and combinations of brown, red, and yellow	Poorly cemented highly weathered sandstone and cemented sandstone (auger refusal material)	*Moisture Content: 6 to 18%* *A moisture content of 23% was recorded for interbedded clay layers in P-02 at about 6 feet*

Table 3: Stratification Summary

Notes:

(1) Encountered in borings P-01 through P-06 only. Hand Auger refusal was encountered in borings SB-01 and SB-02 on what appeared to be sandstone cobbles at a depth of about 1.5 feet.

(2) Thin (~1 foot) layer of silty sand noted below the pavement section in boring P-01.

(3) Encountered in borings P-03 and P-05 through P-08 only.

(4) All borings were terminated within the Atoka Formation at depths of about 8.1 to 13.7 feet below current grades. Auger refusal was encountered in borings P-06 and P-08 on sandstone at a depth of about 8 feet.

(5) For Atterberg Limits: LL = Liquid Limit, and PI = Plasticity Index

A subsurface profile has been prepared based on the data obtained at the specific boring locations. The subsurface profile is presented in the Appendix. For specific details on the information obtained from individual test borings, refer to the Boring Logs included in the Appendix.

Building and Earth did not determine the approximate ground surface elevations at each boring location. Ground surface elevations shown on the boring logs and used for the development of the subsurface profile were estimated from Google Earth elevation data. Actual ground surface elevations will vary from those presented in this report.

3.2.1 AUGER REFUSAL

Auger refusal is the drilling depth at which the borehole can no longer be advanced using soil drilling procedures. Auger refusal can occur on boulders, buried debris or bedrock. Coring is required to sample the material below auger refusal, which was beyond the scope of work presented in this report. Auger refusal occurred on sandstone in borings P-06 and P-08 at a depth of approximately 8 feet below current grades.

Hand Auger refusal was encountered in supplemental borings SB-01 and SB-02 on what appeared to be sandstone cobbles at a depth of about 1.5 feet.

3.2.2 GROUNDWATER

The following table presents a summary of the groundwater conditions encountered during drilling and at the time of backfilling.

Boring No.	Groundwater Depth During Drilling, ft	Groundwater Depth at Time of Backfilling, ft
P-01	Not Encountered	7.2
P-02	6.0	2.8
P-03	8.5	3.0
P-04	Not Encountered	8.0
P-05	6.0	2.2
P-06	Not Encountered	5.5
P-07	Not Encountered	5.2
P-08	Not Encountered	7.0
SB-01	Not Encountered	Not Encountered
SB-02	Not Encountered	Not Encountered
SB-03	Not Encountered	Not Encountered
SB-04	Not Encountered	Not Encountered
SB-05	Not Encountered	Not Encountered

Table 4: Summary of Groundwater Levels

Water levels reported are accurate only for the time and date that the borings were drilled. Long term monitoring of the boreholes was not included as part of our subsurface exploration. The borings were backfilled, and pavements patched the same day that they were drilled.

4.0 PAVEMENT SUBGRADE PREPARATION CONSIDERATIONS

A grading plan was not available at the time of this report. For the purposes of this report, we assume that new pavements will closely match the existing grades across the site, and thus we anticipate cuts and fills of less than 1 foot will be required to achieve design grades during construction.

The primary geotechnical considerations for this project are:

- Existing fill materials were encountered beneath the pavements in borings P-01 through P-06, SB-01, and SB-02.
- Hand Auger refusal was encountered in supplemental borings SB-01 and SB-02 on what appeared to be sandstone cobbles within the fill at a depth of about 1.5 feet.
- Moisture sensitive lean clays were encountered at surface and beneath the pavements. These soils are prone to losing strength and stability with slight increases in moisture content.
- Portions of the onsite clay soils exhibited medium stiff consistencies.
- Portions of the residual clays exhibited medium to high plasticity characteristics that have a moderate to high shrink-swell potential with moisture fluctuations.
- Highly weathered sandstone with interbedded clays was encountered in borings P-01, P-02, and P-04 at depths ranging between 1.5 to 2 feet below top of existing pavement.
- Relatively harder sandstone associated with the Atoka Formation was encountered in all borings below the residual clays and weathered zone. SPT refusal was encountered within the sandstone, which is indicative of potential excavation difficulties. Auger refusal occurred on sandstone at a depth of approximately 8 feet below top of pavement in borings P-06 and P-08.
- At the time of drilling, groundwater was encountered in borings P-02, P-03, and P-05 at depths of about 6 to 8.5 feet below top of pavement, respectively. Prior to backfilling the boreholes, free water was measured in all borings at depths of about 2.2 to 7.2 feet.

Recommendations addressing the site conditions are presented in the following sections.

4.1 INITIAL SITE PREPARATION

The initial site preparation should commence with demolition of existing pavements. All pavement materials should be removed from the proposed construction area prior to any fill placement or new construction. Soils disturbed during the process should be undercut to undisturbed material and replaced with structural fill.

All vegetation, roots, topsoil, and any other deleterious materials, should be removed from the proposed widening areas. Approximately 2.5 to 4.5 inches of topsoil was observed in the supplemental borings SB-01 through SB-05; however, the topsoil could extend to greater depths in unexplored areas of the site. For this report, topsoil is defined as the horizon which contains most of the root mat of the noted vegetation.

Materials disturbed during clearing operations should be stabilized in place or, if necessary, undercut to undisturbed materials and backfilled with properly compacted, approved structural fill.

During site preparation activities, the contractor should identify borrow source materials that will be used as structural fill and provide samples to the testing laboratory so that conformance to the *Structural Fill* requirements outlined below and appropriate moisture-density relationship curves can be determined.

4.2 MOISTURE SENSITIVE SOILS

Moisture sensitive soils were encountered across the site. These soils will degrade if allowed to become saturated. Therefore, not allowing water to pond by maintaining positive drainage and temporary dewatering methods (if required) is important to help avoid degradation and softening of the soils.

The contractor should anticipate some difficulty during the earthwork phase of this project if moisture levels are moderate to high during construction. Increased moisture levels will soften the subgrade and the soils may become unstable under the influence of construction traffic. Accordingly, construction during wet weather conditions should be avoided, as this could result in soft and unstable soil conditions that would require ground modification, such as in place stabilization or undercutting.

4.3 PAVEMENT SUBGRADE PREPARATION

Following initial site preparation, we anticipate existing fill materials and/or residual clays to be exposed across the planned pavement construction areas. The subgrade materials exposed across the planned pavement areas should be prepared in accordance with following sections:

4.3.1 EVALUATION OF EXISTING FILL MATERIALS

Existing fill materials were encountered in borings P-01 through P-06 below aggregate base and they extended to depths of at about 1.5 to 4.5 feet below top of existing pavement. The fill material mainly consisted of lean clays with some silty sands. In addition, (possible) fill materials comprised of silty sand with sandstone cobbles were encountered in shoulder borings SB-01 and SB-02.

Although not encountered in the borings, there is a risk the existing fill may contain soft zones, large amounts of debris, or unsuitable soils.

As a minimum, we recommend existing fill be thoroughly evaluated by the geotechnical engineer or their designated representative. The exposed fill can be evaluated by means of proofrolling with a loaded tandem-axle dump truck (20- to 25-ton). Areas with unsuitable or soft/loose soils identified during the evaluation shall be removed and replaced in accordance with the *Structural Fill* section of this report.

4.3.2 MODERATE TO HIGH PLASTICITY CLAYS

Following initial site preparation, moderate to high plasticity lean to fat clays are anticipated to be exposed at finished subgrade within the west portion of the existing roadway alignment (boring P-08) and within the grass shoulders (borings SB-04 and SB-05). These clays exhibited higher plasticity characteristics which are prone to swelling when subjected to soil moisture increases. Swelling clay soils typically cause uneven pavement surface conditions and formation of cracks that open further with continuing swelling of the clay soils when precipitation and run off seep into the open cracks into the fat clay subgrade.

Although the risk of swelling clays cannot be eliminated, the risk can be reduced by considering one of the following. The options are presented in order of reduced risk of swelling of the clay soils.

- **Option 1:** Scarify the exposed clay soils to depth of 12 inches, moisture condition the clay soils to within range of 0 to 3 percent above the optimum moisture content, and recompact the subgrade to at least 95 percent of the material's standard Proctor maximum dry density (ASTM D698); or
- **Option 2:** Provide at least 8 inches of approved lower plasticity structural fill below all pavement materials.

4.3.3 FULL-DEPTH REMOVAL OF LOW CONSISTENCY SOILS

Portions of onsite soils encountered in the borings, especially within the existing grass shoulder areas, exhibited medium stiff consistencies. Following initial site preparation and prior to any fill placement, we recommend that low consistency and unstable soils be undercut full depth to expose a stable, suitable subgrade and they should be replaced with properly compacted and approved structural fill.

The placement procedure, compaction, and composition of the structural fill must meet the requirements of the *Structural Fill* section of this report. The undercutting should be conducted under the observation of the geotechnical engineer or their designated representative. Once the undercut is complete, the areas planned for construction should be proofrolled to identify any additional soft soils requiring further removal.

4.4 SUBGRADE PREPARATION

Following evaluation of fill materials, undercutting, and prior to fill placement, the exposed subgrade within the proposed pavement areas should be scarified, moisture conditioned, and recompacted to a minimum depth of 12 inches. The subgrade soils should be moisture conditioned within a range of 2 percent below to 2 percent above the material's optimum moisture content, and the subgrade soils recompacted to at least 95 percent of the material's standard Proctor maximum dry density. Where higher plasticity lean to fat clay soils are exposed and Option 1 of Section 4.3.2 is selected for this project, the subgrade should be moisture conditioned to within range of 0 to 3 percent above the optimum moisture content.

We recommend the project geotechnical engineer, or their qualified representative evaluate the subgrade after the site is prepared. Some unsuitable or unstable areas may be present in unexplored areas of the site. All areas that will require fill or that will support structures should be carefully proofrolled with a fully loaded, tandem-axle dump truck (20- to 25-ton), at the following times.

- After an area has been stripped, and undercut as required, prior to the placement of any fill.
- After grading an area to the finished subgrade elevation in pavement areas.
- After areas have been exposed to any precipitation, and/or have been exposed for more than 48 hours.

