GEOTECHNICAL EXPLORATION AND SUBGRADE RECOMMENDATIONS

STREETS OF WEST PRYOR – LOT 7
Lee's Summit, Missouri
CFS Project No. 20-5555

Prepared For
Streets of West Pryor, LLC
7200 West 132nd Street
Overland Park, Kansas

November 23, 2020

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SYNOPSIS

A subsurface exploration and an evaluation were performed at Lot 7 of the ongoing Streets of West Pryor project site in Lee's Summit, Missouri to provide geotechnical engineering related recommendations for design and construction of the proposed project.

Exploratory soil borings have been drilled and a laboratory testing program was conducted on selected soil samples. The data has been analyzed based upon the project information provided the project team.

The results of the exploration and analysis indicate that conventional spread and continuous wall footings appear to be a suitable foundation system for support of the proposed structure. However, due to the varying bedrock elevations encountered during drilling, some additional site work inclusive of rock excavation will be necessary to provide a uniform bearing condition beneath the entire foundation system in order to limit the risk of differential settlement to manageable amounts.

Detailed analysis of subsurface conditions, any alternate foundation types, and pertinent design recommendations are included, herein.

Groundwater conditions are not expected to cause any major difficulties. These conditions will be further discussed in the report. Please note, groundwater levels should be expected to fluctuate based on seasonal changes and precipitation events.

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STREETS OF WEST PRYOR – LOT 7
OLATHE, KANSAS

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this geotechnical exploration was to evaluate the underlying materials at Lot 7 of the ongoing Streets of West Pryor project site in Lee's Summit, Missouri, and based upon this information, provide geotechnical engineering related recommendations for design and construction of the planned project. This exploration was performed in accordance with Cook Flatt & Strobel Engineers, P.A. (CFS) proposal dated November 2, 2020 and authorized by Streets of West Pryor, LLC.

This report includes geotechnical recommendations and considerations pertaining to site development, foundation support, concrete slab on grade and pavement construction. Also, included in this report are earthwork, construction and drainage considerations associated with the proposed project.

1.2 SCOPE OF SERVICES

This exploration and this analysis include an engineering reconnaissance of the planned site, a subsurface exploration as outlined below, a field and laboratory testing program, and an engineering analysis and evaluation of the subsurface materials.

The scope of services did not include any environmental assessment for wetlands or hazardous materials in the soil, surface water, groundwater, air or surrounding area. Any statement in this report or on the boring logs regarding odors, colors or unusual or suspicious items is strictly for the information of the client.

1.3 GENERAL

The general subsurface conditions used in this analysis are based upon an interpolation of the subsurface data between the borings; varying conditions may be encountered between boring locations. If deviations from the noted subsurface conditions are encountered during construction, they should be brought to the attention of the Geotechnical Engineer.

The recommendations submitted for the proposed structure are based on the available soil information and the preliminary design details. Any revision in the plans for the proposed structure from those described in this report should be brought to the attention of the Geotechnical Engineer to determine if changes in the foundation recommendations are required.

The Geotechnical Engineer warrants that the findings, recommendations, specifications, and professional advice contained, herein, have been presented after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

After the plans and specifications are complete, it is recommended that the Geotechnical Engineer be provided the opportunity to review the final design and specifications, in order to verify that the earthwork and foundation recommendations are properly interpreted and implemented.

2 PROJECT DESCRIPTION

It is understood that the planned project comprises the new construction of two (2) multi-story apartment buildings with associated paving at Lot 7 of the ongoing Streets of West Pryor project site. The buildings are to be structural steel framed, concrete slab on grade structures. The proposed finish floor elevation will be approximately three (3) feet beneath existing grade. Foundation loads are expected to be on the order of 150 kips for column footings and three (3) to five (5) kips per linear foot for continuous wall footings.

CFS anticipates approximately three (3) feet of cut will be necessary across the site to establish the desired construction grade. If any changes to the project occur, please notify CFS to allow for review of these changes and, if necessary, amend this report.

2.1 SITE LOCATION & SURFACE CONDITIONS

The project site is located at Lot 7 of the ongoing Streets of West Pryor project site in Lee's Summit, Missouri. Lot 7 is bounded by NW Lowenstein Drive to the southwest. It is on the northeast corner of the intersection of Black Twig Lane and NW Lowenstein Drive.

Currently, the planned project site slope subtly downward from the south to the north. It is partially graded and dirt covered at the surface with construction activity around it.

2.2 SITE GEOLOGY

Jackson County is located in the Central Lowland province of the Interior Plains and is near the middle of an approximate 150 mile-wide, north-south trending band of Pennsylvanian-Age Rocks that is located in western Missouri and eastern Kansas. Generally, the rock beds exhibit a subtle prevailing dip to the west-northwest of about 10 feet per mile. The region is underlain by rock units of the Pennsylvanian System, Missourian Series (Kansas City Group, Lansing Group, and Pleasanton Group) in the Time Stratigraphic Unit age classification.

3 SUBSURFACE EXPLORATION

Based on the project information as outlined above, CFS Engineers conducted a field exploration to determine the underlying materials at the proposed project site and to establish their engineering characteristics.

3.1 Scope of Work

This geotechnical exploration consisted of drilling four (4) borings within the footprint of the planned structures. The borings were drilled to auger refusal encountered at depths ranging from approximately one (1) to 2.5 feet beneath existing grade. The boring locations can be seen on the Boring Location Plan included in Appendix A.

The boring locations were determined in the field using measurements from existing landmarks and should be considered accurate only to the degree implied. The locations were established by Cook, Flatt & Strobel Engineers.

Boring logs representing the materials encountered in the borings are included in Appendix B. The boring logs represent CFS Engineers' interpretation of the field logs combined with laboratory observations and testing of the samples. The stratification boundaries indicated on the boring logs were based on field observations, an extrapolation of information obtained by examining samples from the borings, and comparisons of soils and/or bedrock types with similar engineering characteristic. As such, the boundaries between subsurface strata should be expected to vary from the logs to some extent.

