



ECS Southeast, LLC

Geotechnical Engineering Report

Express Oil – Shelbyville, KY

Freedom's Way & Protegrity Drive
Shelbyville, Shelby County, Kentucky 40065

ECS Project Number 61:3446

December 17, 2025





ECS SOUTHEAST, LLC

Geotechnical • Construction Materials • Environmental • Facilities

December 17, 2025

Mr. Tyler Hendon
Express Oil Change & Tire Engineers
1880 Southpark Drive
Birmingham, AL 35244

Reference: Geotechnical Engineering Report
Express Oil – Shelbyville, KY
Freedom's Way & Protegrity Drive
Shelbyville, Shelby County, Kentucky 40065
ECS Project 61:3446

Dear Mr. Hendon,

ECS Southeast, LLC (ECS) has completed the subsurface exploration and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with ECS Proposal No. 61:P4169, dated October 28, 2025.

This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration, laboratory testing conducted, and our geotechnical related design and construction recommendations.

It has been our pleasure to be of service to Express Oil Change & Tire Engineers during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase and would like to provide our services during construction operations as well to confirm the interpreted subsurface conditions utilized in this report. Should you have any questions concerning the information contained in this report, or if we can be of further assistance to you, please contact the writers.

Respectfully submitted,

ECS Southeast, LLC

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EXECUTIVE SUMMARY

The following conditions were characteristic of the encountered site and subsurface conditions:

- Based on the provided information, the proposed construction will include the construction of a new Express Oil Change building with associated paved parking areas and drive lanes located at the southwest corner of Freedom's Way and Protegrity Drive in Shelbyville, Shelby County, Kentucky.
- At the time of the subsurface exploration, the site was partially developed. The lot appeared to have undergone prior grading during the construction of Protegrity Drive in 2024. According to Google Earth historic aerial imagery, the site had originally been a residential lot prior to 2008-2009, at which point it was demolished during the construction of Freedom's Way. The site generally falls from west to east, with approximately 12 to 15 feet of elevation change across the proposed construction footprint.
- Surface materials encountered consisted of 2 to 4 inches of topsoil in all borings.
- Surface materials were underlain by existing fill that generally consisted of brown, moist, low to moderate plasticity, silty LEAN CLAY (CL), with trace organics and gravel in two (2) borings (B-05 and B-06) conducted and extended approximately 0.2 to 1.5 feet below existing grades.
- Surface materials or existing fill were generally underlain by native soils consisting of brown to yellowish brown, stiff, moist, low to moderate plasticity LEAN CLAY (CL) and yellowish brown, very stiff to hard, moist, moderate to high plasticity FAT CLAY (CH).
- Drilling equipment refusal was encountered in seven (7) borings from 3.5 to 7.9 feet below existing grades.
- Drilling equipment refusal was not encountered in one (1) boring (B-05) prior to termination depth of 10.5 feet below existing grades.
- Groundwater was not observed in our borings at the time of our exploration.

GEOTECHNICAL CONCERNS:

- | | | |
|-------------------------------|--------------------------|-------------------------|
| – Shallow Rock | – Karst | – Subgrade Improvement |
| – Variable Bearing Conditions | – Highly Plastic Clays | – Weather Consideration |
| – Existing Fill | – Reuse of On-Site Soils | |
| – Groundwater | – Degradable Soils | |

DESIGN & CONSTRUCTION RECOMMENDATIONS:

- Recommendations in this report were based on assumed finish floor elevations. ECS should be contacted to provide appropriate values and recommendations for changes to the assumed elevations.
- Existing uncontrolled fill was encountered at depths extending to approximately 1.5 feet below existing grades in two (2) borings. ECS considers the existing fill as not adequate bearing material for foundations. The existing fill may be left in-place in the slab and pavement areas, provided, the risks associated with the existing fill are acceptable by the owner.
- The proposed building may be supported on conventional shallow foundations bearing on stiff or stronger native materials (weathered or competent limestone), structural fill, lean concrete, flowable fill, or continuous rock as defined in this report. The following net allowable design bearing pressures may be used in foundation design:
 - 2,000 psf for continuous wall foundations
 - 2,500 psf for isolated column foundations.
- The foundation excavations and floor subgrades should be evaluated by an ECS representative during construction to confirm that encountered conditions are consistent with this exploration.
- Floors may be designed as slabs-on-grade with a subgrade modulus of 100 pci.
- A site class of "C" may be used in seismic design per the 2018 Kentucky Building Code.
- Flexible and/or rigid pavements may be used in proposed pavement areas. Rigid pavements should be considered for entranceways, dumpster pads, or other areas where heavy vehicles will turn on a tight radius or be parked for extended periods of time.

This Executive Summary is intended as a very brief overview of the primary geotechnical conditions that are expected to affect design and construction. Information gleaned from this Executive Summary should not be utilized in lieu of reading the entire geotechnical report. Details of our conclusions and recommendations are discussed in the report text.

1.0 INTRODUCTION

1.1 GENERAL

The purpose of this study was to provide geotechnical information for the design of foundations, floor slabs, and pavements for the proposed development of a new one-story Express Oil Change building with associated paved areas and a dumpster pad located at the southwest corner of Freedom's Way and Protegrity Drive in Shelbyville, Shelby County, Kentucky. The recommendations developed for this report are based on project information supplied by Mr. Tyler Hendon of Express Oil Change & Tire Engineers.

This report contains the results of our subsurface exploration and laboratory testing programs, site characterization, engineering analyses, and recommendations for the design and construction of the planned structures and pavements.

This report discusses our exploratory and testing procedures, presents our findings and evaluations and includes the following:

- Summary of the project information provided.
- Description of existing site conditions, reported geology, and encountered subsurface conditions.
- Assessment of general adequacy of the site for the intended use from a geotechnical standpoint.
- Site preparation and controlled fill placement recommendations.
- Recommended foundation type(s), design parameters (including lateral earth pressure coefficients) and construction evaluations.
- Recommended slab-on-grade design parameters and construction evaluations.
- Site class for seismic design based on the boring data and on available data from the vicinity.
- Recommended pavement design parameters and construction evaluations.
- Other identified geotechnical concerns and recommended additional sampling/testing/analysis.

Our services were provided in accordance with our Terms and Conditions of Service included in ECS Proposal No. 61:P4169, dated October 28, 2025.

2.0 PROJECT INFORMATION

2.1 SITE INFORMATION

SUBJECT	SUMMARY OF EXISTING SITE CONDITIONS
Site Address	The site was located at the southwest corner of Freedom's Way and Protegrity Drive in Shelbyville, Shelby County, Kentucky. Refer to Site Location Diagram in the Appendix for approximate location of site.
General Description & Topography	At the time of the subsurface exploration, the site was partially developed. The lot appeared to have undergone prior grading during the construction of Protegrity Drive during 2024. According to Google Earth historic aerial imagery, the site had originally been a residential lot prior to 2008-2009, at which point it was demolished during the construction of Freedom's Way. The site generally falls from west to east, with approximately 12 to 15 feet of elevation change across the proposed construction footprint.
Surface Water Drainage	Surface drainage appeared to be fair.
Ground Cover	Grass with some gravel areas over existing fill and native soils.

2.2 PROPOSED CONSTRUCTION

SUBJECT	DESIGN INFORMATION / EXPECTATIONS
Project Description	The proposed construction will include the construction of a new Express Oil Change building with associated paved parking areas and drive lanes located at the southwest corner of Freedom's Way and Protegrity Drive in Shelbyville, Shelby County, Kentucky.
Usage	Commercial.
Maximum Column Loads	25 kips (provided).
Maximum Wall Loads	2.5 kips per linear foot (provided).
Finish Floor Elevation	748 EL (assumed).
Maximum Cut/Fill	± 5 feet overall site grading (assumed).
Conversations/E-mail	Mr. Tyler Hendon of Express Oil Change & Tire Engineers.
Project Information Sources	"Shelbyville, KY (Protegrity Place) – Boring Plan (Undated) – provided by Mr. Tyler Hendon of Express Oil Change & Tire Engineers.

3.0 SITE GEOLOGY

According to the Geologic map of the Simpsonville Quadrangle, Shelby County, Kentucky, published by the Kentucky Geological Survey, and information obtained from the Kentucky Geologic Map Service website, the project site is underlain by the Grant Lake Limestone formation.

Site Geology - Underlying Formations ⁽¹⁾		
FORMATION	DESCRIPTION	KARST POTENTIAL ^{2,3}
Grant Lake Limestone	Primary Lithology: Limestone and shale Description: Limestone and shale: Limestone (about 75 percent) is medium gray to olive gray, composed of abundant whole fossils and fossil fragments in a fine to coarse grained calcitic matrix containing some quartz silt and clay. Shale is dominantly greenish gray, silty, argillaceous, calcareous; contains abundant whole fossils and fossil fragments.	Prone ⁴

Notes:

- (1) Source: Geologic map of the Simpsonville Quadrangle, Shelby County, Kentucky, published by the Kentucky Geologic Survey, and information obtained from the Kentucky Geologic Map Service website.
- (2) Karst is topography commonly formed over limestone or dolomite and characterized by sinkholes, irregular rock conditions, underground drainage, springs, and caves.
- (3) The karst potential level is based on the tendency for the site to develop or have karst features and is not necessarily indicative of the actual presence or absence of existing karst activity at the site.
- (4) According to the Kentucky Geologic Survey (KGS) Karst Potential Classification definitions, sites designated as "Prone" designate areas underlain by bedrock with moderate potential for karst development. Development of karst features in this category is variable and dependent on site-specific conditions. Occurrence of caves may be influenced by physiographic setting, unit thickness, and lithology.

4.0 FIELD EXPLORATION AND LABORATORY TESTING

4.1 SUBSURFACE CHARACTERIZATION

SUBJECT	SUMMARY OF SUBSURFACE EXPLORATION ⁽¹⁾
Boring Method	Direct Push.
Sampling Method	Standard Penetration Testing (ASTM D-1586).
Number of Borings	Eight (8) soil test borings were performed. - Borings B-01 through B-06 were within the proposed paved areas. - Boring B-07 was within the proposed building area. - Boring B-08 was within the proposed building area (within the planned pit area).
Boring Locations	Refer to Boring Location Diagram in the Appendix for specific locations.
Boring Depths	Refer to Geotechnical Borehole Logs in the Appendix .
Logging Method	Full-time presence of an ECS engineer to observe, direct, and document the drilling, sampling and testing results, and encountered conditions.
Groundwater	Groundwater was not observed in our borings at the time of exploration.
Refusal ⁽²⁾	Drilling equipment refusal was encountered in seven (7) of the eight (8) borings from 3.5 to 7.9 feet below existing grades.

Notes:

- (1) Detailed descriptions of the exploration methods are listed in the **Field Procedures** section of the **Appendix**.
- (2) Refusal is the term applied to material that cannot be penetrated with augers or has a Standard Penetration resistance exceeding 50 blows per 6-inch increment or 10 blows with little to no penetration of the splitspoon. Refusal may be encountered on continuous bedrock, discontinuous floaters, cemented soil, weathered rock, debris, buried structures, or other hard subsurface materials.

The following sections provide generalized characterizations of the soil strata. Please refer to the **Geotechnical Borehole Logs** and **Generalized Subsurface Soil Profile** in the **Appendix**.

APPROXIMATE DEPTH (FT)	STRATUM	DESCRIPTION	N-VALUES BLOWS PER FOOT (BPF)
0.2 – 1.5	I	FILL – LEAN CLAY (CL) – Generally consisted of brown, moist, low to moderate plasticity, silty LEAN CLAY (CL), with trace organics and gravel. Encountered in two (2) of the eight (8) borings below surface materials extending approximately 0.2 to 1.5 feet below existing grades.	N/A
0.2 – 4.0	II	LEAN CLAY (CL) – Generally consisted of brown and yellowish brown, moist, low to moderate plasticity, LEAN CLAY (CL) with some silt. Encountered in all eight (8) borings extending approximately 0.2 to 4.0 feet below existing grades.	6 to 8
3.5 – 10.5	III	FAT CLAY (CH) – Generally consisted of yellowish brown, moist, moderate to high plasticity FAT CLAY (CH) with some black oxide nodules and rock fragments. Encountered in all seven (8) of the borings extending to boring termination or drilling equipment refusal depths of 3.5 to 7.8 feet below existing grades.	9 to 50+

Notes:

- (1) This summary is generalized and does not describe the actual conditions in each boring. These zones also may not occur at each location. Depths are approximate. Detailed descriptions of the encountered materials are listed on the **Geotechnical Borehole Logs** in the **Appendix**.