Some instability may exist during construction, depending on climatic and other factors immediately preceding and during construction. If any soft or otherwise unsuitable soils are identified during the proofrolling process, they must be undercut or stabilized prior to fill placement or pavement construction. All unsuitable material identified during construction shall be removed and replaced in accordance with the *Structural Fill* section of this report.

4.5 STRUCTURAL FILL

Recommendations for structural fill on this project are as follows:

Soil Type	USCS Classification	Property Requirements	Placement Location
Imported Lean Clay, Clayey Sand, Shale	CL, SC	LL<40, PI<20, γ_d>100 pcf, P200>15%, Maximum 3" particle size in any dimension	**Low Plasticity Structural Fill** to be used for construction of pavements
Onsite Existing Fill and Residuum Lean Clays, Silty Sand with sandstone	CL, SM	As noted above	***Likely suitable*** for placement as low plasticity structural fill in pavements (see note 5)
Onsite Residuum Lean to Fat Clays	CL-CH	Not Applicable	***Not suitable*** for placement as structural fill due to higher plasticity characteristics

Table 5: Structural Fill Recommendations

Notes:

1. All structural fill should be free of vegetation, topsoil, and any other deleterious materials. The organic content of materials to be used for fill should be less than 3 percent.
2. LL indicates the soil Liquid Limit; PI indicates the soil Plasticity Index; P200 indicates the percent of material by weight that passes the #200 sieve; γ_d indicates the maximum dry density as defined by the density standard outlined in the table below.
3. Laboratory testing of the soils proposed for fill must be performed to verify their conformance with the above recommendations.
4. Any fill to be placed at the site should be reviewed by the geotechnical engineer.
5. The onsite fill materials appeared suitable for use as structural fill, provided they are free of debris, over-sized rock fragments (i.e., greater than 3 inches in any dimension), topsoil, organics, and any other deleterious materials.

Placement recommendations for structural fill are as follows:

Specification	Requirement
Lift Thickness	Maximum loose lift thickness of 8 to 12 inches, depending on type of compaction equipment used.
Density	At least 95% of the standard Proctor (ASTM D698) maximum dry density
Moisture	±2% of the optimum moisture content as determined by ASTM D698
Density Testing Frequency	**Pavement area**: One test per 5,000 SF per lift with a minimum of three tests performed per lift **Utility trenches**: One test per 150 linear feet per lift with a minimum of two tests performed per lift

Table 6: Structural Fill Placement Recommendations

4.6 EXCAVATION CONSIDERATIONS

All excavations performed at the site should follow OSHA guidelines for temporary excavations. Excavated soils should be stockpiled according to OSHA regulations to limit the potential cave-in of soils.

4.6.1 DIFFICULT EXCAVATION

Based on the information gathered during our subsurface exploration, we anticipate that the overburden soils can be excavated using a backhoe in good working condition.

Excavations within the proposed pavement areas will likely encounter highly weathered sandstone at depths of about 1.5 to 13.5 feet below existing grades. A large track hoe, in good working condition and equipped with rock teeth, may be able to excavate the weathered sandstone. It should be noted that cemented sandstone layers were noted within the weathered zone that may require the use of a hydraulic hoe ram attachment in confined excavations.

Relatively harder sandstone associated with the Atoka Formation was encountered in all borings below the residual clays and weathered zone. Auger refusal occurred on sandstone at a depth of approximately 8 feet below top of existing pavement in borings P-06 and P-08. The contractor will need to anticipate rock excavation techniques when excavations extend into the harder sandstone unit.

The ability to excavate rock is a function of the material, the equipment used, the skill of the operator, the desired rate of removal and other factors. The contractor should review the boring logs and should use his own method to evaluate excavation difficulty.

4.6.2 GROUNDWATER

At the time of drilling, groundwater was encountered in borings P-02, P-03, and P-05 at depths of about 6 to 8.5 feet below top of existing pavement, respectively. Prior to backfilling the boreholes, free water was measured in all borings at depths of about 2.2 to 7.2 feet.

It should be noted that fluctuations in the water level could occur due to seasonal variations in rainfall. The contractor must be prepared to remove groundwater seepage from excavations if encountered during construction. Excavations extending below groundwater levels will require dewatering systems. The contractor should evaluate the most economical and practical dewatering method based on the conditions encountered during construction.

4.7 UTILITY TRENCH BACKFILL

All utility trenches must be backfilled and compacted in the manner specified above for structural fill. It may be necessary to reduce the lift thickness to 4 to 6 inches to achieve compaction using hand-operated equipment.

4.8 DRAINAGE CONSIDERATION

The potential for soil moisture fluctuations within pavement subgrades should be reduced to lessen the potential of subgrade movement. Site grading should include positive drainage away from pavements. Ponding of water poses a risk of saturating soils below pavements, which could result in premature failure of pavements.

4.9 WET WEATHER CONSTRUCTION

Excessive movement of construction equipment across the site during wet weather may result in ruts, which will collect rainwater, prolonging the time required to dry the subgrade soils.

During rainy periods, additional effort will be required to properly prepare the site and establish/maintain an acceptable subgrade. The difficulty will increase in areas where clay or silty soils are exposed at the subgrade elevation. Grading contractors typically postpone grading operations during wet weather to wait for conditions that are more favorable. Contractors can typically disk or aerate the upper soils to promote drying during intermittent periods of favorable weather. When deadlines restrict postponement of grading operations, additional measures such as undercutting and replacing saturated soils or stabilization can be utilized to facilitate placement of additional fill material.

5.0 PAVEMENT CONSIDERATIONS

Specific traffic information was not provided for reconstruction of West 530 Roadway. We assumed the roadway will be subjected to passenger cars, heavy delivery trucks, and trash collection truck traffic, etc., with design ESAL capacity of 825,000. Alternate pavement sections can be considered once actual traffic information is provided to our office.

In addition, we have assumed the following design parameters:

Design Criteria	Value
Design life (Years)	20
Terminal Serviceability	2.0
Reliability	85%
Initial Serviceability	4.2 (Flexible) 4.5 (Rigid)
Standard Deviation	0.45 (Flexible) 0.35 (Rigid)

Table 7: Assumed Design Parameters

All subgrade, base and pavement construction operations should meet minimum requirements of the Oklahoma Department of Transportation (ODOT), Standard Specifications for Highway Construction, dated 2019. The applicable sections of the specifications are identified as follows:

Material	Specification Section
Portland Cement Concrete Pavement	414 & 701
Bituminous Asphalt Wearing Layer	411 & 708
Bituminous Asphalt Binder Layer	411 & 708
Mineral Aggregate Base Materials	303 & 703

Table 8: ODOT Specification Sections

5.1 FLEXIBLE PAVEMENT

The asphalt pavement sections described herein were designed using the “AASHTO Guide for Design of Pavement Structures, 1993”. Alternative pavement sections were designed by establishing the structural numbers used for the AASHTO design system and substituting materials based upon structural equivalency as follows:

Material	Structural No.
Asphalt Concrete	0.44
Crushed Stone Base	0.14

Table 9: Structural Equivalent Coefficient

Based on the materials encountered at the boring locations and after our recommendations for site preparation are implemented, flexible pavements at the subject site may be designed based on an estimated California Bearing Ratio (CBR) of 3.

The following flexible pavement sections are based on the design parameters presented above:

Minimum Recommended Thickness (in)	Material
2.0	HMAC Surface Course (Superpave "S4")
4.0	HMAC Binder Course (Superpave "S3")
8.0	Crushed Aggregate Base (ODOT Type "A")

Table 10: Flexible Pavement Section Alternate

5.2 RIGID PAVEMENT

The following rigid pavement sections are based on the design parameters presented above. We assume a modulus of subgrade reaction (k) of 100 pci. We have assumed concrete elastic modulus (E_c) of 3.1 X 10^6 psi, and a concrete modulus of rupture (S'_c) of 600 psi.

Minimum Recommended Thickness (in)	Material
7.0	Portland Cement Concrete, f'_c=3,500 psi
6.0	Crushed Aggregate Base (ODOT Type "A")

Table 12: Rigid Pavement Recommendations

The concrete should be protected against moisture loss, rapid temperature fluctuations, and construction traffic for several days after placement. All pavements should be sloped for positive drainage. We suggest that a curing compound be applied after the concrete has been finished.

Although not referenced in the ODOT specifications, based on our experience with project sites in this region and anticipated traffic loads, we recommend Portland cement concrete should have a minimum 28-day compressive strength of 3,500 psi, maximum slump of 4 inches, and air content of 5 to 7 percent.

For rigid pavements, we recommend a jointing plan be developed to control cracking and help preclude surficial migration of water into the base course and subgrade. Doweled construction joints are recommended to improve load transfer between the concrete panels. We recommend joints be sealed to further preclude surficial moisture migration into the underlying supporting soils.

All pavements should be sloped, approximately ¼ inch per foot, to provide rapid surface drainage. Water allowed to pond on or adjacent to the pavement could saturate the subgrade and cause premature deterioration of the pavements because of loss of strength and stability. Periodic maintenance of the pavement should be anticipated. This should include sealing of cracks and joints and maintaining proper surface drainage to avoid ponding of water on or near the pavement areas.

6.0 SUBGRADE REHABILITATION

The subgrade soils often become disturbed during the period between initial site grading and construction of surface improvements. The amount and depth of disturbance will vary with soil type, weather conditions, construction traffic, and drainage.

The engineer should evaluate the subgrade soil during final grading to verify that the subgrade is suitable to receive pavement base materials. The final evaluation may include proofrolling or density tests.

Subgrade rehabilitation can become a point of controversy when different contractors are responsible for site grading and building construction. The construction documents should specifically state which contractor will be responsible for maintaining and rehabilitating the subgrade. Rehabilitation may include moisture conditioning and re-compacting soils. When deadlines or weather restrict grading operations, additional measures such as undercutting and replacing saturated soils or chemical stabilization can often be utilized.

