ECS Midwest, LLC

Geotechnical Engineering Report

Proposed Valvoline Instant Oil Change - Lee's Summit

NWC of NW Chipman Road and NW Ward Road
Lee’s Summit, Jackson County, Missouri

ECS Project Number 16:15951

October 16, 2025

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Ms. Kelsey Peterson
Valvoline, Inc.
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Lexington, Kentucky 40509
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ECS Project No. 16:15951

Reference: Geotechnical Engineering Report
Proposed Valvoline Instant Oil Change - Lee's Summit
NWC of NW Chipman Road and NW Ward Road
Lee's Summit, Jackson County, Missouri

Dear Ms. Peterson:

ECS Midwest, LLC (ECS) has completed the subsurface exploration, laboratory testing, and geotechnical engineering analyses for the above-referenced project. Our services were performed in general accordance with our agreed upon scope of services. This report presents our understanding of the geotechnical aspects of the project along with the results of the field exploration and laboratory testing conducted, and our design and construction recommendations.

It has been our pleasure to be of service to Valvoline, Inc. during the design phase of this project. We would appreciate the opportunity to remain involved during the continuation of the design phase, and we would like to provide our services during construction phase operations as well to verify subsurface conditions determined for this report. Should you have questions concerning the information contained in this report, or if we can be of further assistance to you, please contact us.

Respectfully submitted,

ECS Midwest, LLC

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EXECUTIVE SUMMARY

The following text summarizes the main findings of the exploration, particularly those that may have a cost impact on the planned development. This Executive Summary is intended as a very brief overview of the primary geotechnical conditions expected to affect design and construction. Information gleaned from this Executive Summary should not be utilized in lieu of reading the entire geotechnical report.

- Four (4) of the seven (7) test borings were terminated at depths of about 17 to 18 feet below the existing grades due to auger refusal on weathered shale bedrock.
- Possible fill materials were encountered, extending approximately 3½ to 5 feet below existing grades. The possible fill consisted of lean clay with sand. The possible fill appeared to be relatively clean (no construction debris or unsuitable materials based on the visual classifications) and showed some level of compaction.
- Highly expansive 'fat' clays were encountered below the undocumented possible fill, extending to weathered shale bedrock or terminal depth of test borings. These soils exhibit higher than typical shrink-swell potential and could cause potential rise/heave (PVR - potential vertical rise) in the range of 1 to 2 inches if encountered within 24 inches of lightly loaded structure foundations, floor slab, and pavements final subgrade/bearing elevations. Therefore, ECS recommends removal and replacement of higher plasticity 'fat clays' with low volume change material (LVC) to a depth of about 18 inches below the mat foundation. In addition, ECS recommends removal and replacement of these fat clays to a depth of about 24 inches below grade supported slabs, shallow foundations and pavements subgrade (if encountered).
- The mat foundation bearing on the engineered fill over the fat clay (Stratum II) can be designed for a maximum allowable soil bearing pressure of 2,000 psf.
- The proposed trash enclosure walls and columns can be supported on a shallow foundation system using a net allowable soil bearing pressure of 2,000 psf bearing within possible fill (after field testing) or on low volume change (LVC) overlying Stratum II.
- Below-grade walls should be designed as restrained retaining walls to resist at-rest earth pressures and other lateral pressures imposed on the walls, such as surcharge loads. A drainage system should surround the below-grade walls and underlie the below-grade floor slab.
- For pavement design purposes, the rigid pavements may be designed based on an estimated modulus of subgrade reaction, k_{v1} of 100 psi/in (pounds per square inch per inch) and flexible pavements may be designed using a California Bearing Ratio (CBR) of 3 supported on low volume change material.
- Based on the results of the subsurface exploration and knowledge of the local geology, Seismic Site Class D is recommended for this site.

1.0 INTRODUCTION

The purpose of this report is to provide geotechnical information for the design of foundations, floor slabs, and pavements for the proposed development. The recommendations developed for this report are based on project information supplied by the client.

ECS provided its services in accordance with ECS Proposal No. 16:25490-GP, dated September 9, 2025, and authorization via signature of the aforementioned proposal by Ms. Bonnie Carrington with Valvoline, Inc. on September 10, 2025 which includes our Terms and Conditions of Service.

This report contains the procedures and results of our subsurface exploration and laboratory testing programs, review of existing site conditions, engineering analyses, and recommendations for the design and construction of the project.