4.2 LABORATORY TEST SUMMARY

The laboratory testing was performed on selected samples obtained during our field exploration operations. Classification and index property tests were performed. The laboratory testing program included:

- Natural Moisture Content
- Atterberg Limits

Each sample was visually classified in the field on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures), including Unified Soil Classification System (USCS) classification symbols, and ASTM D2487 Standard Practice for Classification for Engineering Purposes. After classification, the samples were grouped in the major zones noted on the **Geotechnical Borehole Logs** in the **Appendix**. The group symbols for each soil type are indicated in parentheses along with the soil descriptions. The stratification lines between strata on the logs are approximate; in situ, the transitions may be gradual.

SUMMARY OF LABORATORY TEST RESULTS ⁽¹⁾					
STRATUM	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	UNIFIED SOIL CLASSIFICATION
I	20.5 – 30.3	–	–	–	–
II	21.0 – 26.1	41	20	21	CL
III	13.4 – 28.9	61	23	38	CH

Notes:

- (1) A more detailed summary of the laboratory test results is included on the **Geotechnical Borehole Logs** in the **Appendix**. Detailed descriptions of the laboratory test methods are listed in the **Laboratory Procedures** section of the **Appendix**.

5.0 GEOTECHNICAL CONCERNS

Analysis of the provided project information, observed site conditions, encountered subsurface conditions, and our past experience with similar projects, revealed the following important geotechnical considerations. These considerations should be properly addressed in planning, budgeting, design, and construction phases to reduce impacts on construction cost, completion schedule, performance of the building and site improvements, and long-term maintenance of the proposed construction. Our recommendations for addressing these concerns are provided in subsequent sections of this report.

5.1 SHALLOW ROCK

- Refusal was encountered 3.5 to 7.9 feet below existing grades in seven (7) of the eight (8) borings conducted on-site during this exploration.
- The finished building elevation was estimated to be EL 748. Based on the assumed finished floor elevations, rock removal should be anticipated during foundation and utility trench excavations throughout the proposed building footprint (assuming oil change pit foundations will rest at a depth of about 8 to 10 feet below existing grades).
- The upper few feet of weathered limestone can generally be excavated with a large trackhoe. However, thicker bedded and less weathered limestone will likely require the use of a hoe-ram, blasting, or other specialty rock removal methods for efficient excavation.
- If blasting is required to remove the rock, the nearby structures, effects of fractured rocks and over-shot rock, and the potential effects of blasting in karst activity need to be taken into consideration. If possible, rock removal with a hoeram or other suitable equipment should be used.
- The difficulty of rock removal will be affected by the methodology used, the experience of the operator, and the type of equipment used.
- Isolated karst features, including rock pinnacles, ledges, and “floaters” projecting above the predominant rock surface, and deep soil filled or open slots, may be encountered in excavations and cut areas.
- In consideration of such variations, the available data may not reliably depict the irregularities of the actual rock present.

5.2 VARIABLE BEARING CONDITIONS

- The presence of refusal material (apparent bedrock) at or within approximately 12 inches of foundation bearing elevations can create concerns related to variable foundation bearing conditions.
- Stress concentrations, which can damage overlying construction if not properly accommodated, tend to develop at the transition from soil to rock. The differential settlement created by two differing bearing materials also can be a concern.
- Variable bearing conditions should be anticipated in areas where both rock and soil/highly to completely weathered rock are exposed at or near the planned foundation elevations.
- The stress concentrations and differential settlement concerns caused by shallow rock in limited areas can be addressed by constructing a minimum 12-inch thick soil cushion between the rock and structural building element (i.e., foundations, slabs, etc.) that can dissipate the stress concentrations, strategically placed control joints, or designing foundations as a grade beam system that can dissipate and accommodate the differential stresses.

- The predominance of rock and rock quality for the on-site conditions should be carefully considered when selecting the best approach for areas where variable bearing conditions are anticipated (e.g., whether rock removal, excavating the soil/highly to completely weathered rock to bear entirely on rock is preferable, or designing for differential conditions with control joints or grade beams).

5.3 EXISTING FILL

- Existing fill was encountered in two (2) of the seven (7) borings and extended approximately 0.2 to 1.5 feet below existing surface grades. Fill generally consisted of brown, moist, low to moderate plasticity, silty LEAN CLAY (CL), with trace organics and gravel. Based on assumed bearing elevations, minimal (e.g., less than 0.5 feet) to no existing fill is anticipated at or below the building foundation bearing elevations.
- Depths of existing fill may vary drastically between borings, resulting in significant existing fill depths in foundation excavations.
- The fill was considered uncontrolled or undocumented because no recorded data is available documenting the material quality or content of the existing fill.
- The existing fill encountered on site creates numerous subsurface challenges that increase costs, including the cost of designing foundations to mitigate or reduce the risks inherent with uncontrolled fill.
- Potential problems for the proposed construction created by the presence of the existing uncontrolled fill include larger than normal total and differential settlements, collapse of buried objects, and poor bearing support. The manifestation of these problems can cause poor foundation and slab performance.
- If existing, uncontrolled fill is encountered on site in areas unexplored during drilling activities, it may be likely that the material encountered will vary in consistency and composition from what was encountered during our exploration. If existing fill conditions encountered on-site are significantly different from those described in this report, ECS should be notified so that recommendations for removal and/or remediation can be updated, if necessary.

5.4 KARST

- The site was underlain by geologic formations that have a “prone,” KGS Karst Potential Classification for solution features, such as an irregular rock surface with pinnacles and slots, isolated rock slabs or “floaters”, sinkholes, soil-filled or open joints and bedding planes, springs, etc.
- According to the Kentucky Geological Survey (KGS), one (1) karst depression was mapped approximately 1 mile southeast of the site. However, no surface signs of closed depressions were observed on-site during the geotechnical exploration. No obvious evidence of karst activity was encountered in the borings conducted during the exploration.
- Construction in karst areas presents risks that the owner must be willing to accept. The primary geotechnical risks include:
 - Settlement, subsidence and/or collapse of the subsurface materials.
 - Deposits of soft and/or organic soils in existing sinkholes.
 - Irregular upper rock surface, discontinuous rock layers, highly weathered rock, and generally variable conditions.
 - Poor correlation between refusal depths and the actual depth to rock.

- Changes to natural sinkhole/spring drainage systems, as well as poor surface drainage, and leaking water or sewer lines can lead to the development of new sinkholes.
- Site development costs typically are higher in karst areas due to the costs associated with reducing the karst risks during design and construction.
- The risks associated with karst topography are common for the project vicinity, are not unique to the site, and can be reduced, but not eliminated, by following the recommendations provided in this report.
- Treatment of individual sinkholes, if encountered, is heavily dependent on the specific conditions unique to each sinkhole, but typically would consist of stabilization of the feature and construction of an inverted filter over the feature (larger rocks progressing to smaller rocks, enclosed in non-woven filter fabric).

5.5 HIGH PLASTICITY CLAYS

- High plasticity clays (i.e., plasticity index greater than 30 – generally designated as “CH” in report and on boring logs) were encountered in all eight (8) of the borings.
- High plasticity clays are susceptible to volume changes (shrink/swell problems) with changes in moisture. Accordingly, it is advisable to reduce the potential for moisture changes to the soil because of the shrink/swell concerns and the possible impact on the proposed construction.
- Volume changes associated with the highly plastic clays in the geologic formation underlying the site have the potential to produce damage (e.g., heave or subsidence, and pavement cracking).
- Movement may be cyclic (shrink when dry, swell when wet), continuing to produce distortions that require increased and regular maintenance or repair.
- Typically, the volume changes are not of the magnitude to result in damage that would impair the structural integrity.
- Exposure to prolonged wet or dry weather conditions during construction can result in volume changes in bearing and subgrade materials or problems achieving the required compaction levels.

5.6 REUSE OF ON-SITE SOILS

- In general, most of the on-site soils, appeared adequate for reuse as structural fill provided the soils are moisture conditioned to appropriate moisture contents for compaction.
- Existing fill may be considered for reuse provided no inadequate materials are present. Sorting to remove inadequate (e.g., organics, remnant topsoil, remnant construction debris, etc.) or oversized material from the existing fill should be expected prior to reuse.
- Some wetting, drying, mixing or chemical treatment of the soils may be necessary to obtain workable moisture contents for the on-site soils, especially during wetter times of the year.
- Reuse of the on-site soils will be subject to the weather considerations described subsequently.

5.7 DEGRADABLE SOILS

- Most of the soils on-site are susceptible to degradation (i.e., silty clay soils). Degradable soils readily lose strength, become soft, and “pump” when subjected to construction equipment, especially under wet conditions.
- Exposure to wet or dry weather conditions may result in the need to adjust moisture contents to achieve the desired compaction and fill texture.

- Undercutting and/or stabilization of clay or silt soils could have a cost impact on the project, especially if not properly addressed in the project documents (e.g., definition of what is poor-quality and whose responsibility is maintenance of these soils once stabilized) or if not properly addressed during construction (e.g., subjected to repeated construction traffic with no protection).

5.8 SUBGRADE IMPROVEMENT

- Localized improvements will likely be required in some areas due to the presence of degradable soils, existing fill, and groundwater, especially if construction occurs during the wetter/cooler periods of the year.
- The required extent of improvement will depend to a large degree on when earthwork operations take place as well as on how the earthwork contractor prepares the site. The level of improvement likely will increase if:
 - Construction traffic is concentrated along localized soft or poor subgrade routes.
 - Earthwork occurs during cool, wet periods (typically November through May).
- Provided construction occurs during the drier time of the year, it would be our expectation that much of the improvement could be achieved by scarifying, drying and recompacting the soils. If construction occurs during the wetter periods of the year, more aggressive treatment would likely be required (i.e., removal and replacement or lime drying).
- Subgrade improvement alternatives, if required, include but are not limited to:
 - Scarification, drying, and recompaction of surface materials.
 - Removal of inadequate materials and replacement with structural fill.
 - Bridging with a thick lift of limestone aggregate.
 - Placement of a geosynthetic or geo-grid in combination with granular fill.
 - Chemical stabilization and/or modification (e.g., kiln dust, lime, or Portland cement).
- The type of subgrade improvement chosen should take weather limitations, or other limitations unique to each method, into consideration.

5.9 WEATHER CONSIDERATIONS

- Conducting site work during periods of cool and/or wet weather (typically November to May) can be problematic for sites in the project region.
- Proper compaction of soil fill generally is very difficult to achieve during periods of cool and/or wet weather. Some drying, mixing, or chemical treatment of the soils would be necessary to obtain workable moisture contents for the on-site soils or proposed borrow materials if placed during the cool, wet seasons.
- If compaction of soil fill takes place under wet weather conditions, increased earthwork costs, an extended construction schedule, and soil improvement (likely chemical stabilization) likely would be required. In addition, reuse of the site soils may be severely limited.
- Surface soils tend to be softer during wet weather conditions due to the excess moisture in the near surface soils.
- Weather-softened surface soils tend to result in more undercutting and/or stabilization than would be required during dry weather conditions, which increases site development costs.
- Project specifications should include definitions and unit rates for subgrade stabilization, removal of inadequate soils, and replacement of inadequate soils with structural fill appropriate for use during the anticipated construction season.