7.0 CONSTRUCTION MONITORING

Field verification of site conditions is an essential part of the services provided by the geotechnical consultant. To confirm our recommendations, it will be necessary for Building & Earth personnel to make periodic visits to the site during site grading. Typical construction monitoring services are listed below.

- Periodic observations and consultations by a member of our engineering staff during site development
- Continuous monitoring during structural fill placement
- Field density tests during structural fill placement
- Continuous monitoring during pavement installation

8.0 CLOSING AND LIMITATIONS

This report was prepared for Childers Architect and Wallace Design Collective for specific application to the subject project in Pryor, Oklahoma. The information in this report is not transferable. This report should not be used for a different development on the same property without first being evaluated by the engineer.

The recommendations in this report were based on the information obtained from our field exploration and laboratory analysis. The data collected is representative of the locations tested. Variations are likely to occur at other locations throughout the site. Engineering judgment was applied regarding conditions between borings. It will be necessary to confirm the anticipated subsurface conditions during construction.

This report has been prepared in accordance with generally accepted standards of geotechnical engineering practice. No other warranty is expressed or implied. If changes are made, or anticipated to be made, to the nature, design, or location of the project as outlined in this report, Building & Earth must be informed of the changes and given the opportunity to either verify or modify the conclusions of this report in writing, or the recommendations of this report will no longer be valid.

The scope of services for this project did not include any environmental assessment of the site or identification of pollutants or hazardous materials or conditions. If the owner is concerned about environmental issues Building & Earth would be happy to provide an additional scope of services to address those concerns.

This report is intended for use during design and preparation of specifications and may not address all conditions at the site during construction. Contractors reviewing this information should acknowledge that this document is for design information only.

An article published by the Geoprofessional Business Association (GBA), titled *Important Information About Your Geotechnical Report*, has been included in the Appendix. We encourage all individuals to become familiar with the article to help manage risk.

Appendix Table of Contents

GEOTECHNICAL INVESTIGATION METHODOLOGIES

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

DRILLING PROCEDURES – STANDARD PENETRATION TEST (ASTM D1586)

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

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

The SPT testing was performed using a drill rig equipped with an automatic hammer. Automatic hammers mechanically control the height of the hammer drop, and doing so, deliver higher energy efficiency (90 to 99 % efficiency) than manual hammers (60 % efficiency) which are dropped using a manually operated rope and cathead system. Because historic data correlations were developed based on use of a manual hammer, it is necessary to adjust the N-values obtained using an automatic hammer to make these correlations valid. Therefore, an energy correction factor of 1.3 was applied to the recorded field N-values from the automatic hammer for the purpose of our evaluation. The N-values discussed or mentioned in this report and shown on the boring logs are recorded field values.

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

HAND AUGER BORINGS AND DYNAMIC CONE PENETRATION TESTING

Hand auger borings were drilled with a 3-inch diameter auger to advance the hole below the existing grade. A Building & Earth representative collected samples of the subsurface soils at regular depth intervals and at depths where a change in lithology occurred.

Dynamic Cone Penetration (DCP) testing was performed in the hand auger borings to evaluate the consistency of the subgrade soils. The DCP apparatus consists of a steel, cylindrical shaft with a conical tip at the end. The conical tip measures 1.5-inches in diameter, with a 45^{o} tip angle. A 15-pound sliding ring weight is mounted to the shaft. When dropped from a height of 20 inches, the ring weight strikes a steel anvil, driving the point into the soil. After seating the point into the soil 2 inches, the weight is dropped until the shaft travels an interval of 1.75 inches. The number of blows necessary to drive the tip each 1.75-inch increment is recorded. Given the material type and certain soil properties, this number can then be correlated to the Standard Penetration Test (ASTM D1586) N-values. The DCP test results are shown under the “Remarks” column on the boring logs.

BORING LOG DESCRIPTION

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

DEPTH AND ELEVATION

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

SAMPLE TYPE

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

SAMPLE NUMBER

Each sample collected is numbered sequentially.

BLOWS PER INCREMENT

When Standard Split Spoon sampling is used, the blows required to drive the sampler each 6-inch increment are recorded and shown in column 5.

SOIL DATA

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

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

SOIL DESCRIPTION

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

GRAPHIC

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

REMARKS

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

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

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

SOIL CLASSIFICATION METHODOLOGY

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

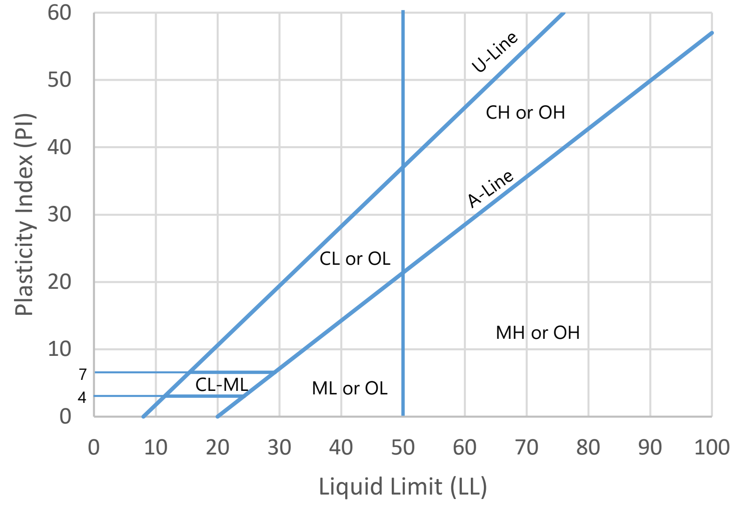


Figure 1: Plasticity Chart (based on ASTM D2487)

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

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

* - Modified based on 90% hammer efficiency

KEY TO LOGS

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

Table 1: Symbol Legend

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

Table 2: Standard Sieve Sizes

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

Table 3: Soil Data

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

Table 4: Soil Drilling Methods

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

Table 5: Descriptors

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

Table 6: Sampling Methods

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

Table 7: Plasticity

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

Table 8: Moisture Condition

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

Table 9: Structure

KEY TO HATCHES

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

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

BORING LOCATION PLAN

REFERENCE USED TO PRODUCE THIS DRAWING:

Google Earth Satellite Imagery Dated October 2015

BORING LOCATION PLAN

DATE: 6/15/2022

PROJECT NO.

TU220100

PROJECT NAME / LOCATION:

West 530 Roadway
Improvements
Pryor, OK

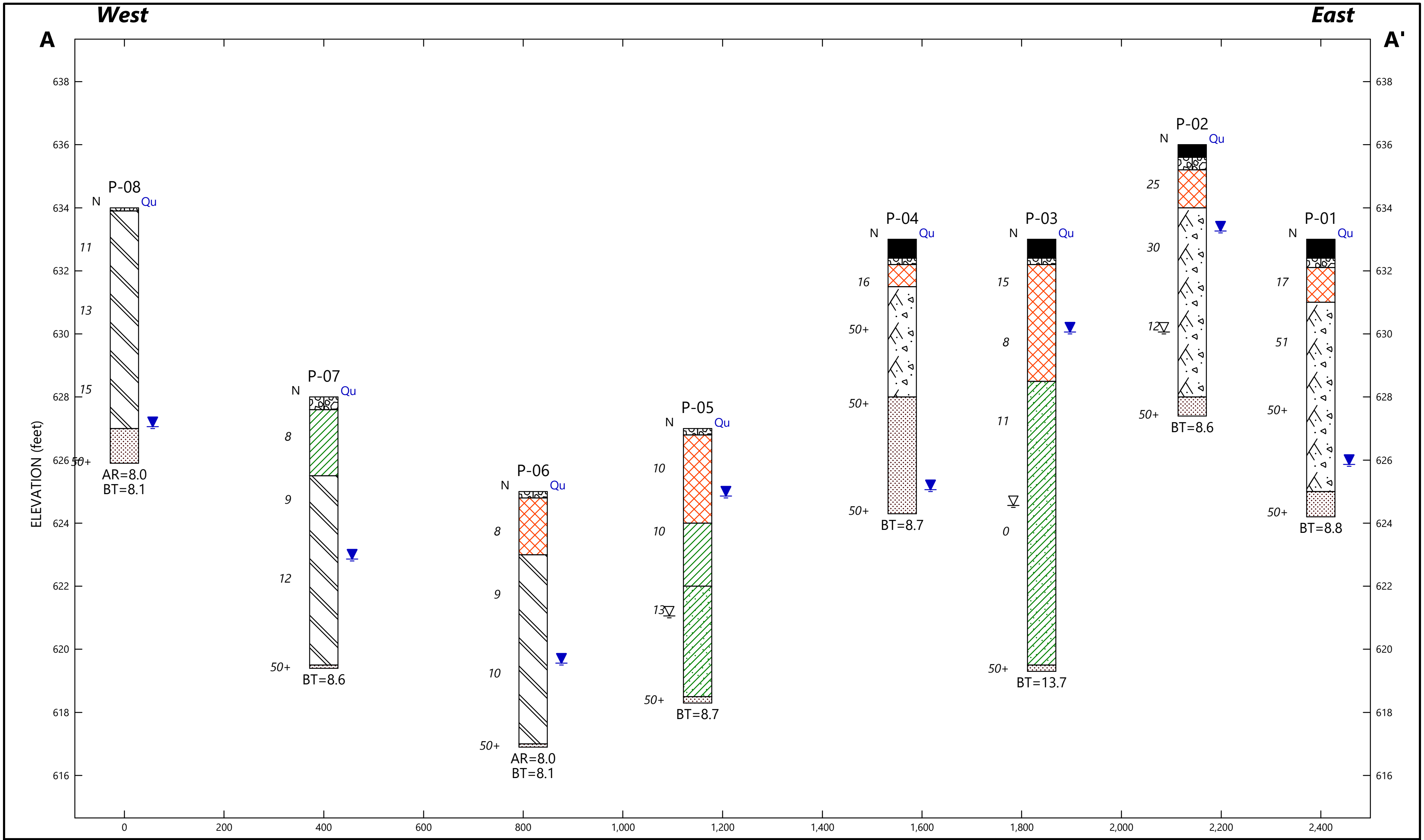
SCALE:

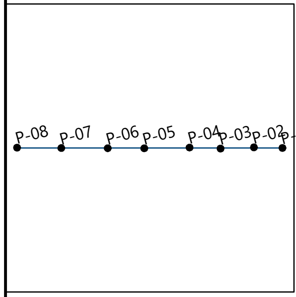
As Shown

BUILDING & EARTH

Geotechnical, Environmental, and Materials Engineers

SUBSURFACE PROFILE





Site Map Scale 1 inch equals 1,740 feet

Key to Hatches

■	Asphalt	▨	Aggregate Base Material	▨	Fill
▨	Weathered Rock	▨	Sandstone	▨	USCS Low Plasticity Sandy Clay
▨	USCS Low Plasticity Clay	▨	USCS Low to High Plasticity Clay		

Legend

BT=Boring Termination, TPT=Test Pit Terminated
AR=Auger Refusal, ER=Excavation Refusal
N=Standard Penetration Test N-Value
Qu=Unconfined compressive strength estimate from pocket penetrometer test (tsf)
▽ Water Level Reading at time of drilling.
▼ Water Level Reading after drilling.