The depth to groundwater, if encountered, was recorded in each test boring during drilling and can be seen in Section 3.5, Groundwater Conditions. After completion of drilling, sampling, and field testing, the excavations were backfilled with auger cuttings.

3.2 Drilling and Sampling Procedures

The auger borings were drilled using a truck mounted SIMCO 2400 drill rig equipped with a rotary head. 3.25-inch solid-stem augers were used to drill the holes. 6-inch hollow stem augers were used to advance the holes that required rock coring. During drilling, field logs were created and maintained by CFS personnel to catalog the materials encountered.

The borings were continued below the point of auger refusal with standard core barrel sample techniques. Descriptions of the rock cores are presented on the respective boring logs in addition to recovery and Rock Quality Designation (RQD) for the core recovered. Recovery is defined as the length of core obtained expressed as a percentage of the total length cored. Rock Quality Designation is defined as the sum of core pieces longer than 10 cm divided by the total length of the core run, expressed as a percentage. Rock Quality Designation provides an indication of the integrity of the rock mass and relative extent of seams and bedding planes.

Representative samples were obtained during drilling using split-barrel sampling procedures in general accordance with the procedures for "Standard Test Methods for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM D 1586).

Upon completion of drilling, the samples were then sealed and returned to CFS's laboratory for further examination, classification and testing. The samples recovered were identified, classified and evaluated by a Geotechnical Engineer.

3.3 Field Tests and Measurements

During the soil boring procedure, Standard Penetration Tests (SPT) were performed at pre-determined intervals to obtain the standard penetration value of the soil as outlined in the ASTM D1586 test method. The standard penetration value (N) is defined as the number of blows of a 140-pound hammer falling 30 inches, required to advance the split-barrel sampler one foot into the soil. The sampler is lowered to the bottom of the previously cleaned drill hole and advanced by blows from the hammer.

The number of blows is recorded for each of three successive increments of six inches penetration. The "N" value is then obtained by adding the second and third incremental numbers. The results of the standard penetration test are shown on the Boring Logs and indicate the relative density of cohesionless soils and comparative consistency of cohesive soils, and thereby provide a basis for estimating the relative strength and compressibility of the soil profile components.

The Standard Penetration Test (SPT) was also used to evaluate the consistency of the in-situ materials. The N-values for the site's materials were greater than 50 blows/foot.

3.4 Subsurface Conditions

The materials encountered in the test borings have been visually classified according to the Unified Soil Classification System (USCS). They are described on the Boring Logs in Appendix B. The results of the field tests, water level observations and laboratory tests are presented on the Boring Logs (Appendix B).

The following presents a general summary of the major strata encountered during this subsurface exploration and includes a discussion of field and laboratory tests conducted. Specific subsurface conditions encountered—including field tests, lab tests, and water level observations—at the boring locations are also presented on the individual boring logs found in Appendix B of this report.

3.4.1 Overburden Material

Approximately 12 to 30 inches of graybrown, moist and medium stiff fat clay (CH) was encountered at the surface of the borings. The fat clay was underlain by limestone bedrock.

3.4.2 Refusal Materials

Auger refusal on slightly weathered to weathered limestone was encountered at shallow depths in the borings. Boring B1 and B4 were continued beyond auger refusal by means of standard core barrel techniques. In generally, a thin shelf of highly weathered limestone (approximately 1.5 feet thick) was encountered beneath the surface of the northern-most planned apartment. A highly weathered to slightly weathered shelf of limestone (approximately 4.5 feet thick) was encountered beneath the overburden material in the southernmost apartment building's footprint. Please reference the table below for additional information.

Table 1: Auger Refusal Depths

Boring ID	Location	REFUSAL DEPTH (ft)	CORE LENGTH (ft)	TOTAL DEPTH (ft)	REFUSAL MATERIAL
B1	North Apartment	2.0	10	13.9	LIMESTONE/SHALE
B2	North Apartment	1.0	NA	1.0	LIMESTONE
B3	South Apartment	2.5	NA	2.5	LIMESTONE
B4	South Apartment	1.0	10	11	LIMESTONE/SHALE
Note: all depths are approximate					

3.5 GROUNDWATER CONDITIONS

Groundwater was not encountered in the borings at the time of the investigation. Please note, the reported groundwater levels reflect the conditions observed at the time the borings were drilled. Groundwater levels should be expected to fluctuate with changes in grading, precipitation changes and seasonal changes. The water levels included in this report do not indicate a permanent groundwater condition. Additionally, the materials encountered during this exploration are, generally, low permeable soils.

4 LABORATORY TESTING

Upon completion of drilling, the samples were returned to CFS's laboratory located in Kansas City, Kansas for laboratory testing. A supplemental laboratory testing program was conducted to evaluate additional engineering characteristics of the in-situ soils necessary in analyzing the behavior of the support systems for the proposed building.

The laboratory testing program included the following tests:

- Supplementary visual classification (ASTM D2488) of all samples,
- Water content (ASTM D2216) of all samples, and
- Atterberg limit tests (ASTM D4318) on a selected sample.

The results of the laboratory testing program can be seen in on the boring logs in Appendix B. The Atterberg limits can be seen in the following table.

Table 2: Atterberg Limits Results

Boring ID	Sample #	Moisture Content (%)	Atterberg Limits			USCS Classification
			Liquid Limit	Plastic limit	Plasticity Index	
B1	SS1	53	70	38	32	FAT CLAY (CH)

Based on the Atterberg limits, the reddish-brown overburden material classifies as Fat Clay (CH) and is considered highly expansive. To limit the risk of differential slab movements, all concrete slabs on grade should be constructed in accordance with Section 7.2, "Slab On Grade" of this report.