6.0 SITE CONSTRUCTION RECOMMENDATIONS

6.1 PLANNING

- Adjust project plans, specifications, schedules, and budgets to incorporate the issues discussed in **Section 5.0** and the recommendations provided herein.
- Findings and recommendations in this report are based on the provided finished floor elevation. As such, ECS should be contacted to provide appropriate values and recommendations for changes to the provided elevation.
- ECS should be contacted to provide appropriate recommendations if the assumed loading values, or the planned design (including site layout) changes significantly than those stated in **Section 2.0**.

6.2 SUBGRADE PREPARATION

- Localized improvements will likely be needed in some areas, especially if construction occurs during the wetter/cooler periods of the year.
- Subgrade improvements may include chemical stabilization, bridging with stone, or use of geogrid.
- The depth and extent of improvement required will be dependent on the time of year of construction, the weather preceding site work, and the site work techniques employed.
- The following subsections describe our general recommendations for preparing the site subgrade prior to fill placement operations.

Stripping and Grubbing:

- Materials required to be stripped and removed:
 - Vegetation, topsoil, organic material, rootballs, asphalt pavements, existing construction, existing gravel surfaces, and excessively wet, desiccated, frozen, contaminated or otherwise inadequate materials.
- Minimum extent of stripping:
 - 10 feet beyond the building limits.
 - 5 feet beyond the pavement limits.
- ECS should observe and document that topsoil and poor-quality surface materials have been removed prior to the placement of structural fill or construction of structures.
- Stripped material not meeting structural fill requirements should be considered for reuse in landscaped areas only.

Subgrade Improvement:

- Based on the conditions encountered at the site and in the borings, some of the native materials could require undercutting to develop an adequate construction platform and fill base, depending on how the site is ultimately developed.
- The construction budget should be adjusted to reflect the adverse subgrade conditions expected in some areas.

Subgrade Evaluation:

- Proofroll the site in the presence of an ECS representative with a pneumatic-tired vehicle (e.g., triaxial dump truck) loaded as recommended by the ECS representative.
- Proofroll subgrades prior to filling or after excavation to grade.

- Proofroll pavement subgrades prior to granular base placement.
- Areas judged by the ECS representative to deflect excessively during proofrolling should be remediated in accordance with the recommendations provided at that time.
- Prepare subgrades with a slight slope to maintain surface drainage.

Other Measures:

- Roll subgrade surfaces smooth if rain is expected.
- Slope final subgrades away from the proposed structure.
- Rough grade subgrades high to allow for removal of degraded soil.
- Remove soil frozen or softened by rain.
- Construct stabilized haul roads for construction equipment.

6.3 STRUCTURAL FILL

Subgrade Requirements:

- Subgrade proofrolled and required improvements completed.

Fill Material Requirements:

- No deleterious debris.
- No rock pieces larger than 3 inches.
- Less than 3% organic material (loss on ignition).
- Maximum dry density of at least 100 pcf according to the Standard Proctor compaction method (ASTM D-698), unless specifically approved otherwise by ECS.
- Acceptable Unified Soil Classifications (USCS): CL, CH (if approved by ECS), ML, GW, GM, GC, GP, SW, SP, SM, and SC.
- Unacceptable USCS classifications: CH (if not approved by ECS), OL, OH, Pt, and MH.
- Evaluated and approved by ECS prior to construction.

Fill Placement Guidelines:

- Minimum compaction:
 - 98 % standard Proctor maximum dry density (ASTM D-698).
- Moisture Content:
 - Within 2 % of optimum (ASTM D-698) if plasticity index less than 30.
 - Within 3 % of optimum (ASTM D-698) if plasticity index greater than 30.
- Maximum loose lift thickness: 8 inches.
- Compaction test frequency:
 - One test per lift for each 5,000 square feet of fill placed.
 - Minimum of 3 tests per lift.
- Bench new fill into existing slopes or sidewalls in 1 foot steps or as approved by ECS at the time of construction.
- Compact and test each lift prior to placing additional lifts.
- Scarify smoothed fill surfaces prior to placing the next lift.

- Maintain positive surface drainage on fill surfaces during placement to avoid the likelihood of water ponding.
- Roll fill surfaces smooth if rain is expected.
- Rough grade high to allow for removal of degraded surface soils if fill will be exposed to adverse weather conditions.
- Do not place fill on a frozen subgrade. At a minimum, remove frozen material, or allow to thaw and then recompact.

6.4 SHALLOW ROCK

- Drilling equipment refusal was encountered between approximately 3.5 and 7.9 feet below existing grades in the borings. However, the depth of rock varied on-site and may be present at deeper depths within the building footprint. Specifically, rock may be encountered in the excavation of pit foundations at an assumed depth of 8 to 10 feet below existing grades.
- Greater than normal differential settlement likely will occur if foundations are supported on both rock and soil simultaneously. Alternatives to address this concern include:
 - Adjust the floor elevation and/or building location to avoid this condition.
 - Assume that soil/weathered rock-bearing conditions will be predominate, and create a soil cushion above rock, where necessary to address the shallow rock. To create the soil cushion, remove rock and backfill with compacted clay, weathered rock from on-site, or manufactured sand fill (gravel is not appropriate for creation of a soil cushion) where necessary, so that foundations bear on at least 12 inches of approved native soil or compacted clay or sand fill.
 - Support the building on isolated column foundations tied together with grade beams designed to reduce the effects of differential settlement. Isolated columns may bear entirely on rock or on soil/weathered rock but not both simultaneously. Adjacent columns may bear entirely on rock or soil/weathered rock.
- Shallow rock is anticipated in foundation excavations.
- The method used to remove the on-site rock, if necessary, should be selected by the contractor. Removal of the on-site rock with conventional excavation equipment is not expected to be effective. The competent rock on-site requires special rock removal equipment (e.g., blasting, hoe-ram, etc.) for efficient excavation.
- If blasting is selected, it should be planned to avoid damaging nearby construction. Condition surveys of nearby construction should be conducted prior to blasting. Also, removal and replacement of up to 3 feet of overblast rock should be anticipated and included in the construction budget because overshot rock is not acceptable for support of the planned construction.

6.5 EXISTING FILL

General Comments:

- The recommendations contained in this report assume that the existing fill is uncontrolled fill.
- Structural fill should be placed and compacted in accordance with the recommendations provided in this report.
- Existing uncontrolled fill was encountered in two (2) of the eight (8) borings and extended approximately 0.2 to 1.5 feet below existing grades.

Foundations:

- Existing uncontrolled fill was not encountered within the building borings during this exploration. The uncontrolled fill is not adequate for support of new foundations.
- Due to the shallow depths of fill encountered and reported, existing fill is not anticipated to be encountered at bearing elevations.
- If existing fill is encountered within the foundation excavations, the existing fill should be removed and replaced with structural fill as described in this report (**Section 6.3**).
- We recommend visual observation, probing, hand augering, and dynamic cone penetrometer tests to be performed by an ECS representative at the time of construction to evaluate the bearing conditions.
- Improvement of the bearing conditions as recommended by ECS based on the results of the evaluations mentioned above will be required. This can include undercut and replacement of the existing fill, where inadequate bearing conditions and poor-quality soils are encountered during construction.

Floor Slabs/Pavements:

- Existing fill may be left in-place below floor slabs and pavements provided the owner is willing to accept the associated risks described in **Section 5.3**. Due to the shallow depths of existing fill encountered and reported, the risks associated with existing fill are lessened.
- If existing fill is left in-place in floor slab and pavement areas and the owner is willing to accept the associated risks, the risks associated with the existing fill in floor slab and pavement areas can be reduced by implementing the following recommendations:
 - Visual observation and proofrolling evaluation of the subgrade by an ECS representative at the time of construction.
 - Improvement of the subgrade as recommended by ECS based on the results of proofrolling and observations.
- The risk in floor slab and pavement areas can be somewhat reduced if the upper 2 feet of existing fill is removed and replaced with structural fill. In pavement areas, a geofabric such as Mirafi HP570, or equivalent, should be placed on the existing fill subgrade before placing the structural fill.
- If the risks associated with the existing fill, as described in a previous section, are not acceptable, the existing fill should be entirely removed and replaced with structural fill.

6.6 KARST

- The limestone formation mapped at the site is considered to have an “prone” potential for karst features. Construction in karst areas presents risks that the owner must be willing to accept. The following measures can reduce these risks:
 - Evaluate and proofroll the subgrade prior to any fill placement under the direction of an ECS representative.
 - Remediate any disclosed karst features per recommendations provided by ECS during construction.
 - Provide proper drainage around the proposed construction, including sloping the surface away from the buildings.

- Floor slab and pavement subgrades should be sloped to drain similar to the surface conditions. Provide outlets for any water that may collect in the floor slab or pavement gravel base. This may include providing drainage mechanisms in building areas or installing weepholes in catchbasins in pavement areas.
 - Roof drains should not discharge to the ground surface within 20 feet of proposed or existing structure, unless the surface is impervious (such as concrete or pavement).
- If karst features are discovered during onsite earthwork activities, ECS should be contacted to provide treatment and construction recommendation during the construction phase of the project, based on additional evaluation at that time.
- Treatment of individual sinkholes, if encountered, is heavily dependent on the specific conditions unique to each sinkhole, but typically would consist of stabilization of the feature and construction of an inverted filter over the feature (larger rocks progressing to smaller rocks, enclosed in non-woven filter fabric). Additional recommendations to address karst are provided in subsequent sections.

6.7 HIGH PLASTICITY CLAYS

- The measures provided below will significantly reduce, but not eliminate, the likelihood the proposed construction will be impacted by the presence of high plasticity clays:
 - Test the moisture content of subgrade soils. Adjust soil moisture if the results fall outside the range of optimum to plus 3% above optimum.
 - Roof drains and surface drainage should not discharge or be directed to the ground surface within 20 feet of the proposed structures, unless the surface is impervious (such as concrete or pavement), to reduce moisture changes of the foundation soils.
 - Proper drainage should be provided around the proposed construction (e.g., slope the surface away from the building).
- If the risks associated with the high plasticity clays are not acceptable, then:
 - Do not place high plasticity clay fills within 2 feet of the planned finish subgrades (building and pavement).
 - Undisturbed high plasticity clays within 2 feet of planned finish subgrades and foundation bearing elevations are removed and replaced with low to moderate plasticity clay fill soils.

7.0 DESIGN RECOMMENDATIONS

7.1 SHALLOW FOUNDATIONS

General Comments:

- The proposed buildings may be supported on conventional shallow foundations.
- Foundations must bear in stiff or better undisturbed native soils/weathered rock, structural fill, flowable fill, lean concrete, or continuous rock.
- Foundations must penetrate existing fill and bear on underlying stiff or better natural soils, weathered rock structural fill, lean concrete, flowable fill, or continuous rock.
- Foundation bearing conditions should be carefully evaluated by ECS during construction.
- The design of the foundation should utilize the following parameters:

FOUNDATION DESIGN RECOMMENDATIONS		
DESIGN PARAMETER	SOIL BEARING FOUNDATIONS	
	CONTINUOUS WALL FOUNDATIONS	ISOLATED COLUMN FOUNDATIONS
Net Allowable Bearing Pressure ⁽¹⁾ ⁽²⁾	2,000 psf	2,500 psf
Acceptable Bearing Material	Stiff or better Undisturbed Native Soils/Weathered Rock, Competent Rock, Structural Fill, Flowable Fill, or Lean Concrete	Stiff or better Undisturbed Native Soils/Weathered Rock, Competent Rock, Structural Fill, Flowable Fill, or Lean Concrete
Minimum Width	18 inches	24 inches
Depth of Foundations Subject to Freezing (Below slab or finished grade) ⁽²⁾	30 inches	30 inches
Depth Foundations Protected from Freezing	12 inches	12 inches
Estimated Total Settlement (soil/weathered rock-bearing) ⁽⁴⁾	≤ 1 inch	≤ 1 inch
Estimated Total Settlement (competent rock-bearing) ⁽⁴⁾	< 1/8 inch	< 1/8 inch
Estimated Differential Settlement (soil/weathered rock-bearing) ⁽⁴⁾	≤ ¾ inch along 50 feet	≤ ¾ inch between columns
Estimated Differential Settlement (competent rock-bearing) ⁽⁴⁾	< 1/8 inch along 50 feet	< 1/8 inch between columns

Notes:

- (1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
- (2) The recommended net allowable bearing pressures may be increased 33 percent for transient loading.
- (3) The 2018 Kentucky Building Code requires a minimum foundation embedment depth of 24 inches for foundations subject to freezing in Shelby County. However, a minimum embedment of 30 inches is common for commercial development in the project region.
- (4) The estimated settlement potential is based on the following: empirical guidelines for the project soil types and consistencies; the assumption that ECS will observe and test each foundation excavation during construction; and the provided project information. Actual settlements will depend, in part, on site preparation and conditions at each foundation location.