0 284

Horizontal Scale (feet)
Vertical Exaggeration: 63.5x

Building & Earth Sciences, Inc.
1403 South 70th East Avenue, Tulsa, OK 74133

West 530 Roadway Improvements
Pryor OK

A-A': Subsurface Profile

PROJECT NO: TU220100	PLATE NO: A-1	DATE: 7/1/22

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Geotechnical, Environmental, and Materials Engineers

BORING LOGS

LOG OF BORING

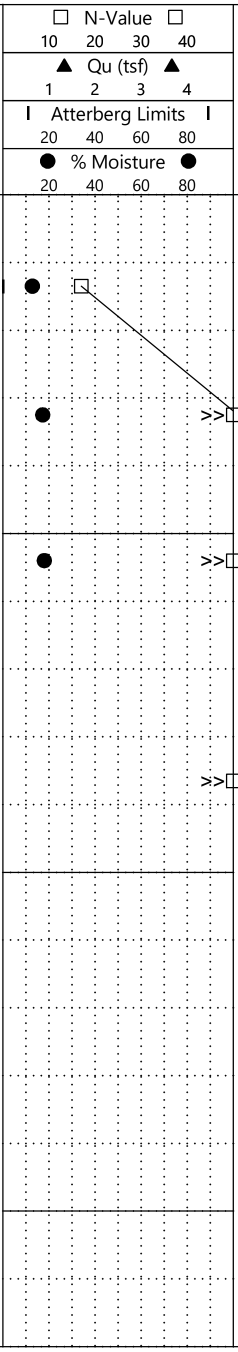
Designation: P-01

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME:	West 530 Roadway Improvements	LOCATION:	Pryor OK
PROJECT NUMBER:	TU220100	DATE DRILLED:	5/6/22
DRILLING METHOD:	Solid Flight Auger	WEATHER:	Cloudy
EQUIPMENT USED:	Diedrich D-50	ELEVATION:	
HAMMER TYPE:	Automatic	DRILL CREW:	Building & Earth
BORING LOCATION:	See Boring Location Plan	LOGGED BY:	Q. Mann

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA
		☒	1	16 9 8	Sample 1 LL: NP PL: NP PI: NP M: 12.8% F: 21%
		☒	2	8 18 33	Sample 2 M: 17.3%
5		☒	3	23 50/4"	Sample 3 M: 18.0%
		☒	4	50/2.5"	
10					
15					



	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.6	ASPHALT: 6.75"	■	
0.9	AGGREGATE BASE: 3"		
2.0	SILTY SAND (SM): medium dense, brown, reddish brown, moist, with sandstone fragments, (FILL)	▨	
8.0	HIGHLY WEATHERED SANDSTONE: poorly cemented, brown, brownish yellow, reddish brown, with ferrous staining and interbedded clay, (WEATHERED ROCK) ▼		Free water was measured at a depth of about 7.2 feet, prior to backfilling the borehole
8.8	SANDSTONE: cemented, yellowish brown, (ATOKA FORMATION)		
	Boring Terminated at 8.8 feet.		Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

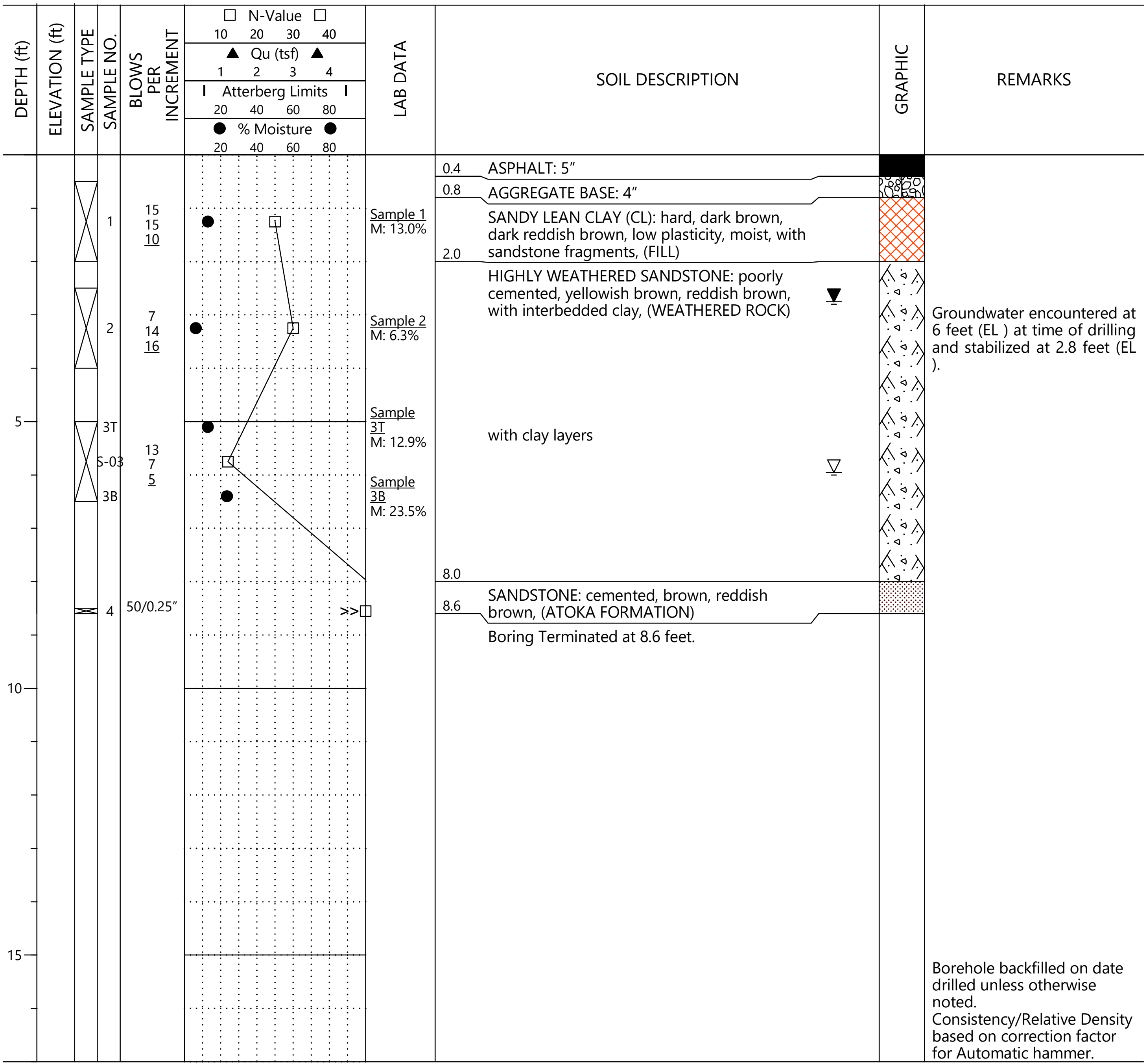
N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING
Designation: P-02
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan
LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.4				ASPHALT: 5"	
0.8				AGGREGATE BASE: 4"	
2.0	1	15 15 10	Sample 1 M: 13.0%	SANDY LEAN CLAY (CL): hard, dark brown, dark reddish brown, low plasticity, moist, with sandstone fragments, (FILL)	
	2	7 14 16	Sample 2 M: 6.3%	HIGHLY WEATHERED SANDSTONE: poorly cemented, yellowish brown, reddish brown, with interbedded clay, (WEATHERED ROCK)	Groundwater encountered at 6 feet (EL) at time of drilling and stabilized at 2.8 feet (EL).
8.0	3T S-03 3B	13 7 5	Sample 3T M: 12.9% Sample 3B M: 23.5%	with clay layers	
8.6	4	50/0.25"		SANDSTONE: cemented, brown, reddish brown, (ATOKA FORMATION)	
				Boring Terminated at 8.6 feet.	Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
∇ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

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Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