5 GEOTECHNICAL CONCERNS

The following geotechnical concerns are based upon the subsurface materials encountered during this exploration and CFS's understanding of the project as described in Section 2, Project Description of this report. If any changes to the planned structure's location, loading or elevations occur, CFS must be allowed to review these changes, and if necessary, issue amendments to this report and its recommendations.

1. *Differential Bearing Condition*: Differential bearing conditions can lead to differential settlements, resulting in structural and architectural damage throughout the structure as it undergoes movements. CFS understand approximately three (3) feet of cut is planned across the proposed site. CFS anticipates this cut will expose highly weathered limestone bedrock with voids and inconsistent thicknesses and engineering properties. To avoid a differential bearing condition, it is recommended that the entire foundation system bear in the native shale bedrock located beneath the thin limestone shelf encountered during this exploration. All foundations should be constructed in accordance with Section 7.1, Foundation Recommendations of this report.

2. *Bedrock Excavation*: CFS encountered shallow bedrock across the proposed site. CFS anticipated one (1) to two (2) feet of limestone excavation will be necessary to achieve the desired construction grade. In addition to this, CFS anticipates 0.5 to 2.5 feet of additional limestone bedrock excavation will be necessary beneath the planned foundations. This may require the use of hydraulic breakers which generally increases the cost of excavation. Additionally, the nature of breaking limestone can be unpredictable. Any over excavation that occurs laterally during bedrock excavation can be replaced with a compacted granular fill, such as MODOT Type 5 or equivalent, or lean concrete.

3. *Expansive Clay Soils*: Expansive clay soils were encountered during this exploration. The on-site materials are NOT suitable for direct support of concrete slabs. All slabs on grade should be supported by a low volume change material (LVC) OR limestone bedrock and constructed in accordance with Section 7.2, Slab on Grade Recommendations of this report or bear directly on the shallow limestone bedrock encountered during this exploration.

6 EARTHWORK & SITE DEVELOPMENT

6.1 SITE PREPARATION

CFS understands primarily cut will be necessary to establish the desired construction grades. However, when necessary, prior to filling any grass and topsoil should be stripped from all structural areas and be stockpiled for later use in landscape areas or it should be wasted. Any trees and shrubs should be properly removed including the entirety of the root ball and root systems. The upper 12-inches of the subgrade should be moisture conditioned and recompacted, as necessary, to provide a stable subgrade upon which to begin placement of engineered fill.

Upon completion of stripping and prior to filling, the newly exposed subgrade should be evaluated by a qualified professional for stability by means of proofrolling. The proofroll should be conducted using a fully loaded, tandem axle dump truck weighing in excess of 20 tons. Any soft or unsuitable areas identified during the proofroll should be corrected by means of additional moisture conditioning and recompacting, or removal and replacement with an acceptable material.

6.2 Grading

6.2.1 Suitable Fill Material

All general and structural fill should be free of debris and defined by ASTM 2487 as CH, CL, ML, GW, GP, SM, SW, SC, and SP. The onsite soils tend to meet this requirement; however, please note that CH (fat clay) classification materials should NOT be used as structural fill within two (2) feet of the finished grade supporting the building slab and within ten (10) feet laterally outside of the building footprint. Fat clays (CH) with Liquid Limits of greater than 55 should not be used in the upper one (1) foot beneath the pavement without being treated with cement as outlined later in this report.

6.2.2 Unsuitable Fill Material

The on-site topsoil contains organic material and is unsuitable for use as structural fill. Unsuitable materials are those defined by ASTM 2487 as MH, OL, OH, and PT.

6.2.3 Engineered Fill Placement

For the purpose of this report, engineered fill means fill placed in controlled layers and compacted and tested according to accepted geotechnical engineering practices to ensure that it meets the required specifications. While structural fill refers to any engineered fill placed within the footprint of the planned structures. Engineered fill materials should be free of organic matter. During placement, engineered fill materials should be within the specified moisture contents and compacted to the specified densities given below in Tables 2 and 3. Maximum dry density and optimum moisture content should be determined by the Standard Proctor test (ASTM D 698).

Fill should be placed in six (6) inch lifts (compacted thickness) in mass fill areas, and as needed to obtain the proper compaction in utility trenches and behind walls. Structural fill should extend a minimum of two (2) feet beyond any structure lines.

A representative of the Geotechnical Engineer should monitor filling operations on a full-time basis. A sufficient number of density tests should be taken to verify that the specified compaction is obtained. See Table 3 below for required testing frequency.

Table 3: Recommended Moisture Ranges

Engineered Fill Material	Maximum Below Optimum	Maximum Above Optimum
Lean Clay (CL)	-2%	+3%
Fat Clay (CH)	0%	+4%
Compacted Base Rock (i.e. MODOT Type 5, AB3 or equivalent)	NA	NA

Table 4: Density Testing Frequency

Location or Area	Standard Proctor Density (ASTM D 698)	Testing Frequency One per lift per …
Building Walkways	95%	20,000 sf
Retaining Walls	95%	1,000 sf
Trenches	95%	150 lf
Lawn or Unimproved Areas	92%	20,000 sf
Building and Pavement Subgrades	95%	10,000 sf
Out-Parcels	95%	20,000 sf

6.3 EXCAVATIONS & TRENCHES

All temporary slopes and excavations should conform to Occupational Safety and Health Administration (OSHA) Standards for the Construction Industry (29 CFR Part 1926, Subpart P). Excavations at this site are *expected* to be made in "Type B" clayey soil. Soil types should be verified in the field by a competent individual.

All excavations should be kept dry during subgrade preparation. Storm water runoff should be controlled and removed to prevent severe erosion of the subgrade and eliminate free standing water. Subgrade that has been rendered unsuitable from erosion or excessive wetting should be removed and replaced with controlled fill.