SOIL PARAMETERS FOR FOUNDATION LATERAL RESISTANCE	ESTIMATED VALUE ⁽¹⁾
Coefficient of At-Rest Earth Pressure (K_o) ⁽²⁾	0.40
Coefficient of Active Earth Pressure (K_a) ⁽²⁾	0.25
Coefficient of Passive Earth Pressure (K_p) ⁽²⁾	4.02
Unit Weight of Soil (γ)	130 pcf
Coefficient of Friction [Concrete on Weathered Rock] (μ)	0.55

Notes:

- (1) These design parameters do not include factors of safety. Appropriate factors of safety should be included in the designs.
- (2) Provided earth pressure coefficients are based on an assumed internal angle of friction (ϕ) of 37 degrees for weathered rock.

- Desiccation or disturbance may result in soil voids or cracks adjacent to foundations, reducing passive and uplift resistance. As a result, for these calculations, the upper 2.5 feet of soils should be neglected for passive resistance.
- Ignore passive earth pressure if the soil against the sides of the foundations may not be present during the life of the structure (e.g., the soil could be excavated or be subject to erosion).

Construction Guidelines:

- The bearing conditions of each foundation should be evaluated by ECS at the time of construction to confirm the presence of adequate bearing soils or rock and to provide recommendations for the remediation of poor-quality soils, if present. This evaluation should be performed before the reinforcing steel is placed in the excavations.
- Concrete should be placed the same day the foundations are excavated to reduce degradation of the bearing surface due to exposure. Alternatively, a “mud mat” of lean concrete should be placed to protect the bearing surface.
- Disturbed, degraded or loose material should be removed from the excavation bottoms prior to concrete placement.

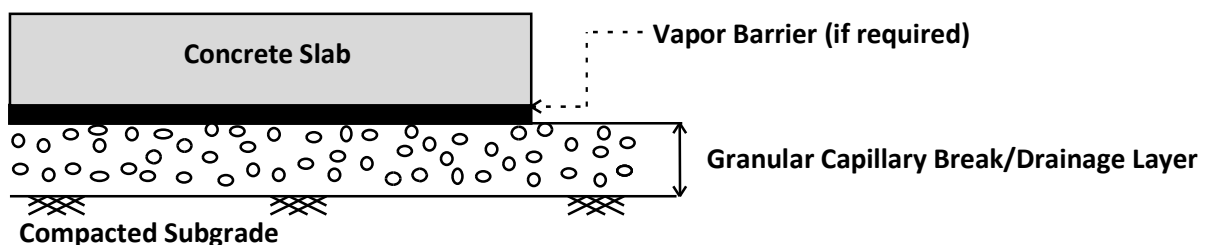
7.2 FLOOR SLABS

General Comments:

- The limitations and recommendations associated with the shallow rock, existing fill, groundwater, and highly plastic clays are described in more detail in **Sections 5.0 and 6.0** and should be carefully understood and incorporated into construction planning.

Slab Subgrade Recommendations:

- Recommended Slab Type: Grade supported floor slabs.
- The following graphic depicts our soil-supported slab recommendations.



Notes:

- (1) Drainage layer should consist of a minimum of 4 inches of well graded crushed stone or angular sand or open-graded coarse gravel. However, if open graded sone is selected then a minimum 2-inch layer of coarse aggregate with fines (e.g., Indiana #53's) should be used to cap the open graded stone.
- (2) Subgrade compacted to 98% maximum dry density per ASTM D698

- Prepare subgrade in accordance with recommendations contained within this report.
- Subgrade proofrolled by an ECS representative and required improvements completed.
- Subgrade modulus for slab design: 100 pci.
- Unless specifically approved otherwise, do not support floor slabs directly over open-graded coarse aggregate. If coarse aggregate is used as a drainage base, cap the coarse aggregate with a 2-inch (minimum) layer of well-graded aggregate.
- Compact base material in accordance with the structural fill recommendations provided previously.

Construction Guidelines:

- If a vapor barrier will be used, an adequate concrete design mix, placement, finishing, and curing techniques should be employed to reduce the potential for differential slab shrinkage, cracking, and curling.
- Special care must be taken to avoid puncturing the vapor barrier during construction. We recommend utilizing the ACI 302 guidelines for placement of the vapor barrier, manufactured sand layer, and concrete as a function of the construction sequence.
- Drying shrinkage and concrete curing methods frequently causes floor slab cracks. Control joints and saw cuts should be installed in accordance with ACI guidelines to control cracking.
- Slab joints should be doweled or keyed to allow rotation of the slab sections without localized vertical displacement.
- Penetrations of the floor slab by fixed objects, such as drains or piping, restrict shrinkage movement and must be isolated to reduce cracking potential.
- Slab-on-grade floor should be structurally isolated from foundation supported walls.
- Backfill along foundation excavations should be carefully controlled to reduce differential slab settlement

7.3 SEISMIC DESIGN CONSIDERATIONS

Seismic Site Classification:

- The 2018 Kentucky Building Code requires site classification for seismic design based on the upper 100 feet of a soil profile. At least two methods are utilized in classifying sites, namely the shear wave velocity (v_s) method and the Standard Penetration Resistance (N-value) method. The second method (N-value) was used in classifying this site.

SEISMIC SITE CLASSIFICATION			
Site Class	Soil Profile Name	Shear Wave Velocity, V_s , (ft./s)	N value (bpf)
A	Hard Rock	$V_s > 5,000$ fps	N/A
B	Rock	$2,500 < V_s \leq 5,000$ fps	N/A

SEISMIC SITE CLASSIFICATION			
Site Class	Soil Profile Name	Shear Wave Velocity, Vs, (ft./s)	N value (bpf)
C	Very dense soil and soft rock	$1,200 < V_s \leq 2,500$ fps	>50
D	Stiff Soil Profile	$600 \leq V_s \leq 1,200$ fps	15 to 60
E	Soft Soil Profile	$V_s < 600$ fps	<15

- Based upon our interpretation of the subsurface conditions, the appropriate Seismic Site Classification is “C” as shown in the preceding table.
- If an on-site seismic study is conducted, a better site class will likely be achievable.

Ground Motion Parameters:

- In addition to the seismic site classification noted above, ECS has determined the design spectral response acceleration parameters following the International Building Code (IBC) 2015 methodology. The Mapped Responses were estimated from the OSHPD Seismic Design Map website (<http://seismicmaps.org/>). The design responses for the short (0.2-sec, S_{DS}) and 1-second period (S_{D1}) are noted at the right end of the following Table.

GROUND MOTION PARAMETERS [IBC 2015 Method]								
Period (sec)	Mapped Spectral Response Accelerations (g)		Values of Site Coefficient for Site Class		Maximum Spectral Response Acceleration Adjusted for Site Class (g)		Design Spectral Response Acceleration (g)	
0.2	S_s	0.181	F_a	1.2	$S_{MS}=F_a S_s$	0.217	$S_{DS}=2/3 S_{MS}$	0.145
1.0	S_1	0.097	F_v	1.7	$S_{M1}=F_v S_1$	0.165	$S_{D1}=2/3 S_{M1}$	0.11

- The Site Class definition should not be confused with the Seismic Design Category designation which the Structural Engineer typically assesses.

7.4 FLEXIBLE PAVEMENT DESIGN

Application:

- Primary driving lanes, parking areas or other locations where heavy vehicle or other equipment will not turn on a tight radius or be parked for extended periods of time.

General Comments:

- The limitations and recommendations associated with the shallow rock, existing fill, groundwater, and highly plastic clays are described in more detail in **Sections 5.0 and 6.0** and should be carefully understood and incorporated into construction planning.
- The pavement sections below are guidelines that may or may not comply with local jurisdictional minimums.

FLEXIBLE DESIGN PARAMETERS	
DESIGN METHOD	AASHTO Guide for Design of Pavement Structures (1993)
DAILY EQUIVALENT 18-KIP AXLE LOADS	7 (Light Duty) 30 (Heavy Duty)
DESIGN LIFE	20 Years
CALIFORNIA BEARING RATIO (CBR)	3 (Estimated)
RELIABILITY	85%
TERMINAL SERVICEABILITY INDEX	2.0

RECOMMENDED FLEXIBLE PAVEMENT SECTIONS ⁽¹⁾			
PAVEMENT SECTION	HOT MIX ASPHALT WEARING SURFACE	HOT MIX ASPHALT BINDER OR BASE	GRANULAR BASE KY DGA
Light Duty	1½ inches	1½ inches	8 inches
Heavy Duty	2 inches	2 inches	10 inches

Notes:

- (1) It should be noted that although flexible pavement for the 20-year design period is structurally sound, an asphalt overlay is usually necessary after 7 to 12 years due to normal wear and exposure of the surfacing layer. In general, asphalt pavement should be sealed approximately 3 to 5 years to extend the life of the asphalt.
- (2) Granular base may be decreased if site subgrade is stabilized via chemical stabilization, bridging, or placement of geogrid prior to pavement section construction. ECS should be contacted to consult after a method is selected.

Subgrade Requirements:

- Prepare subgrade in accordance with recommendations contained within this report.
- Proofroll under the direction of a ECS representative and complete required improvements.
- Pavement subgrades sloped to facilitate drainage.

Drainage Requirements:

- Permit water movement beneath curbs at the subgrade level.
- Design catch basins to include finger drains at the granular base level.

Construction Guidelines

- Pavements should be constructed in accordance with the construction and material guidelines set by the Kentucky Transportation Cabinet’s “Standard Specifications for Road and Bridge Construction.”
- Granular base should be compacted in accordance with the controlled fill recommendations provided in a previous section.
- In-place density, thickness, and gradation tests should be conducted by a ECS representative on the pavement components during construction to confirm compliance with project specifications.

7.5 RIGID PAVEMENT DESIGN

Application:

- Rigid pavements are adequate wherever flexible pavements can be used. Rigid pavements often provide better service for dumpster aprons, entranceways, or other areas where heavy trucks will turn on a tight radius or be parked for extended periods of time.

General Comments:

- The limitations and recommendations associated with the shallow rock, existing fill, groundwater, and highly plastic clays are described in more detail in **Sections 5.0 and 6.0** and should be carefully understood and incorporated into construction planning.
- The pavement sections below are guidelines that may or may not comply with local jurisdictional minimums.

RIGID PAVEMENT DESIGN PARAMETERS	
DESIGN METHOD	ACI Guide for the Design and Construction of Concrete Parking Lots (ACI 330R-08)
TRAFFIC CATEGORY	A (Light Duty): Car Parking, Access, and Interior Lanes (ADTT = 10) B (Heavy Duty): Shopping Center Entrance and Service Lanes (ADTT = 25)
DESIGN LIFE	20 Years
CALIFORNIA BEARING RATIO (CBR)	3 (Estimated)
EFFECTIVE SUBGRADE MODULUS	50 pci
CONCRETE MODULUS OF RUPTURE	550 psi

RECOMMENDED RIGID PAVEMENT SECTIONS		
PAVEMENT SECTION	PORTLAND CEMENT CONCRETE	GRANULAR BASE KY DGA
Light Duty	5 inches	6 inches
Heavy Duty	6 inches	6 inches

Notes:

- (1) Granular base may be decreased if site subgrade is stabilized via chemical stabilization, bridging, or placement of geogrid prior to pavement section construction. ECS should be contacted to consult after a method is selected.