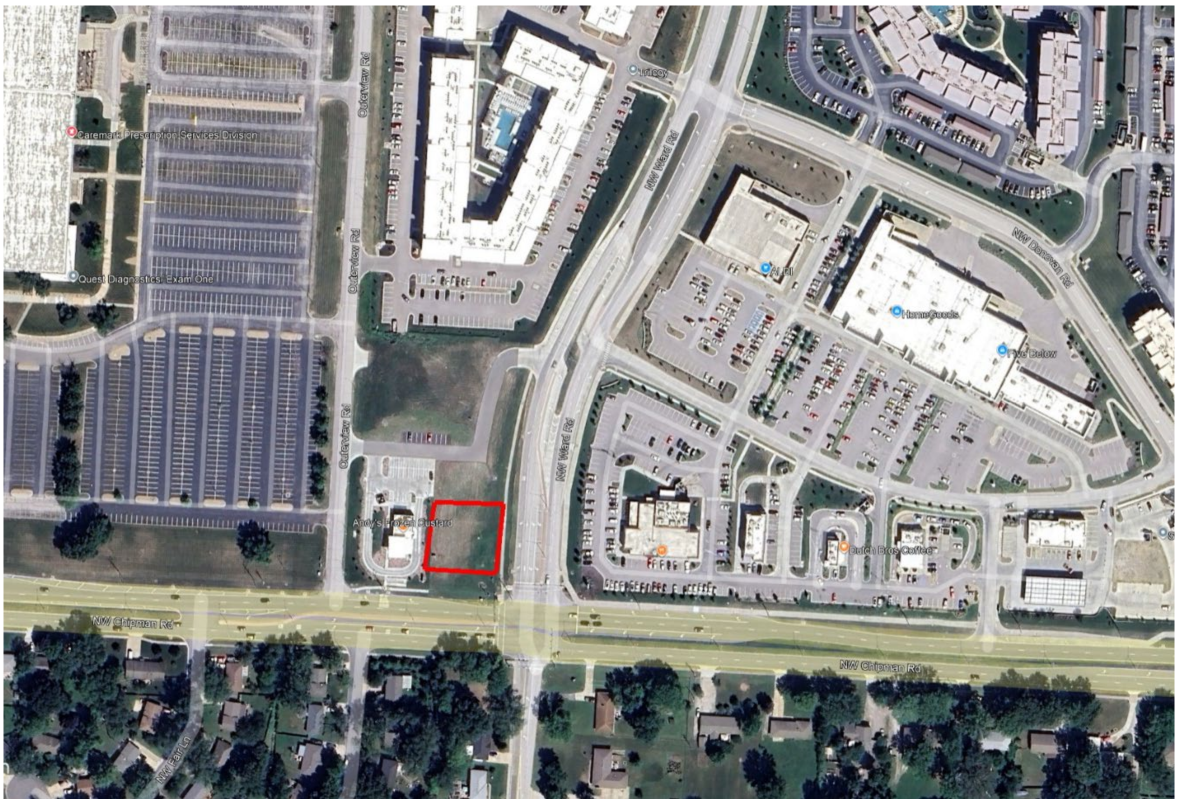
The report includes the following items:

- Descriptions of the current site conditions and surface topographic conditions.
- A brief review and description of our field and laboratory test procedures and the results of testing conducted.
- Records of the field exploration (Test Boring Logs) prepared in accordance with the standard practice for geotechnical engineering.
- A boring location diagram and subsurface cross-sections at the boring locations within the proposed development footprint and at selected boring locations.
- Recommendation for shallow footings and mat foundation including allowable soil bearing pressures and estimated settlements.
- Recommendations for the design and construction of below-grade walls.
- Recommendations for site preparation and construction of compacted fills, including an evaluation of on-site soils for use as compacted fills and identification of potentially unsuitable soils and/or soils exhibiting excessive moisture at the time of sampling.
- General recommendations for pavement design, including a recommended design CBR value.
- General recommendations for dewatering at the project site during construction of the proposed structure and other associated amenities.

2.0 PROJECT INFORMATION

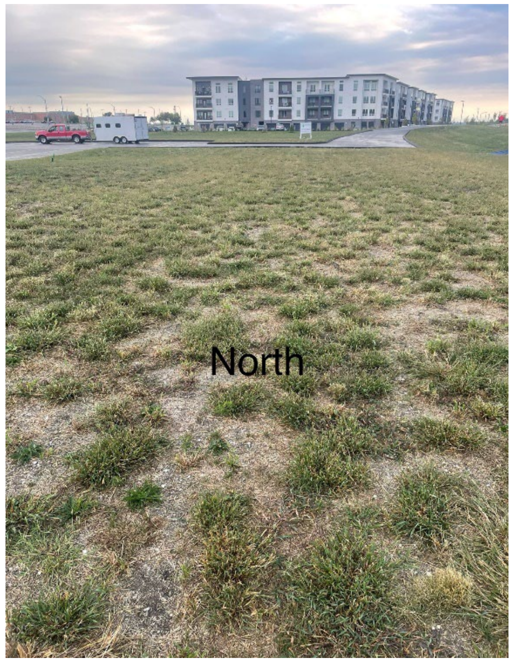
2.1 PROJECT LOCATION AND CURRENT SITE USE

The project site is located at the northwest corner of the intersection of NW Chipman Road and NW Ward Road in Lee's Summit, Jackson County, Missouri. The site is bound to the north by a vacant lot and unnamed access drive, to the west by a recent commercial development, to the east by NW Ward Road and to the south by NW Chipman Road. The site is currently a vacant lot encompassed with grass. The site location is shown below, and in wider scope on the Site Location Diagram in Appendix A:



Site Location Map (Site outlined in RED)

A site-specific topographical information was not available at the time this report was written. Based on our review of available online resources (Google Earth), the existing site grades appear to vary from EL. 998 feet to El. 1,002 feet above MSL. <u>Site grades determined without a professional survey are approximate and should not be used in the final design of structures and site amenities.</u>



Viewing North across the site

Viewing East across the site

Viewing South across the site

Viewing West across the site

2.2 PROPOSED CONSTRUCTION

Based on the provided RFP information, ECS understands the proposed development will include the construction of a Valvoline Instant Oil Change single-story building with a basement level, associated paved parking/drive lanes, and a trash enclosure.