Excavations through the very hard limestone and shale bedrocks will likely be necessary. The Boring Logs (Appendix B) and the Boring Location Plan (Figure 2, Appendix A) should be consulted in estimating the amount of rock to be excavated.

Trenches should be excavated so that pipes and culverts can be laid straight at uniform grade between the terminal elevations. Trench width should provide adequate working space and sidewall clearances. Trench subgrade should be removed and replaced with controlled fill if found to be wet, soft, loose, or frozen. Trench sub-grades should be compacted above 95% of the maximum dry density in accordance with ASTM D 698 at moisture contents between -2% to +3% of the optimum moisture content.

Granular bedding materials for pipes, such as well-graded sand or gravel, may be used provided that the bottom of the trench is graded so that water flows away from building

Bedding material should be graded to provide a continuous support beneath all points of the pipe and joints. Embedment material should be deposited and compacted uniformly and simultaneous on each side of the pipe to prevent lateral displacement. Compacted control fill material will be required for the full depth of the trench above the embedment material except in area landscape area with the compaction may be reduced to 90% Standard Proctor ASTM D698. No backfill should be deposited or compacted in standing water.

Permanent slopes greater than 3 horizontals to 1 vertical should not be used unless additional testing and slope analysis is performed.

6.4 Drainage and Dewatering

Normal seasonal weather conditions should be anticipated and planned for during earthwork. It is recommended that the Contractor determine the actual groundwater levels at the site at the time of the construction activities to assess the impact groundwater may have on construction. Water should not be allowed to collect in the foundation excavation, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of collected rainwater, groundwater, or surface runoff. Positive site drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slabs. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

The site should be graded such that positive drainage (normally 2% minimum) is provided away from any structures. Where sidewalks or paving do not immediately adjoin the building, protective slopes of at least 5% for a minimum of 10 feet from the perimeter walls are recommended. Roof drains and downpours should also be directed away from the building. Open-graded stone is not recommended for use under sidewalks unless the stone is adequately drained to prevent collection of water under the walks.

The site should also be graded to avoid water flows, concentrations, or pools behind retaining walls, curbs or similar structures. When swales are designed at the top of the walls, proper line and slope should be considered to avoid any flow down behind walls. Special attention is needed for sources of storm water from slopes, building roofs, gutter downspouts and paved areas draining to one point.

In paved areas where seasonal water potentially accumulates behind curbs, gutters and planters ensure concrete extends 6-inches into impervious material to reduce seepage under the curbs, saturating and weakening the pavement subgrade.

Perforated plastic pipes should be placed on the backfilled side of the walls near the bottom and day-lighted. Six inches of open graded crushed rock wrapped with geo-textile fabric should be placed behind the walls up to a depth of two feet below the finished grade. As an alternative to the open graded crushed rock, a manufactured geo-composite sheet drain such as Mirafi G100N, Contech C-Drain, or equivalent, may be used in conjunction with the perforated pipe.

6.5 Landscaping

Landscaping and irrigation should be limited adjacent to buildings and pavements to reduce the potential for large moisture changes. Trees and large bushes can develop intricate root systems that can draw moisture from the subgrade, resulting in shrinkage of the bearing material during dry periods of the year. Desiccation of bearing material below foundations may result in foundation settlement.

Landscaped areas near pavements and sidewalks should include a drainage system that prevents over saturation of the subgrade beneath asphalt and concrete surfaces. Drainage systems in irrigation areas should be incorporated into the storm drain system.

7 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

7.1 FOUNDATIONS RECOMMENDATIONS

Conventional spread and continuous wall footings are, generally, most economical when the existing soil conditions allow them to be founded at shallow depths on existing materials. Based on the materials encountered during this exploration, it is CFS Engineers' opinion that the planned structure can be supported by a shallow foundation system, such as spread and/or trench footings bearing in native shale bedrock.

Please note, CFS anticipates approximately 0.5 to 2.5 feet of additional limestone bedrock excavation will be necessary beneath the planned foundations to reach the recommended shale bedrock encountered during this exploration.

It is recommended that spread and trench footings have a minimum width of 24 and 16-inches, respectively. Footings should be suitably reinforced to reduce the effects of differential movement that may occur due to variations in the properties of the supporting soils. Top and bottom reinforcing steel is recommended for continuous wall footings to reduce differential settlement due to possible varying bearing capacities of the existing fill soils.

Every effort should be made to keep the footing excavations dry as the soils will tend to soften when exposed to free water. Footing bottoms should be free of loose soil and concrete should be placed as soon as possible to prevent drying of the foundation soils.

7.1.1 Bearing Capacity Analysis

The bearing capacity of the subsurface materials was evaluated from the results of the field and laboratory tests. Based on this information, shallow foundation systems bearing on the native shale bedrock encountered during this exploration, and constructed as recommended above, can be proportioned for a maximum allowable soil bearing capacity of 5,000 psf.

A representative of the Geotechnical Engineer should test the soils in the footing excavations to verify the design soils bearing pressure. If undercutting of any footing is required to reach design bearing capacity backfill of the undercut footing should be done with a closed grade stone (such as KDOT AB-3) or lean concrete. If compacted structural fill is used to back fill the excavation, widening of the excavation one-half (1/2) the depth of the excavation on either side should be performed. The structural fill should be compacted to at least 95% of the material's maximum dry density within -2 to 3% of the optimum moisture content as determined by ASTM D-698.

Based on the seasonal freeze-thaw cycles associated with the project site, shallow foundation systems should bear a minimum of 36-inches beneath the ground surface for adequate frost protection.

7.1.2 Settlement Analysis

To help mitigate the risk of differential foundation movements such as settlement, a uniform bearing condition should exist beneath the entirety of the foundation system for a given structure. Additionally, the foundation system should bear in the recommended shale bedrock encountered during this exploration. For spread and/or trench footings designed in accordance with these recommendations, total settlements of less than 1-inch and differential settlements of less than 3/4-inches can be anticipated.