Subgrade Requirements:

- Prepare subgrade in accordance with recommendations contained within this report.
- Proofroll under the direction of a ECS representative and complete required improvements.
- Pavement subgrades sloped to facilitate drainage.

Drainage Requirements:

- Permit water movement beneath curbs at the subgrade level.
- Design catch basins to include finger drains at the granular base level.

Concrete Recommendations:

- 4,000 pounds per square inch (psi) minimum 28-day compressive strength.
- 4 to 6 percent entrained air.

- Proper joint spacing to control shrinkage cracking.
- Dowels at construction joints to properly transfer loads between pavement sections.
- Control joints where concrete pavement abuts fixed structures or protrusions.

8.0 CLOSING

There are certain limitations inherent to geotechnical explorations and reports. These limitations are discussed below and in the **GBA “Important Information About Your Geotechnical Engineering Report”** in the **Appendix**. They should be fully considered prior to using the recommendations in this report.

Our geotechnical exploration identified the subsurface conditions that existed only at the locations and times that the borings were advanced. Given the natural variable characteristics of soil and rock, conditions may vary over short distances, change with time, or be affected by natural events, such as floods or earthquakes, or by human activity, such as past land use or new construction. As such, the information generated during our geotechnical exploration may not be representative of the entire conditions that may exist on the project site now or in the future. We use our professional judgment to render an opinion about the subsurface conditions that may exist in the areas of the site not specifically tested during our exploration based on our review of available field and laboratory data and our past experience with similar subsurface conditions. However, the subsurface conditions encountered during construction may vary from the assumed conditions. Variations in the subsurface conditions between our borings and in unexplored areas of the site could affect our interpretations. Thus, it is important to retain ECS to provide construction monitoring services based on our involvement in the project, our knowledge about the site, and our knowledge relating to the assumptions and recommendations contained within this report.

The recommendations contained within this report are dependent on many factors, including, but not limited to, the project information provided by others and the specific conditions encountered during our exploration. If the project information contained within this report is incorrect or changed at a later date or if the location or nature of the structures or facility components changes, ECS should be notified and given the chance to assess the impact of the changes. We cannot and do not accept responsibility or liability for problems that occur because we were not given the opportunity to properly assess changes to the project. The recommendations contained in this report must not be considered valid unless our firm reviews such changes and required modifications to our recommendations are verified in writing.

Our recommendations are dependent on several factors including, but not limited to, our review of project drawings and specifications prior to construction and observation of actual conditions during construction, including providing the required special inspections. We strongly recommend that ECS be retained to review pertinent portions of the project plans and specifications.

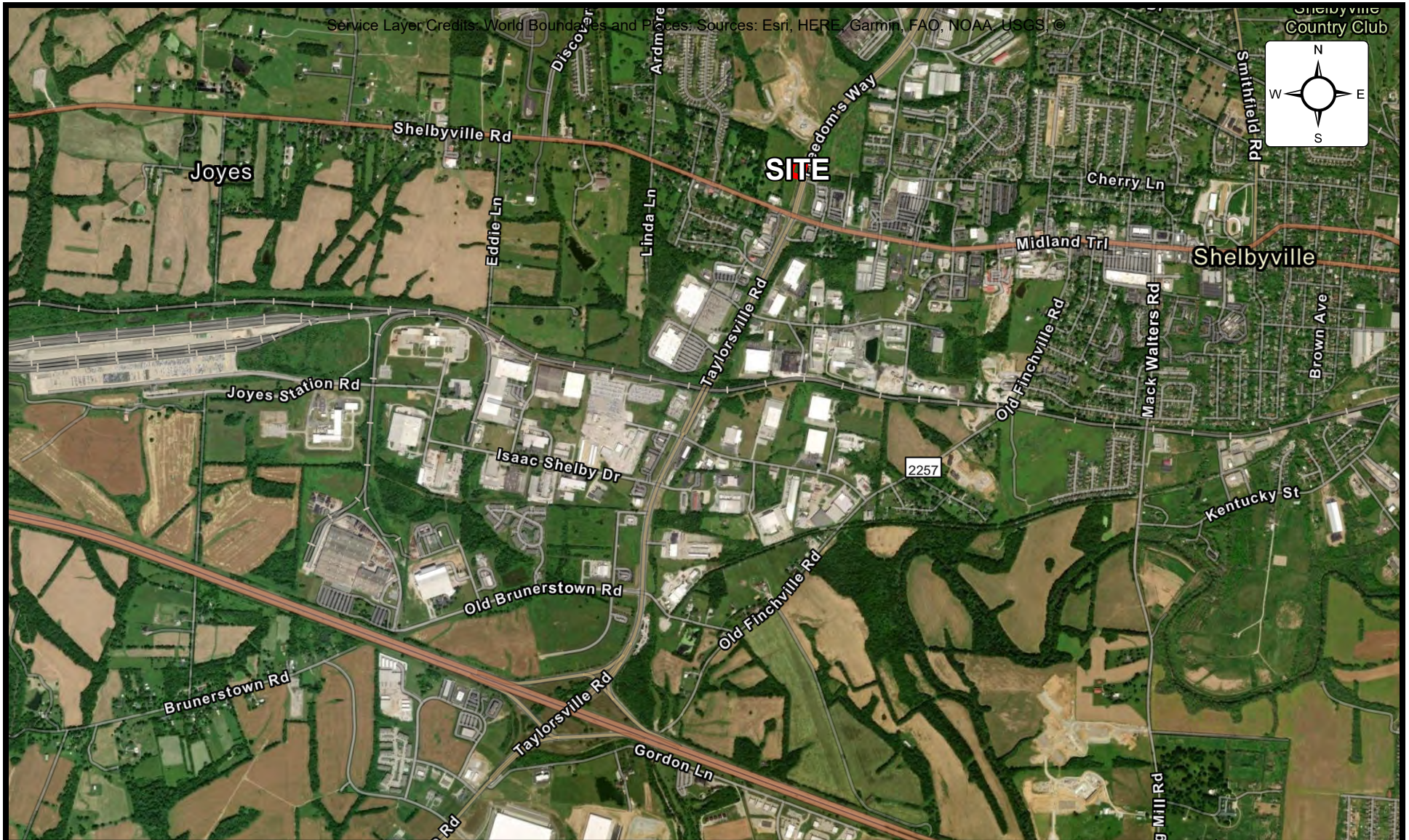
This report should be reproduced in its entirety only. Portions of this report should not be separated and used by others. It should be noted that this report was not prepared for the purpose of bid development and should not be used as such.

This geotechnical report is unique and was based on client needs and project requirements for the specific project described in this report. As such, no one other than who the report was intended and prepared for should rely on this report or the information contained within the report without first consulting with ECS. This report is not valid for any purpose or project except as described in this report.

This report and our recommendations were prepared using the generally accepted standards of geotechnical engineers practicing in this region. No other warranty is express or implied.

APPENDIX A – Drawings

Site Location Diagram
Boring Location Diagram



SITE LOCATION DIAGRAM

Express Oil - Shelbyville, KY

Freedom's Way and Protegrity Drive, Shelbyville, Kentucky
Express Oil Change, LLC

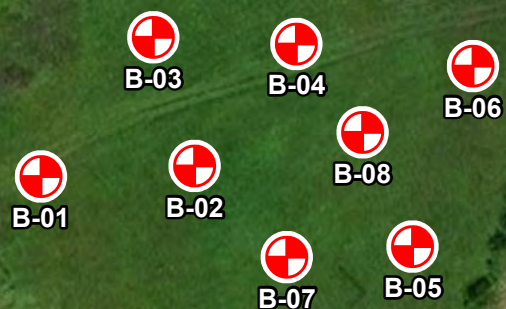
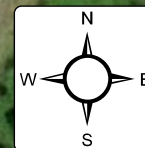
ENGINEER
SJB1

SCALE
NTS

PROJECT NO.
61:3446

SHEET

DATE
12/15/2025



Legend



Approximate Boring Locations - B



BORING LOCATION DIAGRAM

Express Oil - Shelbyville, KY

Freedom's Way and Protegrity Drive, Shelbyville, Kentucky
Express Oil Change, LLC

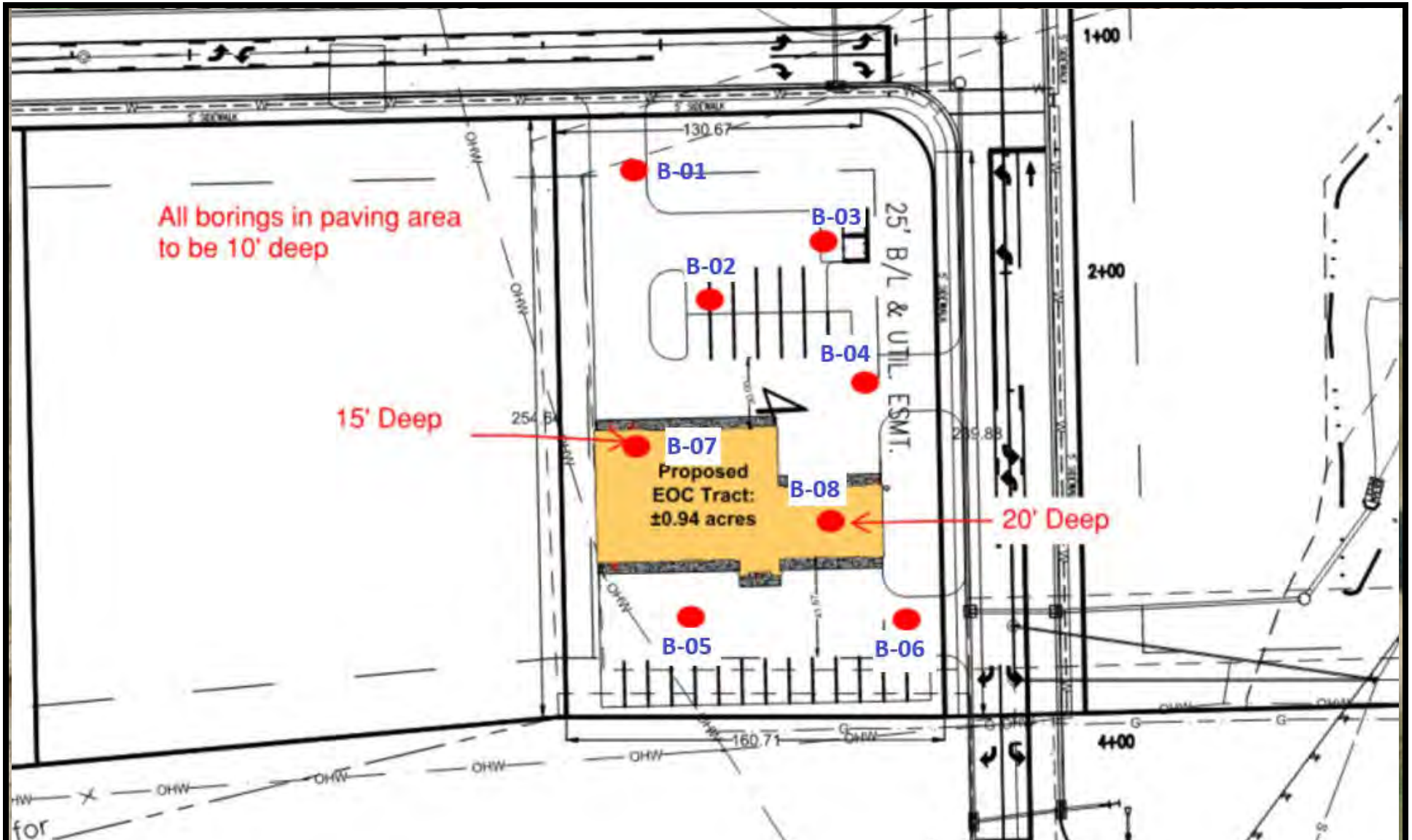
ENGINEER
SJB1

SCALE
1" = 100'