Building: The information listed below summarizes our understanding and estimates of the structure and its loads based on the most recent information provided by the client:

SUBJECT	DESIGN INFORMATION / EXPECTATIONS	
Building Footprint	Approximately 1,470 SF in plan area	R
No. of Stories:	Single-story above grade with a basement level	R
Mat Foundation Dimensions	Length: 47.7 feet; Width: 30.7 feet	R
Framing	Concrete foundation, steel-framed structure	B
Estimated Loads	Anticipated Maximum Mat Foundation Contact pressure of 2,000 psf	R
Anticipated Proposed Ground Level Elevation	About 1,000 feet above MSL (based on average site grades within proposed building footprint; actual elevation not provided)	B
Lowest Basement Level Finished Floor Elevation	About EL. 988 feet above MSL (Estimated at approximately 10 to 12 feet below grade based on similar projects)	B
Foundation Settlements	Approximately 1-inch total	B
Site Grading Operations	Less than about 2 feet	B

R: Reported by client and/or Design Team
B: Based on ECS estimate in absence of information from Client and/or Design Team

Pavement:
The design traffic counts were not available at the time of this report. Consistent with past projects, an ESAL (Equivalent Single Axle Load) value of less than 150,000 was estimated for this project's rigid and flexible pavement areas.

The Valvoline standard pavement sections for a 20-year design life include:

- **Asphaltic Concrete Section**: 1½-inch asphalt surface course with a polymer-modified asphalt binder over a 2½-inch asphalt binder course on an 8-inch-thick compacted aggregate subbase course.

If our understanding of the proposed construction is inaccurate or the design changes, and if the traffic loads become available, please contact ECS immediately so we can review (and revise, if necessary) the recommendations provided herein.

3.0 FIELD EXPLORATION AND LABORATORY TESTING

Our exploration procedures are explained in greater detail in Appendix B including the insert titled *'Exploration Procedures'*. Our scope of services included drilling seven (7) test borings. The drilling contractor located the test borings with a handheld GPS unit and their approximate locations are shown on the Boring Location Diagram in Appendix A.

Ground surface elevations, noted on the boring logs, were estimated from available online resources (i.e. Google Earth Pro). Boring locations and site grades determined without a professional site survey are approximate and may not be appropriate for final design and construction.

Prior to drilling, the drilling subcontractor contacted the State of Missouri's One-Call System, Missouri 811, to clear public underground utilities in the vicinity of the project site. In addition, per client's request, ECS engaged a private utility locator to assist in locating underground private utility at and around the proposed test borings. The test borings were terminated at depths of about 17 to 20 feet below the existing grades. Standard penetration tests (SPTs) were conducted in the borings at regular intervals in general accordance with ASTM D 1586.

The drill crew backfilled the boreholes with cuttings upon completion of drilling. Settlement or expansion of borehole backfill can occur over time resulting in a trip hazard. Monitoring the boreholes after initial drilling activities is not within our scope but should be done by the client or property owner.

3.1 SUBSURFACE CHARACTERIZATION

Listed in the following Table is a generalized characterization of the soil strata encountered at the boring locations during the subsurface exploration. For subsurface information at a specific location, refer to the Boring Logs in Appendix B.

GENERALIZE SUBSURFACE STRATIGRAPHY					
Approximate Depth to Bottom of Stratum (feet)	Stratum No.	Material Description	Calibrated Penetrometer Resistance Q_p (tsf)	Natural Moisture Content (%)	SPT (1) N-values (bpf)
¼	Surficial	**Topsoil:** Approximately 2 to 3 inches (±)	NA	NA	NA
3½ to 5	I	**Possible Fill: LEAN CLAY WITH SAND (CL),** trace gravel, dark brown, moist, very stiff to hard	2¾ to 5+	13 to 21	5 to 12
17 to 20	II	**(CH) FAT CLAY,** trace gravel and sand, gray and brown mottled, stiff to very stiff	1½ to 3	4 to 35	19 to 31
20	III(2)	**WEATHERED SHALE**	NA	NA	50/5"

Notes: (1) Standard Penetration Test
(2) Encountered in test borings B-01 through B-05.
Auger refusal was encountered at four (4) of the seven (7) boring locations

The soil stratification shown on the boring logs represents the interpreted soil conditions at the boring locations. Variations in the stratification can occur between sample intervals and boring locations. The subsurface conditions at other times and locations on the site may differ from those found at the boring locations. If different site conditions are encountered during construction, ECS should be contacted to review our recommendations relative to the new information.

Because the split-spoon sampler has a 1⅜-inch inside diameter, the soil classifications noted on the boring logs may not be representative of the entire soil matrix. Material larger than the 1⅜-inch inside diameter of the split-spoon sampler cannot be collected and observed directly.

3.2 GROUNDWATER OBSERVATIONS

The drillers observed the boreholes for the presence of measurable water during drilling and at the completion of drilling. The groundwater level observations are noted/reported on the soil boring logs in Appendix B. Groundwater was not observed in the boreholes during drilling operations.

Soils in the Midwest frequently oxidize from gray to brown above the level where the soil remains saturated. This zone of change, which may be an indication of the long-term water level, is frequently interpreted to be the groundwater table. Gray soils were not encountered at the soil boring locations. It is our professional opinion that the long-term groundwater table appears to be located below the explored depths.

Please note groundwater in fine-grained or clayey soils may take several days or weeks to stabilize in the boreholes. The boreholes were backfilled immediately after drilling. Also, please note that due to capillary action in fine-grained soils (silts and clays), the soils are likely at least seasonally partially-saturated a few feet above the aforementioned estimated long-term groundwater levels.

Variations in the groundwater table elevation may occur as a result of changes in precipitation, evaporation, surface water runoff, construction activities, and other factors. Perched water conditions may also develop or exist at shallower depths seasonally, particularly within granular soils underlain by clay.