7.2 Seismic Analysis

The determination of the seismic class is based on ASCE Standard 7: Minimum Design Loads for Building and Other Structures. Based upon this information, the seismic properties of the soil were interpolated from the standard penetration test values. A Seismic Site Class "C" was determined for this site. In addition, there is no significant risk of liquefaction or mass movement of the on-site soils due to a seismic event.

7.3 Slab on Grade Recommendations

In its current state, the overburden materials (i.e. Fat Clay) encountered during this exploration are unsuitable for direct support of the planned slabs-on-grade. CFS recommends all concrete slabs on grade be supported by a minimum of 24-inches of Low Volume Change (LVC) material, limestone bedrock, or a combination of the two (2). LVC material should consist of MODOT Type 5 crushed stone or equivalent. In addition to mitigating the swell potential of the fat clays, the crushed stone will act as a transition zone for the slab-on-grade when grading from limestone bedrock to clay. The subgrade can be constructed as outlined below.

1. Cut the subgrade beneath the slab to a minimum depth of 24-inches, or limestone bedrock, whichever is less.

2. Twenty (20) inches, unless limestone was encountered, of a compacted crushed stone material should be placed atop the exposed slab subgrade. The crushed stone should be placed in loose lifts no greater than 8-inches and compacted to 95% of the maximum dry density as determined by ASTM 698.

3. A 4-inch-thick layer of open graded stone (ASTM C33 No. 57 stone or equivalent material) should be placed atop the 20-inches of compacted LVC material to return the subgrade to the original bottom of slab elevation. The open-graded stone will ease construction and provide a capillary break between the LVC and concrete slab.

Every floor slab should be evaluated to determine if a vapor retarder under the concrete floor is required. The slab designer should refer to ACI 302 and/or ACI 360 for procedures regarding the use and placement of a vapor retarder.

To reduce the effects of differential movement, slabs-on-grade should not be rigidly connected to columns, walls, or foundations unless it is designed to withstand the additional resultant forces. Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction. Expansion joints may be used to allow unrestrained vertical movement of the slabs. The floor slabs should be designed to have an adequate number of joints to reduce cracking resulting from differential movement and shrinkage. CFS suggests joints be provided on a minimum spacing of twelve (12) feet on center. For additional recommendations refer to the ACI Design Manual.

The requirements for the slab reinforcement should be established by the designer based on experience and the intended slab use.

7.4 LATERAL EARTH PRESSURES

Lateral earth pressures are determined by multiplying the vertical applied pressure by the appropriate lateral earth pressure coefficient. If the foundation walls are rigidly attached to the building and not free to rotate or deflect at the top, CFS recommends designing the walls for the *at-rest* earth pressure coefficient. Walls that are permitted to rotate and deflect at the top can be designed for the *active* lateral earth pressure condition. Horizontal loads acting on shallow foundations are resisted by friction along the foundation base and by *passive* pressure against the footing face that is perpendicular to the line of applied force.

Table 5: Earth Pressure and Friction Coefficients

	Active (K_a)	**Passive (K_p)**	**At-Rest (K_o)**	**Allowable Base Friction**	**Unit Weight (pcf)**
Open-graded crushed limestone	0.27	3.69	0.43	0.47	130-140
In-situ lean clay soils	0.40	2.5	0.68	0.32	95-115
In-situ fat clay soils	0.49	2.04	0.66	0.24	90-110
Lean clay – conditioned and compacted	0.32	3.12	0.48	0.35	95-115
Fat clay/Weathered Shale – conditioned and compacted	0.45	2.2	0.63	0.27	90-110
Limestone Bedrock	-	-	-	0.55	140-150

These earth pressure coefficients do not include the effect of surcharge loads, hydrostatic loading, or a sloping backfill. Nor do they incorporate a factor of safety. Also, these earth pressure coefficients do not account for high lateral pressures that may result from volume changes when expansive clay soils are used as backfill behind walls with unbalanced fill depths. In addition, any disturbed soils that are relied upon to provide some level of passive resistance should be placed in lifts not exceeding six (6) inches in thickness and compacted to a minimum density of 95% of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within +- 3% of the optimum moisture content. It is recommended that a representative of CFS should verify the compaction of any such materials relied upon to provide passive pressure.

The actual earth pressure on the walls will vary according to material types and backfill materials used and how the backfill is compacted. If the backfill conditions are different than the ones used above, CFS should be notified so the recommendations can be modified. The buildup of water behind a wall will increase the lateral pressure imposed on below-grade walls. Adequate drainage should be provided behind any below grade walls as described in this report. The walls should also be designed for appropriate surcharge pressures such as adjacent traffic, interior building floor slab loads, and construction equipment.

7.5 Pavement Recommendations

The pavement sections presented below are considered typical and minimum for the report basis parameters. The given section has been included at the client's request, but please note that this section is not designed for support of construction traffic which may be associated with this project. CFS recommends paving be completed after completion of construction. Additionally, please note that the pavement section below exceeds the City of Lee's Summit standard section based on a structural number analysis associated with both sections. No traffic data included anticipated ESAL counts was available at the time of this report.

The client should be aware that thinner pavement sections might result in increased maintenance costs and lower than anticipated pavement life. The pavement area subgrade consists of moisture sensitive soils and shallow bedrocks.

The soils expected beneath the pavements consist of fat clays and shallow bedrocks. Please note that fat clays tend to expand and contract with changes in moisture and weather conditions, and they are considered very moisture susceptible, losing strength quickly.

CFS recommends the onsite fat clays be stabilized with Type 1/2 Cement for a depth of twelve (12) inches, when they are to be located directly beneath the planned pavements. *The 12-inch cement stabilization can be omitted if limestone and/or shale bedrock (N>50) material is encountered beneath the planned pavements.* The following tables should be reference for pavement section thicknesses.