PROJECT NO.
61:3446

SHEET

DATE
12/15/2025



BORING LOCATION DIAGRAM

Express Oil - Shelbyville, KY

Freedom's Way and Protegrity Drive, Shelbyville, Kentucky
Express Oil, LLC

ENGINEER
SJB

SCALE
NTS

PROJECT NO.
61:3556-A

SHEET

DATE
12/2/2025

APPENDIX B – Field Operations

Reference Notes for Boring Logs
Geotechnical Borehole Logs
Generalized Subsurface Cross Section
Field Procedures



REFERENCE NOTES FOR BORING LOGS

MATERIAL^{1,2}

	ASPHALT
	CONCRETE
	GRAVEL
	TOPSOIL
	VOID
	BRICK
	AGGREGATE BASE COURSE
	GW WELL-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GP POORLY-GRADED GRAVEL gravel-sand mixtures, little or no fines
	GM SILTY GRAVEL gravel-sand-silt mixtures
	GC CLAYEY GRAVEL gravel-sand-clay mixtures
	SW WELL-GRADED SAND gravelly sand, little or no fines
	SP POORLY-GRADED SAND gravelly sand, little or no fines
	SM SILTY SAND sand-silt mixtures
	SC CLAYEY SAND sand-clay mixtures
	ML SILT non-plastic to medium plasticity
	MH ELASTIC SILT high plasticity
	CL LEAN CLAY low to medium plasticity
	CH FAT CLAY high plasticity
	OL ORGANIC SILT or CLAY non-plastic to low plasticity
	OH ORGANIC SILT or CLAY high plasticity
	PT PEAT highly organic soils

DRILLING SAMPLING SYMBOLS & ABBREVIATIONS

SS	Split Spoon Sampler	PM	Pressuremeter Test
ST	Shelby Tube Sampler	RD	Rock Bit Drilling
WS	Wash Sample	RC	Rock Core, NX, BX, AX
BS	Bulk Sample of Cuttings	REC	Rock Sample Recovery %
PA	Power Auger (no sample)	RQD	Rock Quality Designation %
HSA	Hollow Stem Auger		

PARTICLE SIZE IDENTIFICATION

DESIGNATION	PARTICLE SIZES
Boulders	12 inches (300 mm) or larger
Cobbles	3 inches to 12 inches (75 mm to 300 mm)
Gravel: Coarse	¾ inch to 3 inches (19 mm to 75 mm)
Fine	4.75 mm to 19 mm (No. 4 sieve to ¾ inch)
Sand: Coarse	2.00 mm to 4.75 mm (No. 10 to No. 4 sieve)
Medium	0.425 mm to 2.00 mm (No. 40 to No. 10 sieve)
Fine	0.074 mm to 0.425 mm (No. 200 to No. 40 sieve)
Silt & Clay ("Fines")	<0.074 mm (smaller than a No. 200 sieve)

COHESIVE SILTS & CLAYS

UNCONFINED COMPRESSIVE STRENGTH, QP ⁴	SPT ⁵ (BPF)	CONSISTENCY ⁷ (COHESIVE)
<0.25	<3	Very Soft
0.25 - <0.50	3 - 4	Soft
0.50 - <1.00	5 - 8	Firm
1.00 - <2.00	9 - 15	Stiff
2.00 - <4.00	16 - 30	Very Stiff
4.00 - 8.00	31 - 50	Hard
>8.00	>50	Very Hard

RELATIVE AMOUNT ⁷	COARSE GRAINED (%) ⁸	FINE GRAINED (%) ⁸
Trace	≤5	≤5
With	10 - 20	10 - 25
Adjective (ex: "Silty")	25 - 45	30 - 45

GRAVELS, SANDS & NON-COHESIVE SILTS

SPT ⁵	DENSITY
<5	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
>50	Very Dense

WATER LEVELS⁶

	WL (First Encountered)
	WL (Completion)
	WL (Seasonal High Water)
	WL (Stabilized)

FILL AND ROCK

FILL	POSSIBLE FILL	PROBABLE FILL	ROCK

¹Classifications and symbols per ASTM D 2488-17 (Visual-Manual Procedure) unless noted otherwise.

²To be consistent with general practice, "POORLY GRADED" has been removed from GP, GP-GM, GP-GC, SP, SP-SM, SP-SC soil types on the boring logs.

³Non-ASTM designations are included in soil descriptions and symbols along with ASTM symbol [Ex: (SM-FILL)].

⁴Typically estimated via pocket penetrometer or Torvane shear test and expressed in tons per square foot (tsf).

⁵Standard Penetration Test (SPT) refers to the number of hammer blows (blow count) of a 140 lb. hammer falling 30 inches on a 2 inch OD split spoon sampler required to drive the sampler 12 inches (ASTM D 1586). "N-value" is another term for "blow count" and is expressed in blows per foot (bpf). SPT correlations per 7.4.2 Method B and need to be corrected if using an auto hammer.

⁶The water levels are those levels actually measured in the borehole at the times indicated by the symbol. The measurements are relatively reliable when augering, without adding fluids, in granular soils. In clay and cohesive silts, the determination of water levels may require several days for the water level to stabilize. In such cases, additional methods of measurement are generally employed.

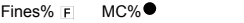
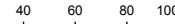
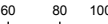
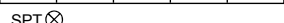
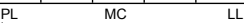
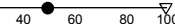
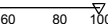
⁷Minor deviation from ASTM D 2488-17 Note 14.

⁸Percentages are estimated to the nearest 5% per ASTM D 2488-17.

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-01		SHEET: 1 OF 1					
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.									
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION					
LATITUDE: 38.215903		LONGITUDE: -85.260308		STRUCTURE:		SURFACE ELEVATION: 754		BOTTOM OF CASING					
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT-N VALUE)*	Recovery % ■ RQD % ■		Fines% F: MC% ●	
										SPT ⊗		PL MC LL	
	S-1	SS	18	18	Topsoil [Thickness=2"].				1-3-5 (8)	8		26.1	
	S-2	SS	17	17	(CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt.				4-23-50/5" (50)	50		26.3	
					(CH) FAT CLAY - yellowish brown, very stiff to hard, moist, moderate to high plasticity, with some rock fragments.								
					EQUIPMENT REFUSAL at 3.8 FT								
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL													
▽ WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed					
▼ WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic					
▽ WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:					
▽ WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-3.8')					
GEOTECHNICAL BOREHOLE LOG													

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-02		SHEET: 1 OF 1					
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.									
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION					
LATITUDE: 38.215919		LONGITUDE: -85.260029		STRUCTURE:		SURFACE ELEVATION: 748		BOTTOM OF CASING					
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT- N VALUE)*	Recovery % ■ RQD % ■		Fines% F MC% ●	
										SPT ⊗		PL MC LL	
5.0	S-3	SS	18	18	Topsoil [Thickness=4"]. (CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt. (CH) FAT CLAY - yellowish brown, stiff to hard, moist, moderate to high plasticity, with some rock fragments.			745	2-3-5 (8)	8		22	
	S-4	SS	18	18					3-4-5 (9)	9		26	
	S-5	SS	18	18					10-8-6 (14)	14		21	
	S-6	SS	3	3	EQUIPMENT REFUSAL at 6.8 FT				50/3" (50)	50			
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL													
▽ WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed					
▼ WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic					
▽ WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:					
▽ WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-6.8')					
GEOTECHNICAL BOREHOLE LOG													

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-03		SHEET: 1 OF 1			
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.							
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION			
LATITUDE: 38.216103		LONGITUDE: -85.260107		STRUCTURE:		SURFACE ELEVATION: 746		BOTTOM OF CASING			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT-N VALUE)*	Recovery % ■ RQD % ■ Fines% F MC% ●	
	S-7	SS	18	3	Topsoil [Thickness=3"].			745	2-3-3 (6)	SPT ⊗	
	S-8	SS	18	18	(CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt. (CH) FAT CLAY - yellowish brown, stiff, moist, moderate to high plasticity, with some black oxide nodules and rock fragments.				3-4-5 (9)	PL ⊗ MC ● LL ▽	
					EQUIPMENT REFUSAL at 3.5 FT					QP 0 1 2 3 4 5	
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL											
WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed			
WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic			
WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:			
WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-3.5')			
GEOTECHNICAL BOREHOLE LOG											

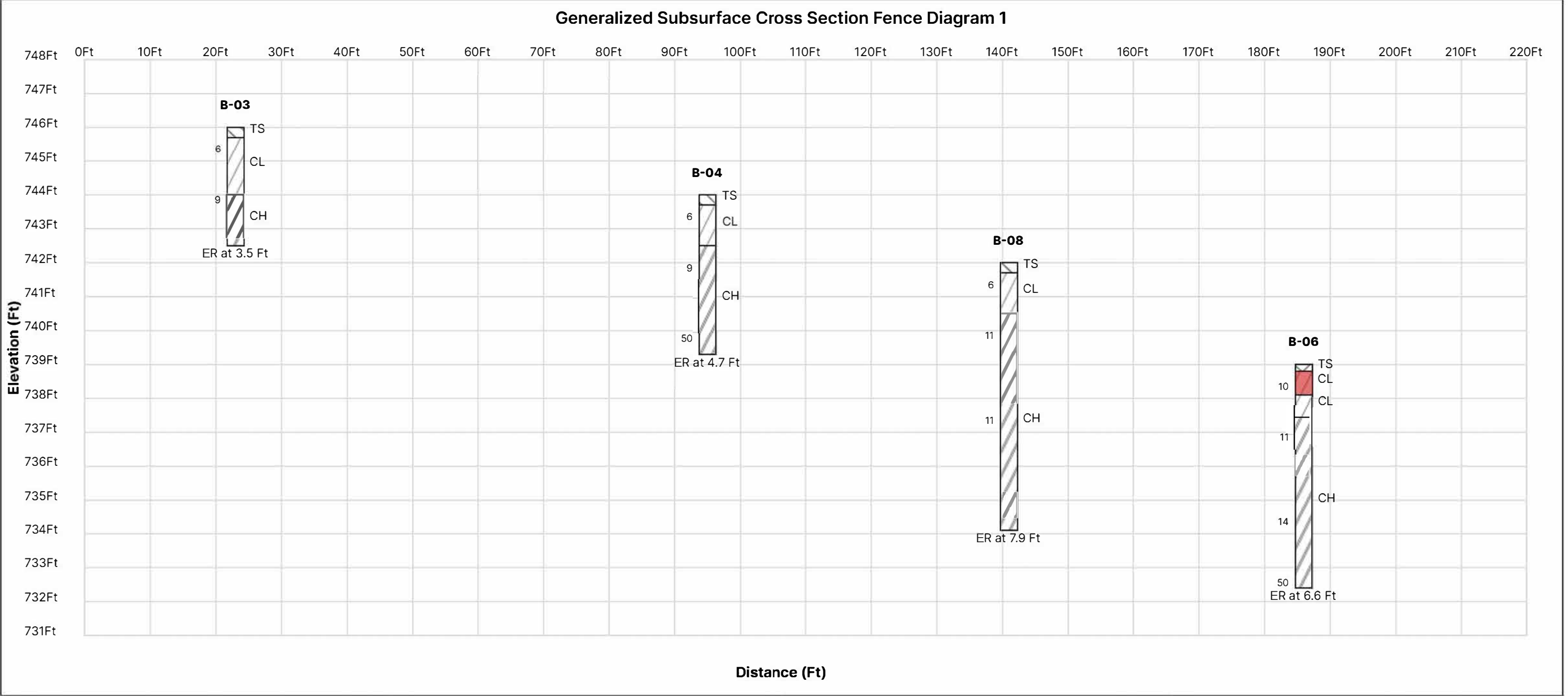
CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-04		SHEET: 1 OF 1			
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.							
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION			
LATITUDE: 38.216096		LONGITUDE: -85.259847		STRUCTURE:		SURFACE ELEVATION: 744		BOTTOM OF CASING			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT-N VALUE)*	Recovery %  RQD %  Fines%  MC%  SPT  PL  QP  LL 	
	S-9	SS	18	18	Topsoil [Thickness=3"].				3-3-3 (6)	6	21.0
	S-10	SS	18	18	(CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt.				5-4-5 (9)	9	25.3
	S-11	SS	8	8	(CH) FAT CLAY - yellowish brown, stiff to hard, moist, moderate to high plasticity, with some black oxide nodules and rock fragments.			740	10-50/2" (50)	50	12.4
					EQUIPMENT REFUSAL at 4.7 FT						
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL											
 WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed			
 WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic			
 WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:			
 WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-4.7')			
GEOTECHNICAL BOREHOLE LOG											