3.3 LABORATORY TESTING

The laboratory testing consisted of selected tests performed on samples obtained during our field exploration operations. Classification and index property tests were performed on representative soil samples. The basic laboratory testing procedures are explained in greater detail in Appendix B. The following tests were performed on soil samples:

- Moisture content determination on fine-grained soil samples in accordance with ASTM D 2216.
- Calibrated hand penetrometer (Q_p) tests on cohesive soil samples.
- Atterberg limits tests on fine-grained soil samples in accordance with ASTM D 4318.
- Material Finer than #200 Sieve in accordance with ASTM D1140.

Each sample was visually classified on the basis of texture and plasticity in accordance with ASTM D2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures) and including USCS classification symbols. After classification, the samples were grouped in the major zones noted on the boring logs in Appendix B. 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.

Atterberg Limit Tests (ASTM D 4318) were performed on select samples from the samples collected from the borings and results are presented in the Table below:

LABORATORY TESTING RESULTS						
Boring Location	Sample Depth	Soil Classification	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Percent Passing #200 Sieve (%)
B-01	3½ to 5	Fat Clay (CH)	63	21	42	91.2
B-04	6½ to 8	Fat Clay (CH)	91	29	62	95.6

Based on the plasticity index test results, the tested soils encountered at depths ranging from 3½ to 20 feet (above the bedrock) exhibit high shrink-swell potential.

The soil samples will be retained in our laboratory for a period of 60 days, after which, they will be discarded unless other instructions are received as to their disposal.

3.4 Photo-Ionization Detector (PID) Readings

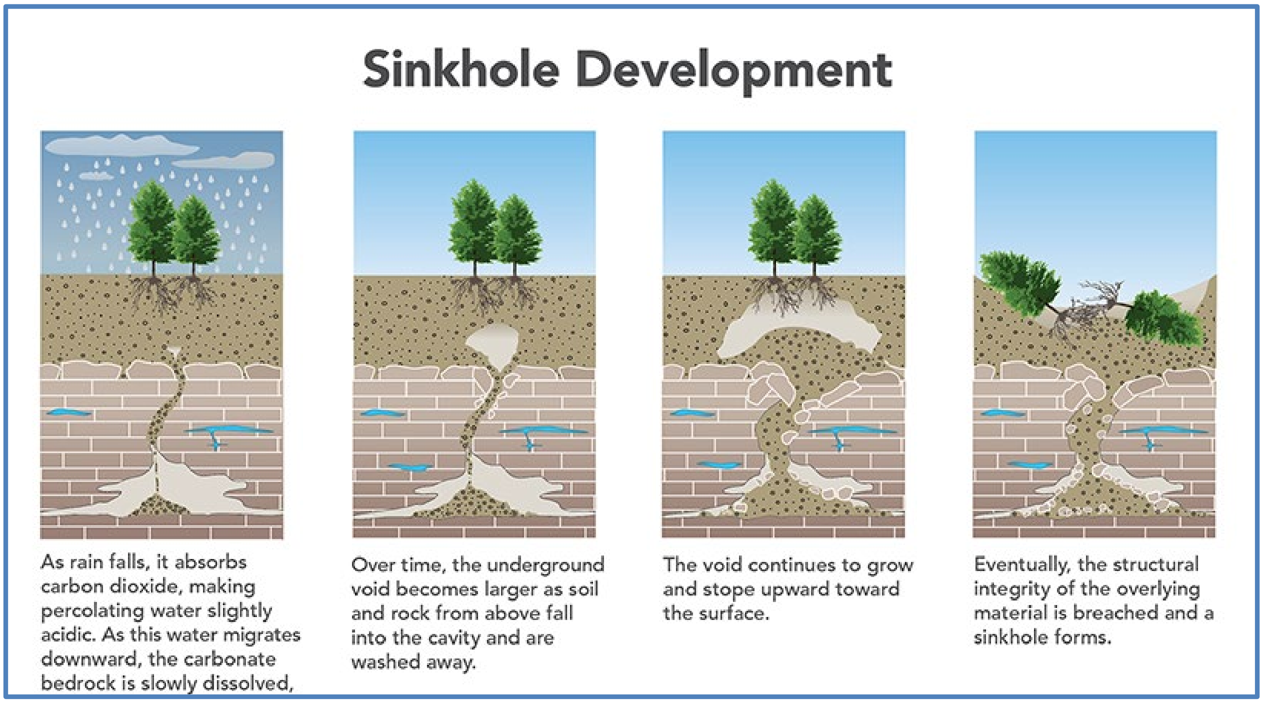
Each soil sample from the borings was logged and underwent headspace screening using a photo-ionization detector (PID). Headspace vapor measurements were taken in the laboratory on recovered split spoon samples to estimate the volatile organic compound (VOC) content using a Rae Systems Mini-Rae® PID. A PID is a type of gas detector that uses ultraviolet (UV) light to ionize chemicals in the air, allowing for the detection and measurement of various VOCs and other gases. The following table presents the PID readings.