Table 6: Recommended Light Duty Pavement Sections (Parking lots)

Recommended Thicknesses (inches) – Light Duty			
Asphalt		**Concrete**	
APWA Type 3-01 AC Surface	3	Concrete	5
Aggregate Base Course	6	Aggregate Base Course	4
5% Cement Stabilized Subgrade	12	5% Cement Stabilized Subgrade	12

Table 7: Heavy Duty Pavement Thicknesses (Truck areas and drives)

Recommended Thicknesses (inches) – Heavy Duty			
Asphalt		**Concrete**	
APWA Type 3-01 AC Surface	3	Concrete	7
Aggregate Base Course	6	Aggregate Base Course	4
5% Cement Stabilized Subgrade	12	5% Cement Stabilized Subgrade	12

Note: Eight (8) inches of concrete and four (4) inches of base rock is recommended for trash and/or recycling dumpster areas.

7.5.1 Cement Treated Base

It is recommended that the upper 12-inches of in-situ subgrade located beneath the planned pavement section and extending a minimum of two (2) feet laterally beyond the pavement lines, be treated with Type 1/2 Portland Cement to increase the strength of the subgrade and mitigate the risk of damage typically associated with expansive soils. Portland Cement should be thoroughly mixed with the in-situ subgrade materials at a concentration of 5% of the materials dry unit weight as determined by ASTM D698. The material should be compacted to 95% of the material's maximum dry density at a moisture content between 0 and 4% above optimum as determined by ASTM D698. Compacted lift thickness should not exceed the 12-inches or the capabilities of the compaction equipment.

Once the treatment has been completed, the subgrade should be hydrated regularly and protected from construction traffic for a minimum of five (5) days. The subgrade should be kept above 40 degrees during for the duration of this period to allow for proper curing and hydrating of the cement.

The cement stabilization can be omitted if limestone or shale bedrock is encountered beneath the pavements.

7.5.2 Aggregate Base Course

The aggregate base recommended in the pavement sections above should be placed in loose lifts not exceeding six (6) inches in thickness and should extend a minimum lateral distance of two (2) feet beyond the pavement lines. This extra width is structurally beneficial for wheel loads applied at pavement edge. The granular based should be compacted to at least 95% of the maximum dry density in accordance with ASTM D698. Please note, a 9-inch cement stabilization can be substituted for the recommended granular base course. However, this is recommended in addition to any cement stabilization used to treat the subgrade (i.e. if liquid limits exceed 55, 18-inches of cement stabilization may be used). Liquid limits should be verified during construction.

If open graded stone is used under the pavement, the pavement subgrade should be graded to provide positive drainage of the granular base section. Provision should be made to provide drainage into the storm water system. The use of a granular blanket drain near storm water inlets that provides weep holes from the drain to the inlets is recommended.

7.5.3 Asphalt Pavement Construction

Asphalt cement (bitumen) used in the manufacture of asphalt pavement should conform to the Performance Grading system. In the project area, the provincial grade asphalt binder course is PG 64-22. The asphaltic mix for conventional roadway should be designed for 4% air voids. During production, the voids can be expected to vary ±1% of the design value of 4%. Under these conditions, the minimum allowable VMA for base and surface course shall be 12% and 14%, respectively.

Immediately after spreading, each course of the pavement mixture should be compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a steel-wheeled vibratory roller. The motion of the roller should be slow enough at all times to avoid displacement of the hot mixture. The surface of the mixture after compaction should be smooth and true to established section and grade. The completed asphalt concrete paving should have a density equal to or greater than 95% for the base and 96% for the surface of theoretical density.

All asphaltic concrete mix designs and Marshall Characteristics should be submitted to our office and reviewed in order to determine if they are consistent with the recommendations given in this report. All materials to be employed and field operations required in connection with the pavement reconstruction should follow requirements and procedural details as per APWA 2001. In addition, representative of CFS should observe and monitor the pavement construction to assure satisfactory compliance with our engineering recommendations.

7.5.4 Concrete Pavement Construction

The pavement on this site will be subjected to freeze-thaw cycles. Sufficient air entrainment in the range of 6% to 8% is required to provide freeze-thaw durability in the concrete. Concrete with a 28-day specified compressive strength of 4,000 psi is recommended. The concrete mix should contain at least 564 pounds of concrete per cubic yard. A mixture with a maximum slump of 4 inch +/- 1 inch is acceptable. If a water-reducing admixture is specified, slump can be higher. For better performance and crack control, synthetic fiber reinforcement such as Fibermesh® 300 is recommended for the concrete instead of welded wire mesh. Add synthetic fiber reinforcement to concrete mixture in accordance with manufacturer's instructions.

8 General Comments

When the plans and specifications are complete, or if significant changes are made in the character or location of the proposed building, a consultation should be arranged to review the changes with respect to the prevailing soil conditions. At that time it may be necessary to submit supplementary recommendations.

It is recommended that the services of Cook, Flatt & Strobel Engineers be engaged to test and evaluate the compaction of any additional fill materials and to test and evaluate the bearing value of the soils in the footing excavations.