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-05		SHEET: 1 OF 1							
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.											
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION							
LATITUDE: 38.215808		LONGITUDE: -85.259632		STRUCTURE:		SURFACE ELEVATION: 741		BOTTOM OF CASING							
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT- N VALUE)*	Recovery % ■ RQD % ■		Fines% F MC% ●			
										SPT ⊗		PL MC LL			
5.0	S-12	SS	18	18	Topsoil [Thickness=3"]. FILL - (CL) LEAN CLAY - brown, stiff, moist, low to moderate plasticity, with some silt, roots, and gravel. (CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt. (CH) FAT CLAY - yellowish brown, very stiff, moist, moderate to high plasticity, with some black oxide nodules.			740	6-3-2 (5)	5					
	S-13	SS	18	18					2-4-4 (8)	8					21.8
	S-14	SS	18	18					6-6-7 (13)	13					19.6
	S-15	SS	18	18					12-9-7 (16)	16					23.9
10.0	S-16	SS	18	18				735	12-9-9 (18)	18					20.0
END OF BORING at 10.5 FT															
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL															
▽ WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed							
▼ WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic							
▽ WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:							
▽ WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-10.5')							
GEOTECHNICAL BOREHOLE LOG															

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-06		SHEET: 1 OF 1			
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.							
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION			
LATITUDE: 38.216067		LONGITUDE: -85.259528		STRUCTURE:		SURFACE ELEVATION: 739		BOTTOM OF CASING			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TC/PR/SC/SPT-N VALUE)*	Recovery % ■ RQD % ■ Fines% F MC% ●	
										SPT ⊗ PL MC LL QP	
										0 20 40 60 80 100 0 20 40 60 80 100 0 20 40 60 80 100	
										0 1 2 3 4 5	
5.0	S-17	SS	18	18	Topsoil [Thickness=2"].				5-5-5 (10)	10	20.5
	S-18	SS	18	18	FILL - (CL) LEAN CLAY - brown, moist, low to moderate plasticity, with some silt, roots, and rock fragments.				5-5-6 (11)	11	22.8
					(CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt.			735			
	S-19	SS	18	18	(CH) FAT CLAY - yellowish brown, very stiff to hard, moist, moderate to high plasticity, with some black oxide nodules and rock fragments.				6-7-7 (14)	14	21.7
	S-4	SS	1	1	EQUIPMENT REFUSAL at 6.6 FT				50/1" (50)	50	
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL											
WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed			
WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic			
WL (Seasonal High Water):				EQUIPMENT: Geoprobe 7800		LOGGED BY: SJB		DRILLING METHOD: Direct Push (0'-6.6')			
WL (Stabilized):											
GEOTECHNICAL BOREHOLE LOG											

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-07		SHEET: 1 OF 1			
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.							
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION			
LATITUDE: 38.215791		LONGITUDE: -85.25986		STRUCTURE:		SURFACE ELEVATION: 747		BOTTOM OF CASING			
DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	STRATIGRAPHY	WATER LEVELS	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT- N VALUE)*	Recovery %  RQD %  Fines%  MC%  SPT  PL  MC  LL  QP 	
5.0	S-21	SS	18	18	Topsoil [Thickness=3"]. (CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt and black oxide nodules.			745	5-4-3 (7)	7	20.8
	S-22	SS	18	18			3-4-4 (8)	8	23.8		
	S-23	SS	18	18	(CH) FAT CLAY - yellowish brown, stiff to hard, moist, moderate to high plasticity, with black oxide nodules and rock fragments.		5-6-8 (14)	14	23.7	28.6	
							8-8-50/3" (50)	50			
	S-24	SS	15	15							
					EQUIPMENT REFUSAL at 7.8 FT						
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL											
 WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed			
 WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic			
 WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:			
 WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-7.8')			
GEOTECHNICAL BOREHOLE LOG											

CLIENT: Express Oil Change, LLC				PROJECT NO.: 61:3446		BORING NO.: B-08		SHEET: 1 OF 1					
PROJECT NAME: Express Oil - Shelbyville, KY				DRILLER/CONTRACTOR: Geo Logic, Inc.									
SITE LOCATION: Freedom's Way and Protegrity Drive, Shelbyville, Kentucky, 40065								LOSS OF CIRCULATION					
LATITUDE: 38.21597		LONGITUDE: -85.259726		STRUCTURE:		SURFACE ELEVATION: 742		BOTTOM OF CASING					
DEPTH (FT) 5.0	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL Topsoil [Thickness=3"]. (CL) LEAN CLAY - brown and yellowish brown, stiff, moist, low to moderate plasticity, with some silt and black oxide nodules. (CH) FAT CLAY - yellowish brown, very stiff to hard, moist, moderate to high plasticity, with some black oxide nodules and rock fragments.	STRATIGRAPHY 	WATER LEVELS	ELEVATION (FT) 740 735	BLOWS/6" (TCP/RS/MC/SPT- N VALUE)*	Recovery % ■ RQD % ■		Fines% F MC% ●	
	0 20 40 60 80 100		0 20 40 60 80 100										
	SPT ⊗		PL MC LL										
	0 10 20 30 40 50		0 20 40 60 80 100										
			QP										
			0 1 2 3 4 5										
	S-25	SS	18	18					2-2-4 (6)	6	22.2	28.9	
	S-26	SS	18	18					5-5-6 (11)	11	22.0		
	S-27	SS	18	18					5-5-6 (11)	11			
	S-4	SS	17	17					11-11-50/5" (50)	50	14.4		
EQUIPMENT REFUSAL at 7.9 FT													
THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL													
▽ WL (First Encountered):				BORING STARTED: 11/13/2025				CAVE IN DEPTH: Not Observed					
▼ WL (Completion): Dry				BORING COMPLETED: 11/13/2025				HAMMER TYPE: Automatic					
▽ WL (Seasonal High Water):				EQUIPMENT:		LOGGED BY:		DRILLING METHOD:					
▽ WL (Stabilized):				Geoprobe 7800		SJB		Direct Push (0'-7.9')					
GEOTECHNICAL BOREHOLE LOG													



Generalized Subsurface Cross Section Fence Diagram 2

Elevation (Ft)

756Ft
755Ft
754Ft
753Ft
752Ft
751Ft
750Ft
749Ft
748Ft
747Ft
746Ft
745Ft
744Ft
743Ft
742Ft
741Ft
740Ft
739Ft
738Ft
737Ft
736Ft
735Ft
734Ft
733Ft
732Ft
731Ft

Distance (Ft)

0Ft 10Ft 20Ft 30Ft 40Ft 50Ft 60Ft 70Ft 80Ft 90Ft 100Ft 110Ft 120Ft 130Ft 140Ft 150Ft 160Ft 170Ft 180Ft 190Ft 200Ft 210Ft 220Ft 230Ft 240Ft

B-01
TS
CL
CH
ER at 3.8 Ft

B-02
TS
CL
CH
ER at 6.8 Ft

B-07
TS
CL
CH
ER at 7.8 Ft

B-05
TS
CL
CH
EOB at 10.5 Ft

CLIENT:	Express Oil Change, LLC	PROJECT:	Express Oil - Shelbyville, KY
DRAWN DATE:	Dec 16, 2025	PROJECT NO.:	61:3446
CHECKED DATE:	Dec 16, 2025	SCALE:	AS SHOWN

Notes: 1-EOB: END OF BORING ER: EQUIPMENT REFUSALSR: SAMPLER REFUSAL 2-SEE INDIVIDUAL BORING LOG AND GEOTECHNICAL INFORMATION. 3-STANDARD PENETRATION TEST RESISTANCE (LEFT OF BORING) IN BLOWS PER FOOT (ASTM D1586). 4- TOPOGRAPHIC INFORMATION IS BASED ON PUBLICLY AVAILABLE DATA (GOOGLE OR CESIUM) THE TOPOGRAPHIC LINE SHOWN BETWEEN BORINGS IS FOR VISUAL REFERENCE ONLY.PLEASE REFER TO THE REFERENCE NOTES FOR BORING LOGS FOR SYMBOL OGY MEANING AND ADDITIONAL	Plastic Limit Water Content Liquid Limit X————●————△	▽	WL (First Encountered)		Fill		
	[FINES CONTENT %]	▼	WL (Completion)		Possible Fill		
		BOTTOM OF CASING	▽	WL (Estimated Seasonal High Water)			Probable Fill
		LOSS OF CIRCULATION	▽	WL (Stabilized)			WR/Rock
		CALIBRATED PENETROMETER					

Field Procedures

General

ECS conducts field sampling and testing procedures in general accordance with methods of the American Society for Testing Materials (ASTM) and widely accepted geotechnical engineering standards. A brief description of the procedures we utilize is provided in the following paragraphs.

Soil Borings (ASTM D-1452)

Soil borings are made with hollow stem augers or continuous augers which are mechanically advanced by a powered drill rig. At selected depths, soil samples are obtained with either a split-barrel sampler or a thin wall tube sampler. Soil borings are advanced to refusal, or to maximum depths as defined in our scope of work. The boring data, including sampling intervals, penetration resistances, soil classifications, and groundwater observations, are presented on the attached **Geotechnical Borehole Logs**.

Boring Locations and Elevations

Boring locations typically are selected by our project manager. The project manager establishes the boring locations in the field by pacing or measuring distances and estimating angles relative to existing site landmarks. When topographic plans of the site are provided, the project manager estimates the surface elevation of the boring locations using available information. Surveying to determine the locations and elevations of the borings is beyond the scope of typical geotechnical studies; therefore, the boring locations and elevations should be considered approximate.

Standard Penetration Test (SPT) Split-Barrel Samples (ASTM D-1586)

A split-barrel or "splitspoon" is inserted into the borehole to obtain soil samples. The sampler is driven three, 6-inch increments with a 140-pound hammer falling from a height of 30 inches. The "standard penetration resistance" or "N-value" is the number of hammer blows required to drive the sampler the final 12 inches. The N-value, when properly evaluated, is an index of soil strength and/or density. Upon completion of each standard penetration test, the sampler is brought to the surface and the tube is opened to expose the recovered soil. Our project manager examines the sample, records the soil description and other pertinent information, and places a representative portion of the soil into a sealed container for transportation to our laboratory.

Water Level Readings

Water level readings are taken in each borehole upon the completion of drilling or excavation. In low permeability soils, such as silts and clays, the water level in the boreholes may take many hours to stabilize. Groundwater levels may be dependent upon recent rainfall activity and other site specific factors. Since these conditions may change with time, the water level information presented on the **Boring Records** represents the conditions only at the time each measurement was taken.

Boring Records

Our interpretation of the conditions encountered at each location is indicated on the **Boring Records**, which are prepared from the observations of the ECS field engineer or geologist during drilling or excavation, our engineering review of the soil samples obtained, the results of laboratory testing on selected samples, and our experience with similar subsurface conditions. Soil descriptions are made using the Unified Soil Classification System and/or ASTM D-2488 as guides. The depths designating strata changes are estimations and only representative of depths at that specific boring location. In many geologic settings, the transition between strata is gradual. A **Reference Notes for Boring Logs**, which defines the symbols and other pertinent information presented on the **Geotechnical Borehole Logs** is provided with this report. The subsurface conditions indicated on our **Geotechnical Borehole Logs** represent only the conditions encountered at the specific boring

location at the time of our exploration. The groundwater observations were made at the time of drilling and may vary with changes in the season and weather.