PHOTOIONIZATION DETECTOR TEST RESULTS					
Boring Number	Sample				PID Reading (ppm)
	Number	Top Depth (ft)	Base Depth (ft)	Soil Type	
B-01	S-1	1	2½	CL	0.0
	S-2	3½	5	CH	0.2
	S-3	6	7½	CH	0.0
	S-4	8½	10	CH	0.0
	S-5	13½	15	CH	0.0
B-02	S-1	1	2½	CL	0.0
	S-2	3½	5	CH	0.0
	S-3	6	7½	CH	0.2
	S-4	8½	10	CH	0.1
	S-5	13½	15	CH	0.2
	S-6	18½	20	Weathered Rock	0.2
B-03	S-1	1	2½	CL	0.0
	S-2	3½	5	CL/CH	0.0
	S-3	6	7½	CH	0.0
	S-4	8½	10	CH	0.0
	S-5	13½	15	CH	0.0
B-04	S-1	1	2½	CL	0.0
	S-2	3½	5	CL	0.0
	S-3	6	7½	CH	0.0
	S-4	8½	10	CH	0.0
	S-5	13½	15	CH	0.0
B-05	S-1	1	2½	CL	0.0
	S-2	3½	5	CH	0.0
	S-3	6	7½	CH	0.0
	S-4	8½	10	CH	0.0
	S-5	13½	15	CH	0.1
B-06	S-1	1	2½	CL	0.0
	S-2	3½	5	CL	0.0
	S-3	6	7½	CH	0.0
	S-4	8½	10	CH	0.1
	S-5	13½	15	CH	0.0
	S-6	18½	20	CH	0.0
B-07	S-1	1	2½	CL	0.0
	S-2	3½	5	CL/CH	0.0
	S-3	8½	10	CH	0.0

4.0 DESIGN RECOMMENDATIONS

4.1 GEOLOGIC HAZARD

Our cursory review of publicly available Maps from Missouri Geological Survey in the general vicinity of the proposed project has identified the potential for this site to be underlain by calcium and calcium-magnesium rock (Burlington-Keokuk Limestone). There was three sinkholes identified in the general vicinity of the proposed site (within a 5-mile radius). A Map of the area is shown below with known sink hole locations around the proposed site. The presence of calcium and calcium-magnesium rock indicates the potential for sinkhole development at this site. Karst development occurs from the dissolution of the native limestone bedrock material. Over time, groundwater can transport the surrounding soil into bedrock voids causing visible surface features such as circular depressions or areas of drainage. However, some sinkholes may not be visible from surface because they are plugged or capped with a thin layer of rock. The extent of the sinkhole occurrence depends on the particular geologic, hydrogeologic and soil conditions of the site and what disturbances are being created by man-made features. The image below, provided by MDNR, depicts the development of sinkholes over time.



General Sinkhole Development (Source: Missouri Department of Natural Resources)

Sink Hole Map Near the Project Site (Source: Missouri Geological Survey)

Additional testing of the subgrade including additional soil borings, bedrock profiling, and subsurface resistivity testing can aid in the detection of the sinkholes and karst development. However, the present state-of-the-art geotechnical engineering does not permit accurate predictions of where or when sinkholes will occur. **Site grading should be established to provide positive drainage both during and after construction so as to minimize the potential for sinkhole development.**

4.2 FOUNDATIONS

4.2.1 Mat Foundation

As discussed in the previous sections, highly expansive fat clay soils were encountered at depths between approximately 3½ to 20 feet below existing grades in the test borings. Based on the client provided information, ECS understands that the proposed basement mat foundation is anticipated to bear at a depth of about 10 to 12 feet below the final grades. In order to reduce the risk of excessive differential settlement from the shrink or swell potential of the fat clay soils, it is recommended to over excavate about 18-inches of the fat clay stratum and replace it with low volume change material (LVC) so that the mat foundation will bear on low plastic engineered fill.

Provided subgrades and structural fills are prepared as recommended in this report, the proposed building can be supported by a mat foundation. ECS recommends the foundation design use the parameters in the Table below:

MAT FOUNDATION DESIGN PARAMETERS		
Design Parameter		**Value**
Maximum Allowable Soil Bearing Pressure[(1)]		2,000 psf
Soil Subgrade Modulus (k) [(2)]		125 psi/in
Estimated Depth of Mat Foundation below adjacent final grades		10 to 12 feet
Minimum Exterior Frost Depth (below final exterior grade)		30 inches
Post-Construction Estimated Settlement [(3)]	Total	Approximately 1 inch
	Differential	Approximately ½ inch

1. The applied pressure above the base of the foundation.
2. The estimated modulus provided is based on a 1 foot by 1 foot rigid plate and assumes 18 inches of fat clay stratum is replaced with LVC engineered fill. Therefore, the modulus used for design may need to be adjusted.
3. Based on maximum loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are more complete.

Soils suitable for direct foundation support or as the subgrade for engineered fill and indirect foundation support should have parameters as noted in the following Table or greater, unless otherwise recommended by ECS:

SUITABLE BEARING SOIL CHARACTERISTICS	
Maximum Allowable Bearing Pressure (psf)	**Bearing Stratum**
2,000	Low Volume Change (LVC) material above the fat clay Stratum II

Potential Foundation Undercuts: The proposed mat foundation must be supported on new low volume material engineered fill. Due to the potentially expansive fat clay (CH) soils encountered at the site, 18 inches of highly plastic ‘fat’ clay stratum should be removed and replaced with low volume change (LVC) material engineered fill.

Drainage layer: We recommend mat foundations be underlain by a granular drainage layer. The granular material will serve as a capillary break, which if properly designed and installed can assist in more uniform curing of concrete. A drainage layer should include a minimum 6 inches thick drainage layer, with a maximum aggregate size of 1 inch and no more than 5 percent passing the No. 200 sieve.