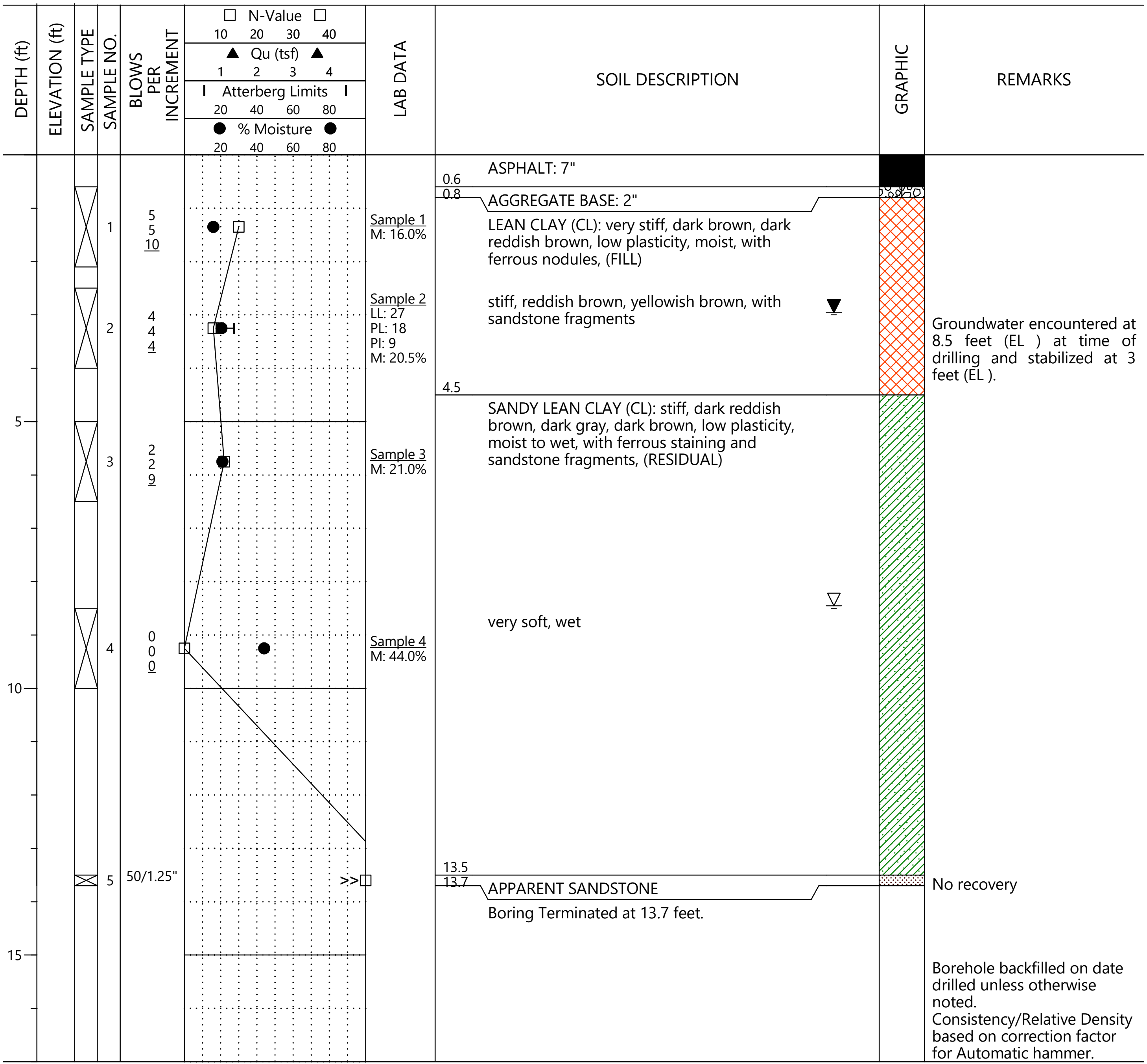
Designation: P-03

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



LAB DATA
Sample 1 M: 16.0%
Sample 2 LL: 27 PL: 18 PI: 9 M: 20.5%
Sample 3 M: 21.0%
Sample 4 M: 44.0%

SOIL DESCRIPTION

ASPHALT: 7"

0.6
0.8

AGGREGATE BASE: 2"

LEAN CLAY (CL): very stiff, dark brown, dark reddish brown, low plasticity, moist, with ferrous nodules, (FILL)

stiff, reddish brown, yellowish brown, with sandstone fragments

4.5

SANDY LEAN CLAY (CL): stiff, dark reddish brown, dark gray, dark brown, low plasticity, moist to wet, with ferrous staining and sandstone fragments, (RESIDUAL)

very soft, wet

13.5
13.7

APPARENT SANDSTONE

Boring Terminated at 13.7 feet.

REMARKS

Groundwater encountered at 8.5 feet (EL) at time of drilling and stabilized at 3 feet (EL).

No recovery

Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Avenue
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Office: (918) 439-9005

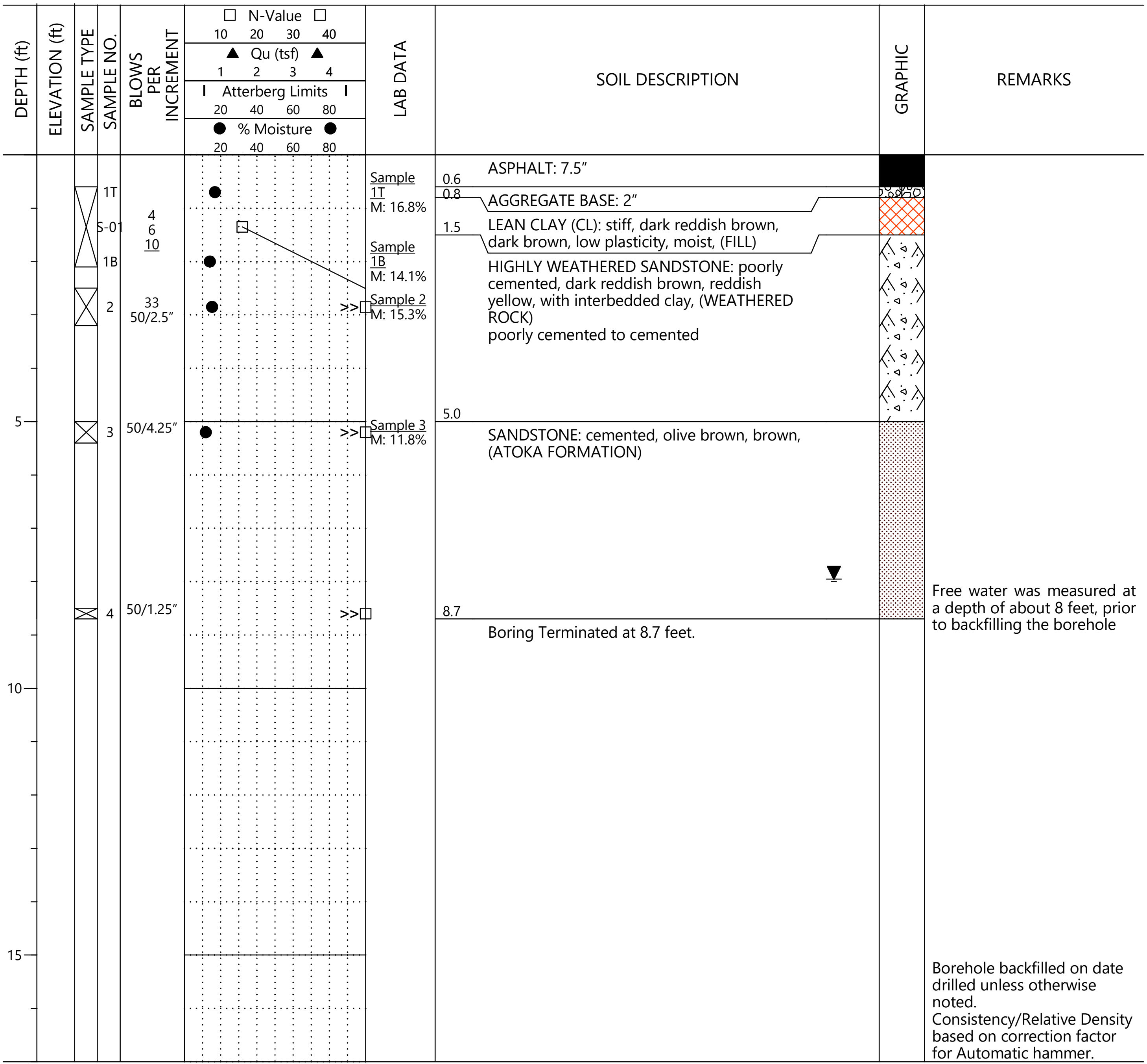
LOG OF BORING

Designation: P-04

Sheet 1 of 1

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



Depth (ft)	Soil Description
	ASPHALT: 7.5"
0.6	AGGREGATE BASE: 2"
0.8	LEAN CLAY (CL): stiff, dark reddish brown, dark brown, low plasticity, moist, (FILL)
1.5	HIGHLY WEATHERED SANDSTONE: poorly cemented, dark reddish brown, reddish yellow, with interbedded clay, (WEATHERED ROCK) poorly cemented to cemented
5.0	SANDSTONE: cemented, olive brown, brown, (ATOKA FORMATION)
8.7	Boring Terminated at 8.7 feet.

Sample No.	Blows per Increment	Lab Data
1T		Sample 1T M: 16.8%
S-01	4 6 10	
1B		Sample 1B M: 14.1%
2	33 50/2.5"	Sample 2 M: 15.3%
3	50/4.25"	Sample 3 M: 11.8%
4	50/1.25"	

Free water was measured at a depth of about 8 feet, prior to backfilling the borehole

Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

LOG OF BORING

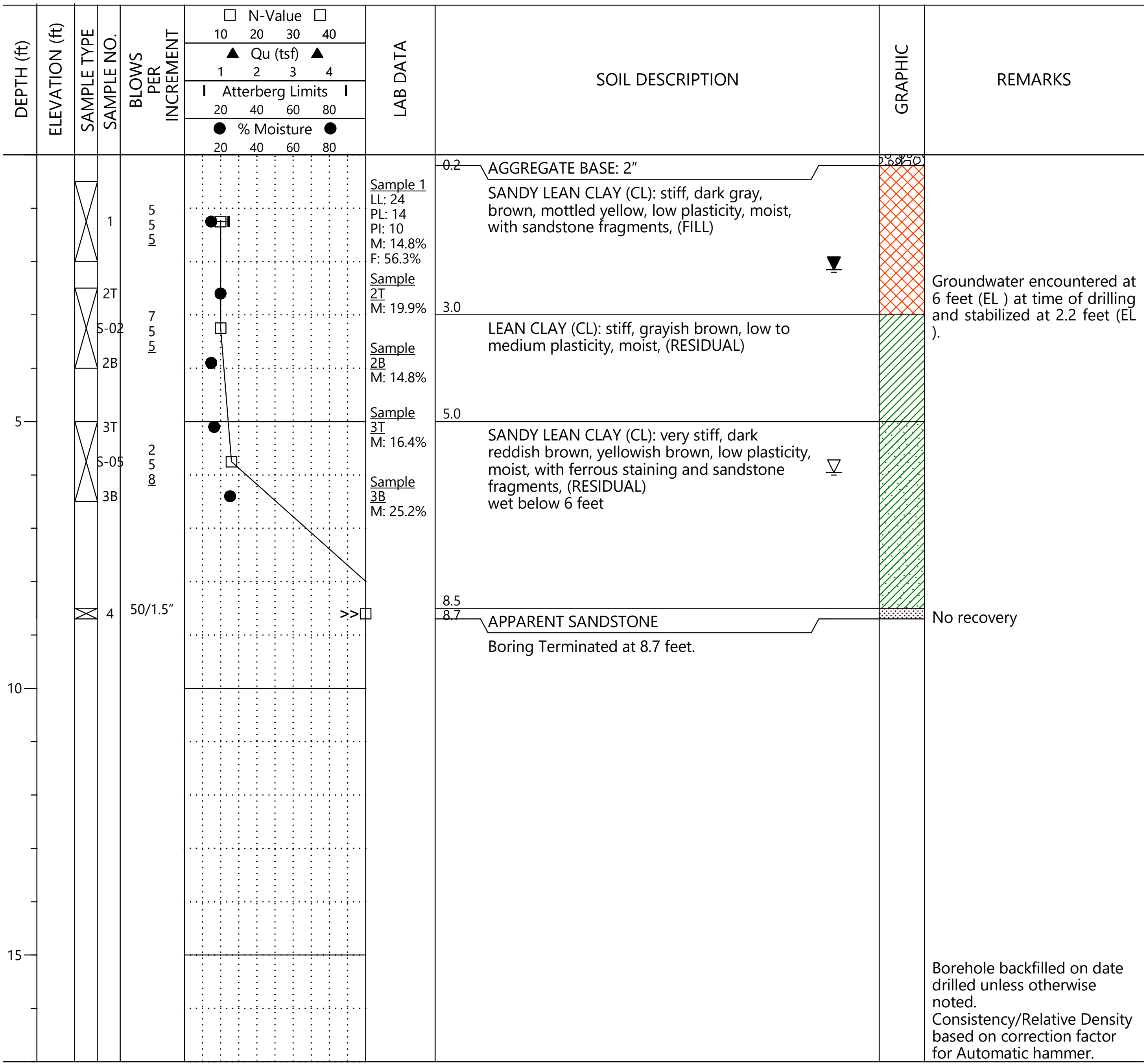
Designation: P-05

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	LAB DATA	SOIL DESCRIPTION	REMARKS
0.2		AGGREGATE BASE: 2"	
	Sample 1 LL: 24 PL: 14 PI: 10 M: 14.8% F: 56.3% Sample 2T M: 19.9%	SANDY LEAN CLAY (CL): stiff, dark gray, brown, mottled yellow, low plasticity, moist, with sandstone fragments, (FILL)	Groundwater encountered at 6 feet (EL) at time of drilling and stabilized at 2.2 feet (EL).
3.0	Sample 2B M: 14.8%	LEAN CLAY (CL): stiff, grayish brown, low to medium plasticity, moist, (RESIDUAL)	
5.0	Sample 3T M: 16.4% Sample 3B M: 25.2%	SANDY LEAN CLAY (CL): very stiff, dark reddish brown, yellowish brown, low plasticity, moist, with ferrous staining and sandstone fragments, (RESIDUAL) wet below 6 feet	
8.5		APPARENT SANDSTONE	No recovery
8.7		Boring Terminated at 8.7 feet.	

Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

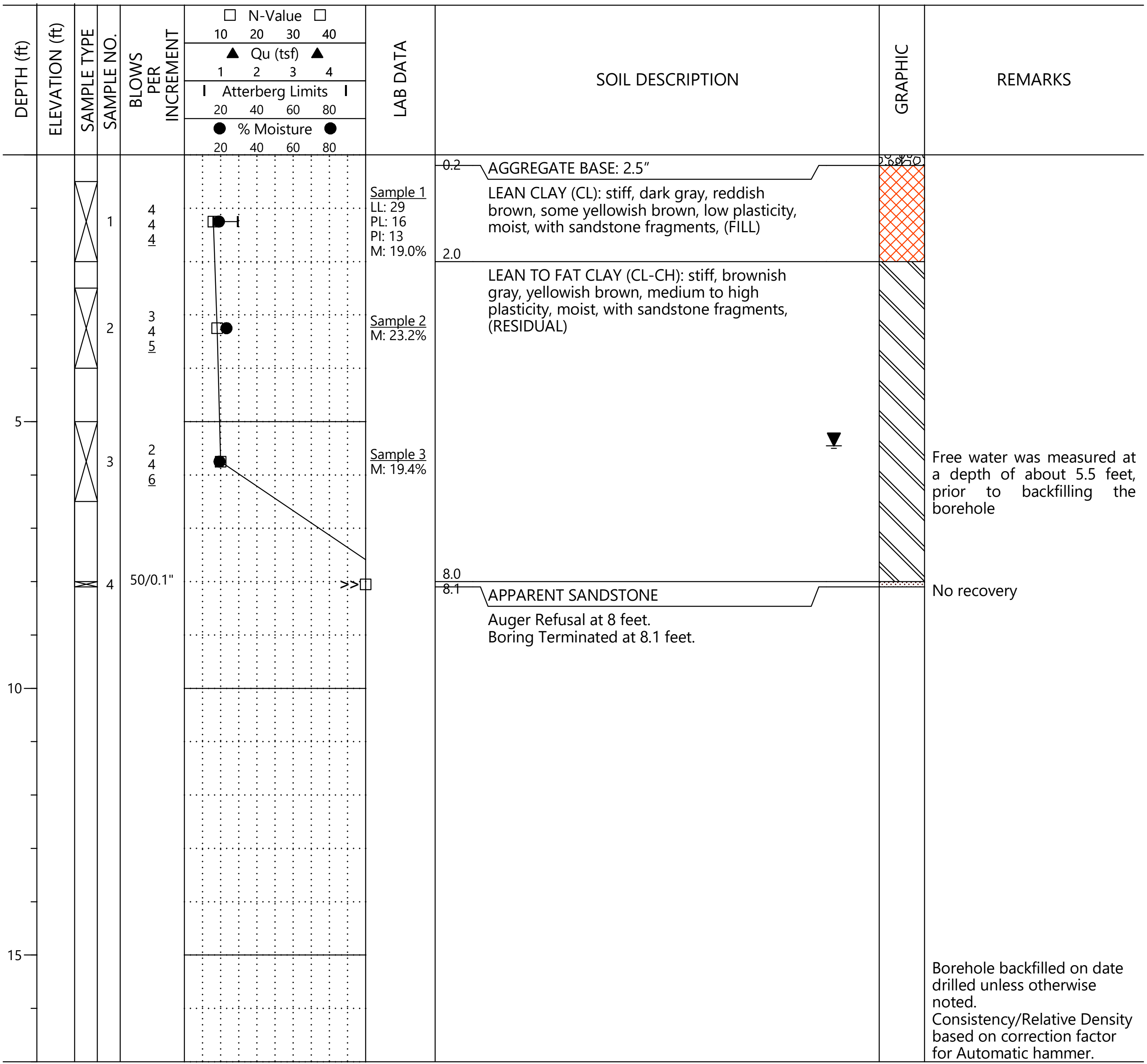
N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL
REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH
LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

LOG OF BORING
Designation: P-06
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



Depth (ft)	Sample No.	Blows per Increment	Lab Data	Soil Description	Remarks
0.2				AGGREGATE BASE: 2.5”	
2.0	1	4 4 4	Sample 1 LL: 29 PL: 16 PI: 13 M: 19.0%	LEAN CLAY (CL): stiff, dark gray, reddish brown, some yellowish brown, low plasticity, moist, with sandstone fragments, (FILL)	
8.0	2	3 4 5	Sample 2 M: 23.2%	LEAN TO FAT CLAY (CL-CH): stiff, brownish gray, yellowish brown, medium to high plasticity, moist, with sandstone fragments, (RESIDUAL)	
	3	2 4 6	Sample 3 M: 19.4%		Free water was measured at a depth of about 5.5 feet, prior to backfilling the borehole
8.1	4	50/0.1"		APPARENT SANDSTONE Auger Refusal at 8 feet. Boring Terminated at 8.1 feet.	No recovery

Borehole backfilled on date drilled unless otherwise noted.
Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:**	LIQUID LIMIT	**M:**	NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT	**F:**	PERCENT PASSING NO. 200 SIEVE
∇	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:**	PLASTICITY INDEX		
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH				