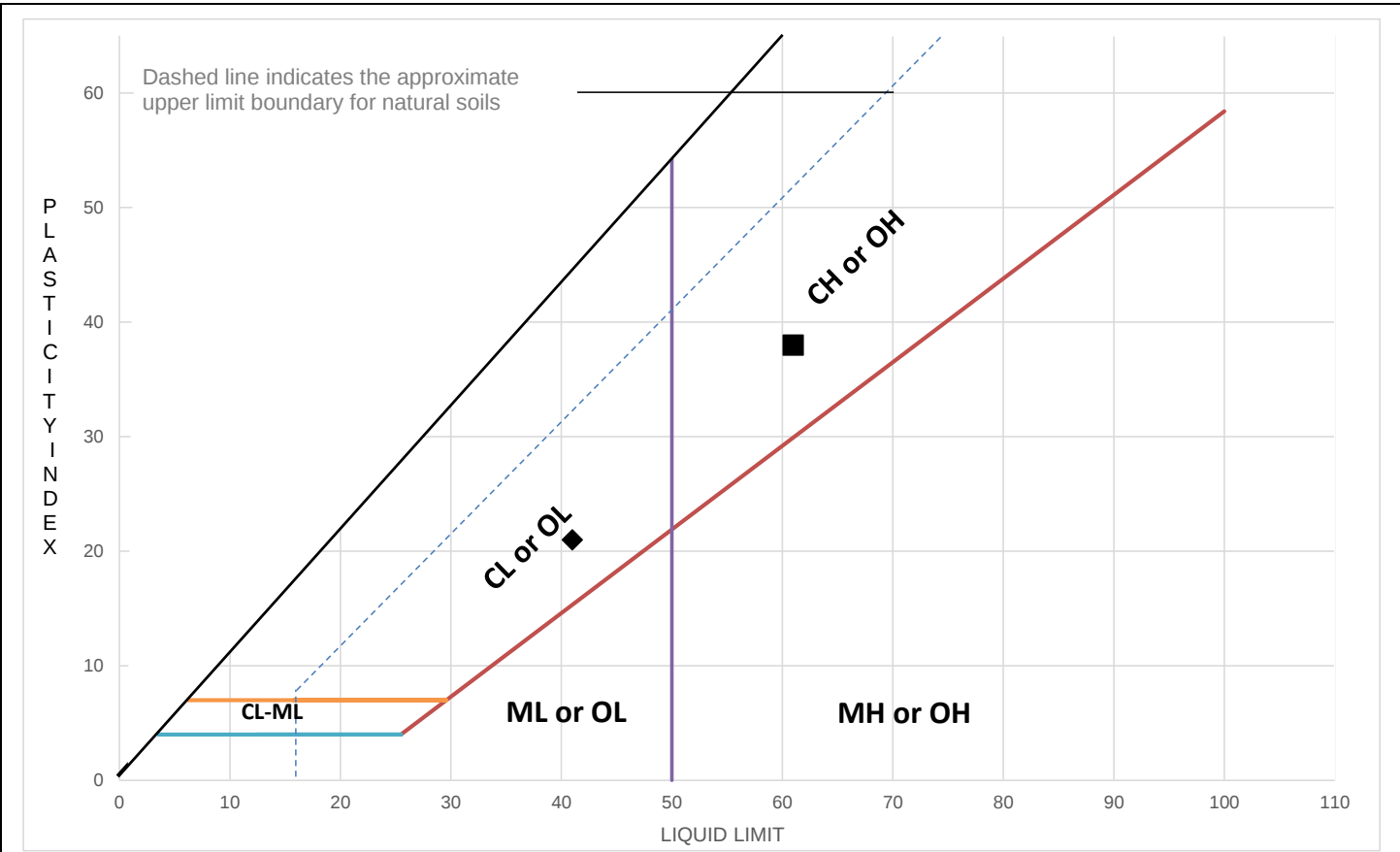
Refusal

Refusal is the term applied to material that cannot be penetrated with augers or has a standard penetration resistance exceeding 50 blows per 6-inch increment. Refusal may be encountered on continuous bedrock, discontinuous floaters, cemented soil, weathered rock, debris, buried structures, or other hard subsurface materials. Refusal materials can be evaluated only by obtaining a core of the material. This limitation must be considered when evaluating refusal depths where coring is not conducted.

APPENDIX C – Laboratory Operations

Laboratory Testing Results
Laboratory Procedures

LIQUID AND PLASTIC LIMITS TEST REPORT



TEST RESULTS (ASTM D4318-10 (MULTIPOINT TEST))

	Sample Location	Sample Number	Sample Depth (ft)	LL	PL	PI	%<#40	%<#200	AASHTO	USCS	Material Description
■	B-07	S-23	4.00-5.50	61	23	38					(CH) Lt - Md Brown Fat CLAY
◆	B-08	S-25	0.00-1.50	41	20	21					(CL) Me Brown Silty CLAY

Project: Express Oil - Shelbyville, KY
Client: Express Oil Change, LLC

Project No.: 61:3446
Date Reported: 12/8/2025



Office / Lab
ECS Southeast LLC - Louisville

Address
1762 Watterson Trail
Louisville, KY 40299

Office Number / Fax
(502)493-7100
(502)493-8190

Tested by	Checked by	Approved by	Date Received
AshleyB	DFBurke	DFBurke	

Laboratory Testing Summary

Sample Location	Sample Number	Depth (ft)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-01	S-1	0.0-1.5	26.1										
B-01	S-2	1.5-2.9	26.3										
B-02	S-3	0.0-1.5	22.1										
B-02	S-4	1.5-3.0	26.7										
B-02	S-5	4.0-5.5	21.6										
B-03	S-7	0.0-1.5	22.8										
B-03	S-8	1.5-3.0	22.6										
B-04	S-9	0.0-1.5	21.0										
B-04	S-10	1.5-3.0	25.3										
B-04	S-11	4.0-4.7	13.4										

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

Project: Express Oil - Shelbyville, KY
Client: Express Oil Change, LLC

Project No.: 61:3446
Date Reported: 12/8/2025



Office / Lab

Address

Office Number / Fax

ECS Southeast LLC - Louisville

1762 Watterson Trail
Louisville, KY 40299

(502)493-7100

(502)493-8190

Tested by	Checked by	Approved by	Date Received
Lawal A	DFBurke	DFBurke	

Laboratory Testing Summary

Sample Location	Sample Number	Depth (ft)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-05	S-12	0.0-1.5	30.3										
B-05	S-13	1.5-3.0	21.8										
B-05	S-14	4.0-5.5	19.6										
B-05	S-15	6.5-8.0	23.0										
B-05	S-16	9.0-10.5	20.0										
B-06	S-17	0.0-1.5	20.5										
B-06	S-18	1.5-3.0	22.8										
B-06	S-19	4.0-5.5	21.7										
B-07	S-21	0.0-1.5	20.8										
B-07	S-22	1.5-3.0	23.6										

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

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Laboratory Testing Summary

Sample Location	Sample Number	Depth (ft)	^MC (%)	Soil Type	Atterberg Limits			**Percent Passing No. 200 Sieve	Moisture - Density		CBR (%)		#Organic Content (%)
					LL	PL	PI		<Maximum Density (pcf)	<Optimum Moisture (%)	0.1 in.	0.2 in.	
B-07	S-23	4.0-5.5	23.7		61	23	38						
B-07	S-24	6.5-7.8	28.6										
B-08	S-25	0.0-1.5	22.2		41	20	21						
B-08	S-26	1.5-3.0	22.0										
B-08	S-27	4.0-5.5	28.9										
B-08	S-28	6.5-7.9	14.4										

Notes: See test reports for test method, ^ASTM D2216-19, *ASTM D2488, **ASTM D1140-17, #ASTM D2974-20e1 < See test report for D4718 corrected values

Definitions: MC: Moisture Content, Soil Type: USCS (Unified Soil Classification System), LL: Liquid Limit, PL: Plastic Limit, PI: Plasticity Index, CBR: California Bearing Ratio, OC: Organic Content

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Laboratory Procedures

General

Laboratory tests are generally conducted to satisfy one or more of the following objectives: (1) confirmation of visual-manual soil identification; (2) determination of index values used to estimate soil engineering properties (i.e., strength, compressibility and permeability); or (3) direct measurement of specific soil properties. The tests selected for a given project are dependent on the subsurface conditions encountered, as well as specific project requirements, such as structural loads and planned grade changes. The results of the laboratory tests conducted for this project are listed on the **Geotechnical Borehole Logs**, Laboratory Test Data Summary, or laboratory data curves in the **Appendix**. Brief descriptions of the test procedures are provided below.

Description and Identification of Soils (Visual-Manual Procedure) (ASTM D 2488)

The Visual-Manual Procedure provides a general guide to the engineering properties of soils and enables the engineer to apply past experience to current situations. Samples obtained during the field exploration are examined and visually described and identified by a geotechnical engineer or geologist. The soils are typically identified according to predominant particle size (clay, silt, sand, etc.), consistency (based on apparent stiffness and the number of blows from standard penetration tests), color, moisture and group symbol (CL, CH, SP, SC, etc.). Unless otherwise indicated, the soil descriptions in this report are based on the Visual-Manual Procedure.

Classification of Soils for Engineering Purposes (Unified Soil Classification System) (ASTM D 2487)

The Visual-Manual Procedure described above is primarily qualitative. The Unified Soil Classification System (USCS) is used when precise soil classification is required. The USCS is based on laboratory determination of particle-size characteristics, liquid limit, and plasticity index. Using these test results, the soil can be classified according to the Unified Classification System, which provides an index for estimating soil behavior.

Water (Moisture) Content of Soil (ASTM D 2216)

Moisture content is one of the most important index properties used in establishing a correlation between soil behavior and soil properties such as strength and compressibility. The moisture content, along with the liquid and plastic limits, are used to express the relative consistency or liquidity index of a soil. Increasing moisture contents typically reflect lower strengths for a given soil. The soil moisture content is the ratio, expressed as a percentage, of the mass of "pore" or "free" water in a given mass of soil to the mass of the solid soil. Moisture content samples are taken from the sealed container obtained during the field exploration phase of a project. Each sample is weighed, and then placed in an oven set to 110°C + 5°C. Each sample remains in the oven until the free moisture evaporates. Each dried sample is removed from the oven, allowed to cool, and then weighed. The moisture content is computed by dividing the weight of evaporated water by the weight of the dry sample.

Liquid Limit, Plastic Limit, and Plasticity Index of Soils (ASTM D 4318)

Depending upon the relative moisture content, a fine-grained soil may occur in a liquid, plastic, or solid state. In current usage, the liquid limit (LL) and plastic limit (PL) of a soil are referred to as the "Atterberg Limits", which establish the approximate moisture contents at which the soil changes state. This test method is an integral part of several engineering classification systems to characterize the fine grained fractions of soils. It is also used with other soil properties to correlate with engineering behavior such as compressibility, permeability, compactability, shrink-swell, and shear strength. The liquid limit is the moisture content at which a soil becomes sufficiently "wet" to behave as a heavy viscous fluid (i.e., transition from plastic to liquid state). It is defined as the moisture content at which the soil, when placed in a standard brass bowl, makes a 1/2-inch closure

in a groove cut through the soil after the bowl is dropped 25 times at a specified height and rate. The plastic limit is the moisture content at which the soil begins to lose its plasticity (i.e., transition from plastic to semi-solid state). It is defined as the lowest moisture content at which the soil can be rolled into 1/8-inch diameter threads without crumbling. The plasticity index (PI) is the difference between the liquid limit and the plastic limit, and is the range of moisture content over which a soil deforms as a plastic material.

APPENDIX D – Supplemental Report Document

GBA “Important Information About
This Geotechnical Engineering Report”

Important Information about This Geotechnical-Engineering Report

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

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

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

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

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

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

You Need to Inform Your Geotechnical Engineer about Change

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

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

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

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

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

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

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

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

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

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

This Report's Recommendations Are Confirmation-Dependent

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

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

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



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