4.2.2 Conventional Shallow Foundations (Trash Enclosure)

Provided subgrades and engineered fills are prepared as recommended in this report, the trash enclosure walls and gate columns can be supported by a shallow foundation system bearing within the possible fill (after performing additional tests such as test pits and checking suitability of possible fill) or low volume change material over fat clays. ECS recommends the foundation design use the parameters in the Table below:

SHALLOW FOUNDATION DESIGN PARAMETERS (TRASH ENCLOSURE)		
Design Parameter	**Column Footing**	**Wall Footing**
Net Allowable Soil Bearing Pressure (1)	2,000 psf	2,000 psf
Acceptable Bearing Soil Material	Very Stiff to Hard Lean Clay (CL) Stratum I(4) or Engineered Fill overlying Stratum II	Very Stiff to Hard Lean Clay (CL) Stratum I(4) or Engineered Fill overlying Stratum II
Minimum Width	30 inches	18 inches
Minimum Exterior Frost Depth (below final exterior grade)	36 inches	36 inches
Estimated Total Settlement (2)	Less than 1-inch	Less than 1-inch
Estimated Differential Settlement (4)	Less than ¾-inch between columns	Less than ¾-inch

Notes:
(1) Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
(2) Based on estimated structural loads. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.
(3) Based on maximum column/wall loads and variability in borings. Differential settlement can be re-evaluated once the foundation plans are more complete.
(4) Additional tests such as test pits should be performed to check suitability of the existing possible fill and confirming no construction debris or unsuitable materials are encountered.

Bearing Materials: Soils adequate as the subgrade for engineered fill and indirect foundation support should have parameters as noted in the following Table or greater, unless otherwise recommended by the geotechnical engineer:

SUITABLE BEARING SOIL CHARACTERISTICS		
Maximum Allowable Bearing Pressure (psf)	**Cohesive Soil**	
	Consistency	**Unconfined Compressive Strength (tsf)**
2,000	Stiff	1 or greater

Potential Foundation Undercuts: The soil borings indicate the presence of possible fill materials extending to depths of approximately 3½ to 5 feet below existing grades. However, the materials encountered appeared relatively clean and free of construction debris (based on the visual observations) and showed some level of compaction. ECS believes that these soils were placed during site grading operations. Compaction testing or fill placement records were not available at this time. ECS suggests that such records, if available, should be provided to ECS for review.

Depending on the final bearing elevations, shallow foundations may be constructed in the Stratum I (possible fill Lean Clay soils). If the foundation bearing level is within 24 inches of the Stratum II Fat Clay soils, it is recommended to undercut the soil as needed and backfill with low volume change (LVC) engineered fill to provide at least 2 feet of separation between the bottom of the footing and the underlying Fat Clay Stratum II soils.

Clay soils encountered at or near the anticipated bearing elevations are sensitive to disturbance when exposed, especially when wet. The contractor should exercise care and minimize traffic and potential disturbance of the soils. If disturbed, the exposed surfaces should be compacted with a plate compacter or jumping jack prior to the placement of reinforcing steel and concrete.

4.2.3 Street Level Apron Slabs

Provided subgrades are prepared as discussed herein and based on the assumed design load, the proposed street level aprons can be supported as monolithic turn down slabs. The design of the turn down slab should utilize the following parameters:

FOUNDATION DESIGN PARAMETERS – STREET-LEVEL APRON SLABS	
Net Allowable Bearing Pressure (1)	2,000 psf
Acceptable Bearing Soil Material	Possible Fill Lean Clay (Stratum I) or Approved LVC Engineered Fill over Stratum II
Minimum Turn Down Width	8 inches
Minimum Turn Down Embedment Depth (below finished exterior grades) (2)	36 inches
Modulus of Subgrade Reaction (k_1)	125 pci
Estimated Total Settlement (3)	Less than 1 inch
Estimated Differential Settlement (3)	½ inch or less in 50 feet

Notes:
1. Net allowable bearing pressure is the applied pressure in excess of the surrounding overburden soils above the base of the foundation.
2. For bearing capacity, frost penetration, and expansive soils considerations.
3. Based on assumed maximum slab load of 1 klf. If final loads are different, ECS must be contacted to update foundation recommendations and settlement calculations.

The turndown slab should be considered similar to foundations. This means that if the apron slab is to bear within 24 inches of the Stratum II Fat Clay soils, it is recommended to undercut the soil to leave 2 feet of separation between the bottom of the apron and the Stratum II Fat Clay soils. The removed material shall be replaced with LVC engineered fill or lean concrete (with a strength of f'c ≥ 1,000 psi at 28 days) up to the original design bottom of the footing elevation. The original footing shall then be constructed on top of the backfill material.

Where utility trenches or other excavations are located adjacent to foundations, the bottom of the footing should be located below an imaginary 1:1 (horizontal to vertical) plane upward from the nearest bottom edge of the utility trench.