Respectfully submitted,

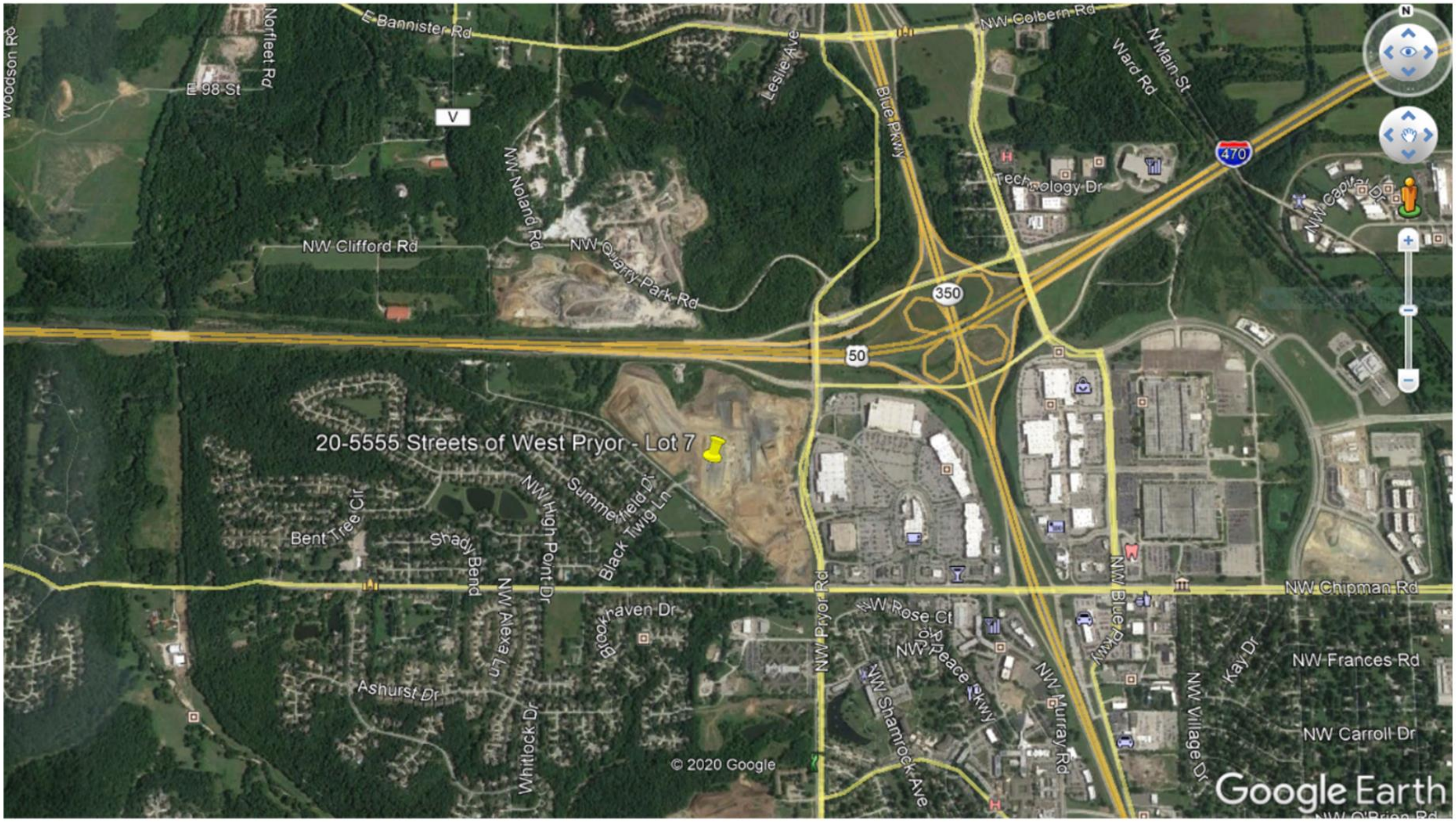
COOK, FLATT & STROBEL ENGINEERS, P.A.

STATE OF MISSOURI
JACOB PHILLIP
ENGLER
NUMBER
PE-2017018964
11/23/20
PROFESSIONAL ENGINEER

Jacob Engler, P.E.
Geotechnical Engineer

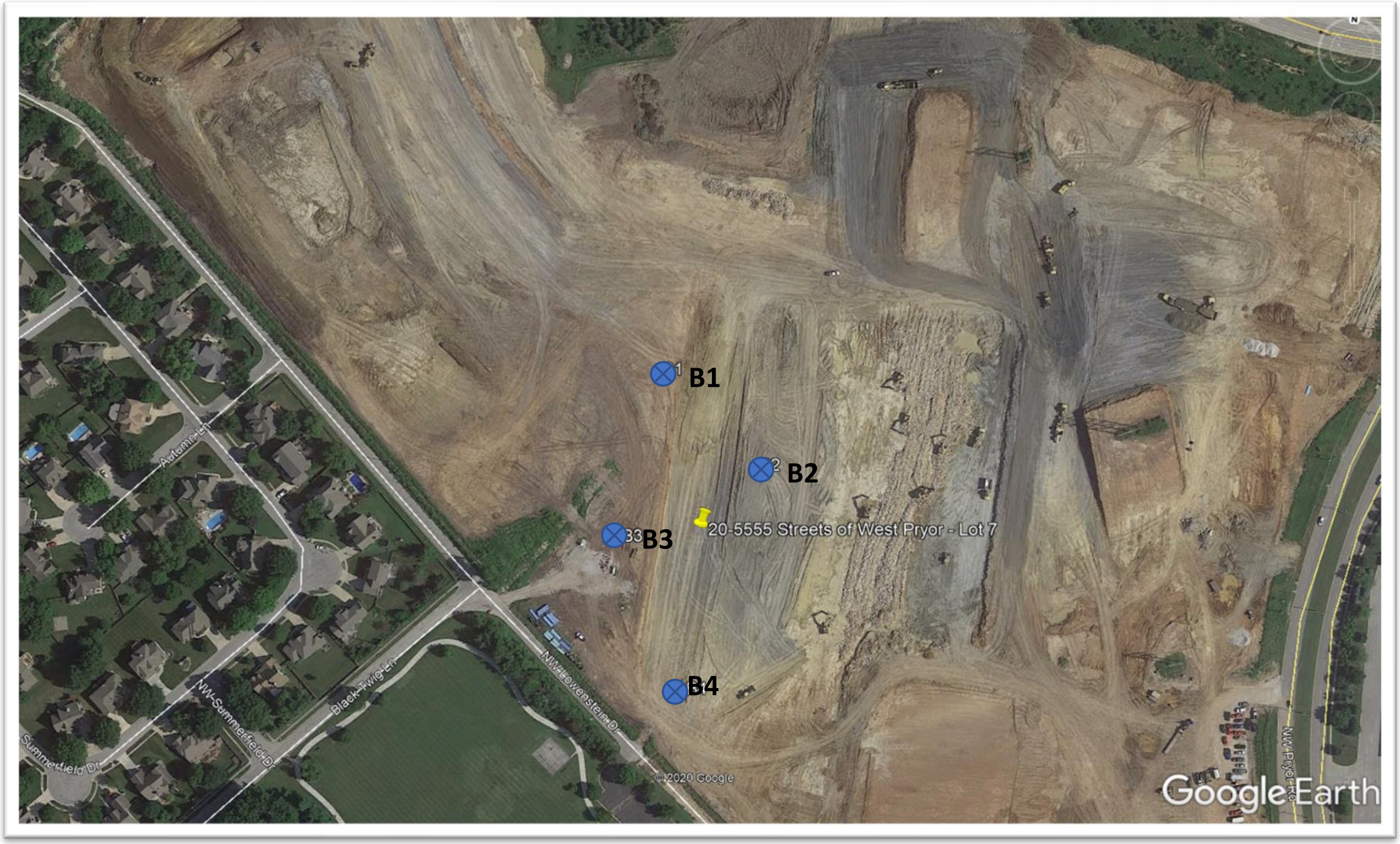
Reviewed by: Adam McEachron, P.E.
Senior Geotechnical Engineer