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LOG OF BORING

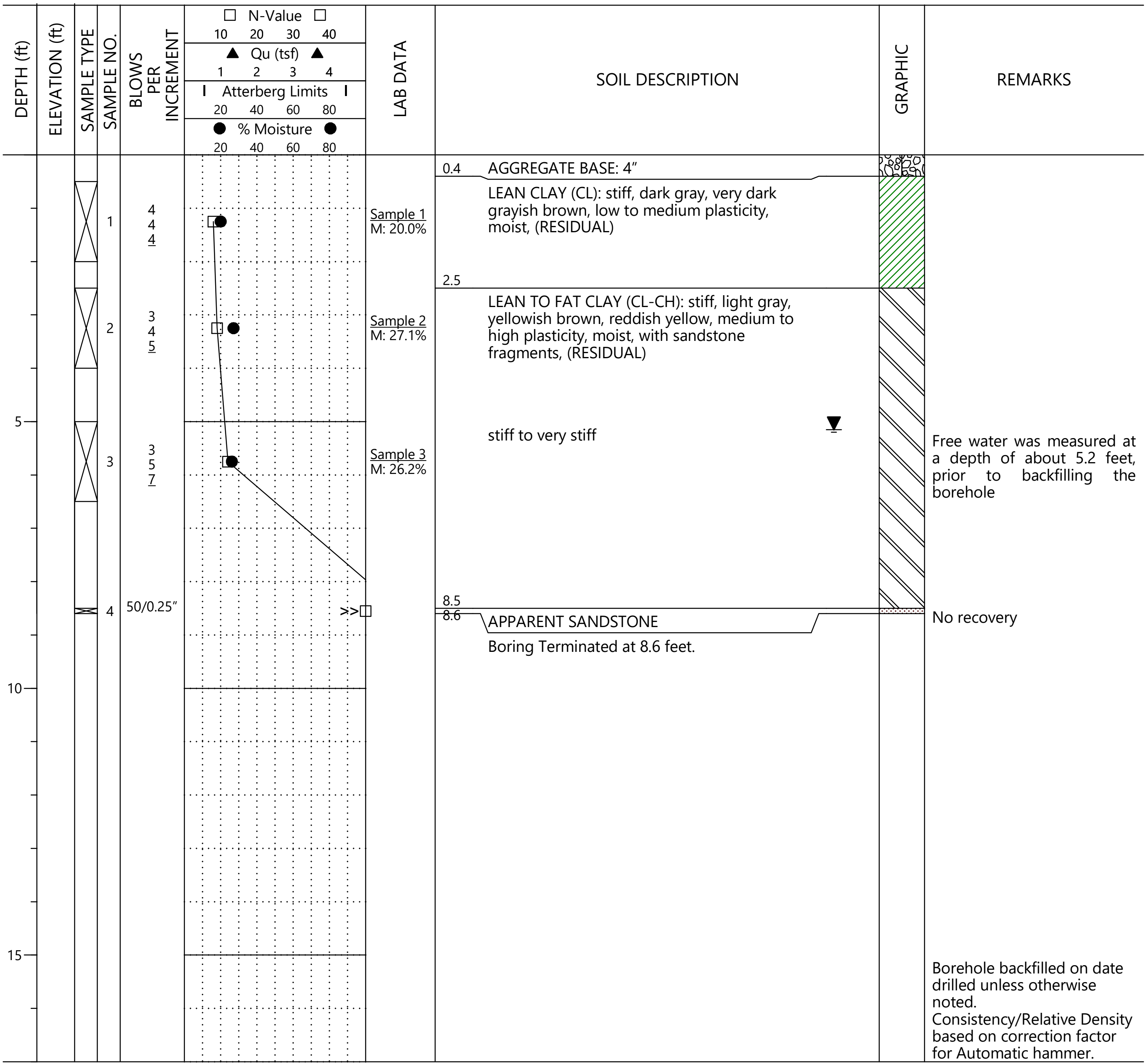
Designation: P-07

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



DEPTH (ft)	SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
0.4				AGGREGATE BASE: 4”	
	1	4 4 4	Sample 1 M: 20.0%	LEAN CLAY (CL): stiff, dark gray, very dark grayish brown, low to medium plasticity, moist, (RESIDUAL)	
2.5	2	3 4 5	Sample 2 M: 27.1%	LEAN TO FAT CLAY (CL-CH): stiff, light gray, yellowish brown, reddish yellow, medium to high plasticity, moist, with sandstone fragments, (RESIDUAL)	
5	3	3 5 7	Sample 3 M: 26.2%	stiff to very stiff ▼	Free water was measured at a depth of about 5.2 feet, prior to backfilling the borehole
8.5 8.6	4	50/0.25”		APPARENT SANDSTONE Boring Terminated at 8.6 feet.	No recovery
					Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX

M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

BUILDING & EARTH
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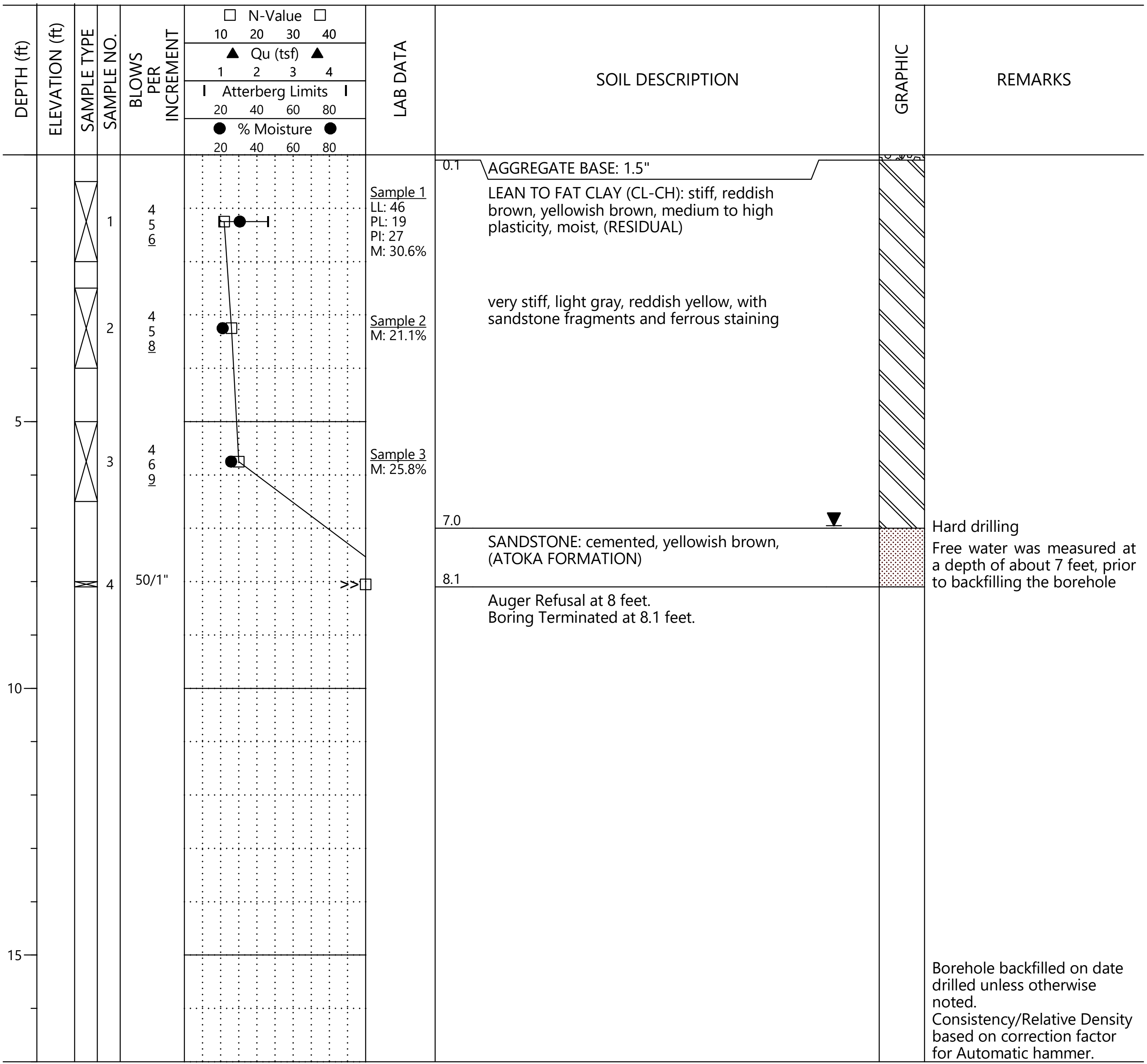
LOG OF BORING
Designation: P-08
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Solid Flight Auger
EQUIPMENT USED: Diedrich D-50
HAMMER TYPE: Automatic
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 5/6/22
WEATHER: Cloudy
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann



SAMPLE NO.	BLOWS PER INCREMENT	LAB DATA	SOIL DESCRIPTION	REMARKS
			0.1 AGGREGATE BASE: 1.5"	
1	4 5 6	Sample 1 LL: 46 PL: 19 PI: 27 M: 30.6%	LEAN TO FAT CLAY (CL-CH): stiff, reddish brown, yellowish brown, medium to high plasticity, moist, (RESIDUAL)	
2	4 5 8	Sample 2 M: 21.1%	very stiff, light gray, reddish yellow, with sandstone fragments and ferrous staining	
3	4 6 9	Sample 3 M: 25.8%		
			7.0 ▼ SANDSTONE: cemented, yellowish brown, (ATOKA FORMATION)	Hard drilling Free water was measured at a depth of about 7 feet, prior to backfilling the borehole
4	50/1"		8.1 Auger Refusal at 8 feet. Boring Terminated at 8.1 feet.	
				Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Automatic hammer.

SAMPLE TYPE ☒ Split Spoon

N-VALUE STANDARD PENETRATION RESISTANCE (AASHTO T-206)
% MOISTURE PERCENT NATURAL MOISTURE CONTENT
▽ GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING
▼ STABILIZED GROUNDWATER LEVEL

REC RECOVERY
RQD ROCK QUALITY DESIGNATION
UD UNDISTURBED
Qu POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH

LL: LIQUID LIMIT
PL: PLASTIC LIMIT
PI: PLASTICITY INDEX
M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

LOG OF BORING

Designation: SB-01

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME: West 530 Roadway Improvements
PROJECT NUMBER: TU220100
DRILLING METHOD: Hand Auger
EQUIPMENT USED: Hand Auger/DCP
HAMMER TYPE: Manual
BORING LOCATION: See Boring Location Plan

LOCATION: Pryor OK
DATE DRILLED: 6/15/22
WEATHER: Clear
ELEVATION:
DRILL CREW: Building & Earth
LOGGED BY: Q. Mann

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	☐ N-Value ☐ 10 20 30 40 ▲ Qu (tsf) ▲ 1 2 3 4 I Atterberg Limits I 20 40 60 80 ● % Moisture ● 20 40 60 80	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
							0.3 TOPSOIL: 3”		DCP @ surface 17-28-15
		✋ ✋	1 2				SILTY SAND (SM): medium dense, dark reddish brown, moist, with sandstone cobbles, (POSSIBLE FILL) 1.5	▨	DCP @ 1' 24-50/0.5"
							Auger Refusal at 1.5 feet.		
5									
10									
15									Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Manual hammer.