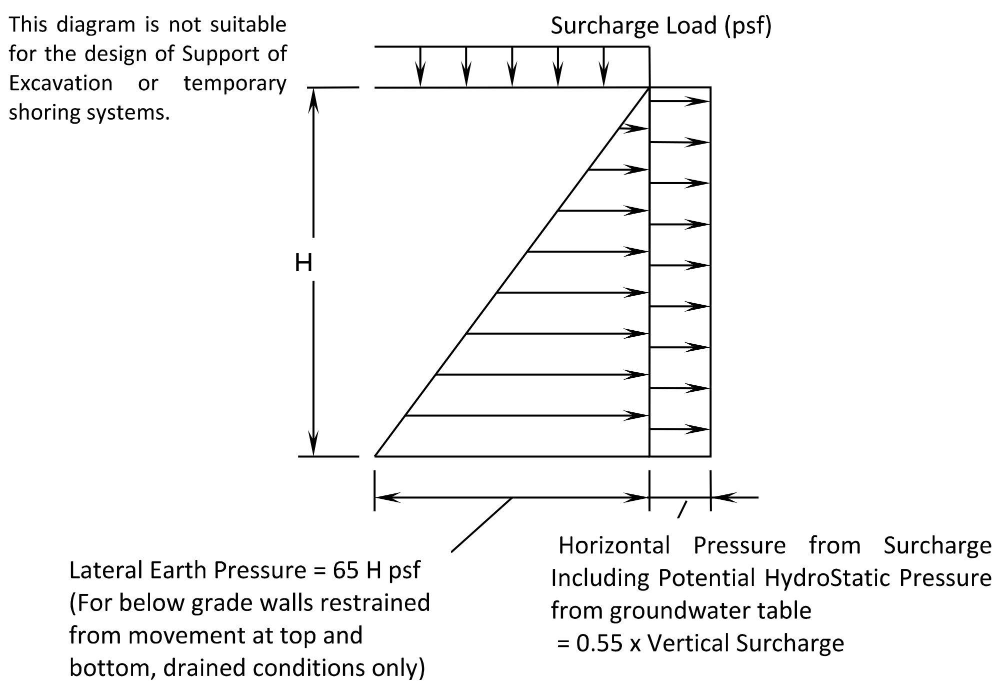
Footing excavations should have firm bottoms and be free from slough prior to concrete or reinforcement placement. The foundation excavations should be observed by a geotechnical engineer or their representative prior to placement of concrete or reinforcing steel to observe the exposed ground conditions.

4.3 BELOW-GRADE WALLS

The proposed building is planned to have a basement level that will extend approximately 10 to 12 feet below the ground level finished floor elevation. Perched water conditions may develop or exist at shallower depths and after prolonged or severe precipitation events. The following below-grade wall design parameters are based on the estimated water conditions and estimated lowest basement floor elevation of the structure being at or below the long-term water level.

Lateral Pressures: We recommend that below grade walls be designed to withstand at-rest lateral earth pressures and surcharge loads from adjacent building foundations, and/or streets. These recommendations apply to a "drained" condition which is where there is drainage material behind below grade walls that prevents hydrostatic water pressures on the back of the below-grade wall. To accomplish a drained condition, drainage materials such as a free draining gravel with drain tile, geo-composite drainage panels, weep holes connected to a sump system with outlet to storm sewer system should be used.

We recommend that walls that are restrained from movement at the top be designed for a linearly increasing lateral earth pressure. The following figure depicts our recommended at-rest lateral earth pressure condition for a "drained below-grade wall" restrained at the top:



Surcharge loads imposed within a 45-degree slope from the base of the restrained wall should be considered in the below grade wall design. These surcharge loads should be based on an at-rest pressure coefficient, k_0, of 0.55. If the proposed below grade walls are designed as unrestrained (free to rotate at the top), the project team should consider a lateral earth pressure of 40 H psf (active condition). Care should be used to avoid the operation of heavy equipment to compact the wall backfill since it may overload and damage the wall; in addition, such loads are not typically considered in the design of below grade walls.

Perimeter Drainage: We recommend below-grade walls be provided with a perimeter drainage system to reduce the potential for excess hydrostatic pressures to be exerted on the walls. This system may consist of perforated or porous wall, closed joint drain tiles (minimum diameter 4 inches, final diameter to be determined by the Civil Engineer) located around the perimeter of the walls, at the slab level.

Based on the groundwater levels observed at the boring locations during the subsurface exploration, we anticipate some significant volume of water may persist at the basement level slab subgrade elevation. Below grade walls as well as the basement slab and mat foundation should be designed to resist the lateral pressure of the water table as well as the hydrostatic uplift pressure due to the potential presence of the groundwater table above basement foundation elevation.

Drainage Aggregate Compaction: Backfill that is placed adjacent to below-ground walls, and will also provide structural support, should be compacted to 90 percent of the maximum dry density obtained by the Modified Proctor compaction test (ASTM D1557). The drainage aggregate should be compacted in maximum 8-inch-thick lifts (measured loose). Do not use heavy compaction equipment, such as mechanical rollers, within approximately 10 feet of the below-grade walls because high lateral pressures could develop and the walls could move and possibly fail. Use hand-operated compaction equipment, such as vibratory plates, within approximately 10 feet of below-grade walls. Brace below-grade walls during construction, backfilling, and compaction. It is common, but not recommended, for below-grade wall backfilled to be compacted with minimal effort. As a result, settlement of the ground surface around the perimeter commonly occurs. To reduce the potential for excessive settlement, we recommend ECS observe, and test backfill activities full-time during construction.