Appendix A: Figures



CFS ENGINEERS	Project: **STREETS OF WEST PRYOR - LOT 7**	Project #: 20-5555	Figure 1: **SITE LOCATION PLAN**
	Project Location: Lee's Summit, MO	Comments:	
	Client: Streets of West Pryor, LLC		
	Date: 11/23/2020		

1100 W. Cambridge Circle Dr, Ste 700
Kansas City, Kansas 66103



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Kansas City, Kansas 66103

Project: **STREETS OF WEST PRYOR - LOT 7**	Project #: 20-5555	Figure 2: **BORING LOCATION PLAN**	
Project Location: Lee's Summit, MO	Comments:		
Client: Streets of West Pryor, LLC			
Date: 11/23/2020			

Appendix B: Boring Logs

BORING NUMBER B1

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Streets of West Pryor
PROJECT NAME STREETS OF WEST PRYOR - LOT 7
PROJECT NUMBER 20-5555
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 11/06/20 **COMPLETED** 11/13/20
GROUND ELEVATION **HOLE SIZE** 6 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 6-inch Hollow Stem
AT TIME OF DRILLING ---
LOGGED BY FT **CHECKED BY** JE
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0	FAT CLAY, (CH) brown and grayish brown, moist, medium stiff										
	(CH) with highly weathered limestone fragments below 1'	SPT 1	100	50	1.5		53	70	38	32	
2.5	LIMESTONE, highly weathered, with voids										
	SHALE, highly weathered, tan, with voids	RC 2	33 (7)								
5.0											
7.5											
	SHALE, slightly weathered, gray	RC 3	63 (30)								
10.0											
12.5											
		SPT 4	100	50/5"							

Refusal at 2.0 feet.
Bottom of borehole at 13.9 feet.

CFS ENGINEERS

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B2

CLIENT Streets of West Pryor
PROJECT NAME STREETS OF WEST PRYOR - LOT 7
PROJECT NUMBER 20-5555
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 11/06/20 **COMPLETED** 11/06/20
GROUND ELEVATION **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING ---
LOGGED BY FT **CHECKED BY** JE
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		FAT CLAY, (CH) brown, moist, with highly weathered limestone fragments										

Bottom of borehole at 1.0 feet.

BORING NUMBER B3

CFS ENGINEERS
CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

CLIENT Streets of West Pryor
PROJECT NAME STREETS OF WEST PRYOR - LOT 7
PROJECT NUMBER 20-5555
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 11/06/20 **COMPLETED** 11/06/20
GROUND ELEVATION **HOLE SIZE** 3.25 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 3.25-inch Continuous Flight
AT TIME OF DRILLING ---
LOGGED BY FT **CHECKED BY** JE
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0.0		FAT CLAY, (CH) brown, moist										
		(CH) with highly weathered limestone fragments below 1.5'	SPT 1	100	4-50	4.25		22				
2.5												

Bottom of borehole at 2.5 feet.

CFS Engineers, Inc
1100 W. Cambridge Circle Drive, Suite 700
Kansas City, Kansas 66103

BORING NUMBER B4

CLIENT Streets of West Pryor
PROJECT NAME STREETS OF WEST PRYOR - LOT 7
PROJECT NUMBER 20-5555
PROJECT LOCATION Lee's Summit, Missouri
DATE STARTED 11/06/20 **COMPLETED** 11/13/20
GROUND ELEVATION **HOLE SIZE** 6 inches
DRILLING CONTRACTOR CFS Engineers
GROUND WATER LEVELS:
DRILLING METHOD 6-inch Hollow Stem
AT TIME OF DRILLING --- No Free Water Encountered
LOGGED BY FT **CHECKED BY** JE
AT END OF DRILLING --- No Free Water Encountered
NOTES
AFTER DRILLING --- No Free Water Encountered

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0.0		FAT CLAY, (CH) brown brown, moist										
		LIMESTONE, highly weathered										
2.5												
		LIMESTONE, slightly weathered, below 3'	RC 1	80 (55)								
5.0												
		SHALE, highly weathered, olive										
		SHALE, slightly weathered, gray, below 6'										
7.5												
			RC 2	100 (63)								
10.0												

Refusal at 1.0 feet.
Bottom of borehole at 11.0 feet.