SAMPLE TYPE ✋ Grab Sample

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:**	LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
∇	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:**	PLASTICITY INDEX
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

LOG OF BORING

Designation: SB-02

Sheet 1 of 1

PROJECT NAME:	West 530 Roadway Improvements	LOCATION:	Pryor OK
PROJECT NUMBER:	TU220100	DATE DRILLED:	6/15/22
DRILLING METHOD:	Hand Auger	WEATHER:	Clear
EQUIPMENT USED:	Hand Auger/DCP	ELEVATION:	
HAMMER TYPE:	Manual	DRILL CREW:	Building & Earth
BORING LOCATION:	See Boring Location Plan	LOGGED BY:	Q. Mann

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	☐ N-Value ☐ 10 20 30 40 ▲ Qu (tsf) ▲ 1 2 3 4 I Atterberg Limits I 20 40 60 80 ● % Moisture ● 20 40 60 80	LAB DATA		SOIL DESCRIPTION	GRAPHIC	REMARKS
							~~0.2~~	TOPSOIL: 2.5”		DCP @ surface" 15-20-23
		🖐	1				1.5	SILTY SAND (SM): medium dense, dark reddish brown, moist, with sandstone cobbles, (POSSIBLE FILL)	▨	DCP @ 1' 50/0.5"
								Auger Refusal at 1.5 feet.		
5										
10										
15										Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Manual hammer.

SAMPLE TYPE 🖐 Grab Sample

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:**	LIQUID LIMIT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:**	PLASTICITY INDEX
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

M: NATURAL MOISTURE CONTENT
F: PERCENT PASSING NO. 200 SIEVE

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LOG OF BORING
Designation: SB-03
Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME:	West 530 Roadway Improvements	LOCATION:	Pryor OK
PROJECT NUMBER:	TU220100	DATE DRILLED:	6/15/22
DRILLING METHOD:	Hand Auger	WEATHER:	Clear
EQUIPMENT USED:	Hand Auger/DCP	ELEVATION:	
HAMMER TYPE:	Manual	DRILL CREW:	Building & Earth
BORING LOCATION:	See Boring Location Plan	LOGGED BY:	Q. Mann

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	☐ N-Value ☐ 10 20 30 40 ▲ Qu (tsf) ▲ 1 2 3 4 I Atterberg Limits I 20 40 60 80 ● % Moisture ● 20 40 60 80	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
							0.3 TOPSOIL: 4"		DCP @ surface" 7-11-10
							LEAN CLAY (CL): stiff, dark brown, low plasticity, moist, with fine roots, (RESIDUAL)		
		✋	1						DCP @ 1' 6-11-13
		✋	2				2.5 reddish brown, with sandstone gravel		DCP @ 2' 16-9-14
							Boring Terminated at 2.5 feet.		
5									
10									
15									Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Manual hammer.

SAMPLE TYPE ✋ Grab Sample

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

BUILDING & EARTH
Geotechnical, Environmental, and Materials Engineers

LOG OF BORING

Designation: SB-04

Sheet 1 of 1

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

PROJECT NAME:	West 530 Roadway Improvements	LOCATION:	Pryor OK
PROJECT NUMBER:	TU220100	DATE DRILLED:	6/15/22
DRILLING METHOD:	Hand Auger	WEATHER:	Clear
EQUIPMENT USED:	Hand Auger/DCP	ELEVATION:	
HAMMER TYPE:	Manual	DRILL CREW:	Building & Earth
BORING LOCATION:	See Boring Location Plan	LOGGED BY:	Q. Mann

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	☐ N-Value ☐ 10 20 30 40 ▲ Qu (tsf) ▲ 1 2 3 4 I Atterberg Limits I 20 40 60 80 ● % Moisture ● 20 40 60 80	LAB DATA	SOIL DESCRIPTION	GRAPHIC	REMARKS
0.4							TOPSOIL: 4.5"		DCP @ surface" 8-8-5
		✋	1				LEAN TO FAT CLAY (CL-CH): stiff, olive brown, reddish brown, yellowish gray, medium to high plasticity, moist, with sandstone fragments, (RESIDUAL)	▨	DCP @ 1' 7-5-9
2.5		✋	2				medium stiff	▨	DCP @ 2' 4-4-4
							Boring Terminated at 2.5 feet.		
5									
10									
15									Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Manual hammer.

SAMPLE TYPE ✋ Grab Sample

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:**	LIQUID LIMIT **M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:**	PLASTIC LIMIT **F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:**	PLASTICITY INDEX
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

Geotechnical, Environmental, and Materials Engineers

1403 South 70th East Avenue
Tulsa, OK 74133
Office: (918) 439-9005

LOG OF BORING

Designation: SB-05

Sheet 1 of 1

PROJECT NAME:	West 530 Roadway Improvements	LOCATION:	Pryor OK
PROJECT NUMBER:	TU220100	DATE DRILLED:	6/15/22
DRILLING METHOD:	Hand Auger	WEATHER:	Clear
EQUIPMENT USED:	Hand Auger/DCP	ELEVATION:	
HAMMER TYPE:	Manual	DRILL CREW:	Building & Earth
BORING LOCATION:	See Boring Location Plan	LOGGED BY:	Q. Mann

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE	SAMPLE NO.	BLOWS PER INCREMENT	☐ N-Value ☐ 10 20 30 40 ▲ Qu (tsf) ▲ 1 2 3 4 I Atterberg Limits I 20 40 60 80 ● % Moisture ● 20 40 60 80	LAB DATA		SOIL DESCRIPTION	GRAPHIC	REMARKS
							0.4	TOPSOIL: 4.5"		DCP @ surface" 8-8-9
		Grab Sample	1					LEAN TO FAT CLAY (CL-CH): stiff, brownish yellow, dark reddish brown, olive yellow, medium to high plasticity, moist, with fine roots, (RESIDUAL) medium stiff, with sandstone fragments		DCP @ 1' 3-3-3
		Grab Sample	2							DCP @ 2' 3-4-5
							2.5	Boring Terminated at 2.5 feet.		
5										
10										
15										Groundwater not encountered at time of drilling. Borehole backfilled on date drilled unless otherwise noted. Consistency/Relative Density based on correction factor for Manual hammer.

SAMPLE TYPE ✋ Grab Sample

N-VALUE	STANDARD PENETRATION RESISTANCE (AASHTO T-206)	**REC**	RECOVERY	**LL:** LIQUID LIMIT	**M:** NATURAL MOISTURE CONTENT
% MOISTURE	PERCENT NATURAL MOISTURE CONTENT	**RQD**	ROCK QUALITY DESIGNATION	**PL:** PLASTIC LIMIT	**F:** PERCENT PASSING NO. 200 SIEVE
▽	GROUNDWATER LEVEL IN THE BOREHOLE AT TIME OF DRILLING	**UD**	UNDISTURBED	**PI:** PLASTICITY INDEX	
▼	STABILIZED GROUNDWATER LEVEL	**Qu**	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH		

LABORATORY TEST PROCEDURES

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

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

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

NATURAL MOISTURE CONTENT (ASTM D2216)

Natural moisture contents (M%) were determined on selected samples. The natural moisture content is the ratio, expressed as a percentage, of the weight of water in a given amount of soil to the weight of solid particles.

ATTERBERG LIMITS (ASTM D4318)

The Atterberg Limits test was performed to evaluate the soil's plasticity characteristics. The soil Plasticity Index (PI) is representative of this characteristic and is bracketed by the Liquid Limit (LL) and the Plastic Limit (PL). The Liquid Limit is the moisture content at which the soil will flow as a heavy viscous fluid. The Plastic Limit is the moisture content at which the soil is between "plastic" and the semi-solid stage. The Plasticity Index (PI = LL - PL) is a frequently used indicator for a soil's potential for volume change. Typically, a soil's potential for volume change increases with higher plasticity indices.

MATERIAL FINER THAN NO. 200 SIEVE BY WASHING (ASTM D1140)

Grain-size tests were performed to determine the partial soil particle size distribution. The amount of material finer than the openings on the No. 200 sieve (0.075 mm) was determined by washing soil over the No. 200 sieve. The results of wash #200 tests are presented on the boring logs included in this report and in the table of laboratory test results.

LABORATORY TEST RESULTS

The results of the laboratory testing are presented in the following tables.

BORING NO.	DEPTH	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE	CLASSIFICATION
P-01	0.6 - 2.1	12.8	NP	NP	NP	21	SM
P-01	2.5 - 4.0	17.3					
P-01	5.0 - 5.8	18.0					
P-02	0.5 - 2.0	13.0					
P-02	2.5 - 4.0	6.3					
P-02	5.1	12.9					
P-02	6.4	23.5					
P-03	0.6 - 2.1	16.0					
P-03	2.5 - 4.0	20.5	27	18	9		
P-03	5.0 - 6.5	21.0					
P-03	8.5 - 10.0	44.0					
P-04	0.7	16.8					
P-04	2.0	14.1					
P-04	2.5 - 3.2	15.3					
P-04	5.0 - 5.4	11.8					
P-05	0.5 - 2.0	14.8	24	14	10	56	CL
P-05	2.6	19.9					
P-05	3.9	14.8					
P-05	5.1	16.4					
P-05	6.4	25.2					
P-06	0.5 - 2.0	19.0	29	16	13		
P-06	2.5 - 4.0	23.2					
P-06	5.0 - 6.5	19.4					
P-07	0.5 - 2.0	20.0					
P-07	2.5 - 4.0	27.1					
P-07	5.0 - 6.5	26.2					
P-08	0.5 - 2.0	30.6	46	19	27		
P-08	2.5 - 4.0	21.1					
P-08	5.0 - 6.5	25.8					

TABLE L-1: General Soil Classification Test Results

Soils with a Liquid Limit (LL) greater than 50 and Plasticity Index (PI) greater than 25 usually exhibit significant volume change with varying moisture content and are considered to be highly plastic
(1) Indicates visual classification. WR indicates weathered rock.

Important Information about This

Geotechnical-Engineering Report

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

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

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

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

Read the Full Report

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

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

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

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

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

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

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

Subsurface Conditions Can Change

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

Most Geotechnical Findings Are Professional Opinions

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

A Report's Recommendations Are Not Final

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

A Geotechnical-Engineering Report Is Subject to Misinterpretation

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

Do Not Redraw the Engineer's Logs

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

Environmental Concerns Are Not Covered

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

Obtain Professional Assistance To Deal with Mold

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

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

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

GEOTECHNICAL
BUSINESS COUNCIL
of the Geoprofessional Business Association

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@geoprofessional.org www.geoprofessional.org