4.4 SEISMIC DESIGN CONSIDERATIONS

Seismic Site Class: The ASCE 7-16 requires site classification for seismic design based on the upper 100 feet of a soil profile. The three parameters used to classify sites are shear wave velocity (v_s); undrained shear strength (s_u); and Standard Penetration Test (SPT) resistance (N-value). The seismic Site Class definitions for the weighted average of shear wave velocity, shear strength or SPT N-value in the upper 100 feet of the soil profile are listed below:

SEISMIC SITE CLASSIFICATION				
Site Class	**Soil Profile Name**	**Shear Wave Velocity, Vs, (ft./s)**	**N value (bpf)**	**Undrained Shear Strength, Su, (psf)**
A	Hard Rock	Vs > 5,000 fps	N/A	NA
B	Rock	2,500 < Vs ≤ 5,000 fps	N/A	NA
C	Very dense soil and soft rock	1,200 < Vs ≤ 2,500 fps	>50	> 2,000
D	**Stiff Soil Profile**	**600 ≤ Vs ≤ 1,200 fps**	**15 to 50**	**1,000 to 2,000**
E	Soft Soil Profile	Vs < 600 fps	<15	< 1,000

Based on the estimated weighted average Standard Penetration Test (SPT) N-values, relatively shallow bedrock at depths of about 17 to 19½ feet below site grades, and our information regarding the subsurface conditions in the project vicinity, seismic Site Class “D” is recommended for this site as shown in the preceding Table.

4.5 PAVEMENTS

The following sections provide recommendations for pavements.

Subgrade Characteristics: Given that the proposed project is in the preliminary design phase and grading information is not available at this time, this report is based on cut and fill operations of less than 2 feet to achieve final grades. Once the grading plans are finalized, ECS may be provided with the plans to review and provide additional recommendations (under a separate scope), which may also include additional soil borings and testing. Extensive laboratory and field testing were not part of ECS scope for the pavement section design and recommendations. Based on the very stiff to hard surficial lean clay fill soils and preparation of the subgrade as recommended in this report, the rigid pavements may be designed using an estimated modulus of subgrade reaction, k_{v1} of 100 psi/in (lbs./cu. inch) and flexible pavements may be designed using an estimated California Bearing Ratio (CBR) of 3.

Pavement Section: As noted in the 'Proposed Construction' section of this report, and based on our experience with similar Valvoline projects, ECS estimated a design ESAL (Equivalent Single Axle Load) value of less than 150,000 for both rigid and flexible pavements. These design ESAL values, along with the estimated CBR (California Bearing Ratio) design parameter referenced above, were used to calculate the necessary asphalt and concrete pavement sections to support the anticipated traffic loads. The recommended pavement section thicknesses align with the standard Valvoline pavement section criteria outlined in the 'Proposed Construction' section of the report are as follows:

PAVEMENT SECTION RECOMMENDATIONS		
Pavement Material	Compacted Material Thicknesses (Inches)	
	Flexible Pavement (CBR=3)	Rigid Pavement (Kv=100 pci)
Portland Cement Concrete [3]	--	6
Hot Mix Asphaltic Surface Course [1]	1½	--
Hot Mix Asphaltic Binder Course [2]	3	--
Crushed Aggregate Base Course [4]	8	6
Total Pavement Section Thickness	12½	12

1. *Hot Mix Asphaltic Concrete: In accordance with MoDOT Standard Specification for Highway Construction Section 401.3/402/403 meeting gradation BP-2 (PG 64-28).*
2. *Hot Mix Asphaltic Concrete: In accordance with MoDOT Standard Specification for Highway Construction Section 401.3/402/403 meeting gradation BP-2 (PG 64-22).*
3. *Portland Cement Concrete: In accordance with MoDOT Standard Specification for Highway Construction Section 502/1036.*
4. *Crushed Aggregate Base: In accordance with MoDOT Standard Specification for Highway Construction Section 304/1007.3 meeting MoDOT Type 5 gradation.*

The pavement materials and construction should be in accordance with the AASHTO Guide for Design of Pavement Structures, and the MoDOT Standard Specifications for Highway Construction. If the pavements will be constructed early during site development to accommodate construction traffic, consideration should be given to the construction of designated haul roads, where thickened pavement sections are provided to accommodate the construction traffic, as well as the future in-service traffic.

Crushed Aggregate Base Course and Hot Mix Asphalt Compaction: The crushed aggregate base course should be compacted to at least 95 percent of the maximum dry density obtained in accordance with ASTM D1557, Modified Proctor Method. The hot mix asphalt should be compacted to a minimum of 93 percent of the maximum theoretical density value.

Rigid Pavements: We recommend an air-entrained concrete mix (compressive strength of at least 4,000 pounds per square inch at 28 days) for rigid pavement. Provide adequate construction joints, contraction joints and isolation joints in the areas of rigid pavement to reduce the impacts of cracking and shrinkage. Please refer to ACI 330R-92 *Guide for Design of Concrete Parking Lots*. The ACI Guide recommends an appropriate spacing strategy for the anticipated loads and pavement thickness. It has been our experience that joint spacing closer to the recommended values in ACI results in a pavement with less cracks outside the joints and better long-term performance. Control joint spacing should be determined in accordance with the current ACI code. Provide expansion joints where the pavement abuts fixed objects, such as the buildings and light poles.

Pavement Drainage: An important consideration with the design and construction of pavements is surface and subsurface drainage. Where standing water develops, either on the pavement surface or within the base course layer, softening of the subgrade and other problems related to the deterioration of the pavement can be expected. Based on our estimated groundwater level, we consider surface water infiltration to be the main source of water to be considered for pavement design on this project.

Shape or crown the final pavement surface to properly direct surface water to suitable on or off-site stormwater drainage infrastructure. Properly slope the clay pavement subgrade to avoid dips or pockets where water may become trapped. Dips in the clay subgrade could result in a “bathtub” effect, which may trap water and potentially soften the subgrade. The subgrade in areas requiring undercut and backfill with granular soils are recommended to be graded to drain toward a drain tile. The drain tile should be sloped a minimum of ½ to 1 percent to discharge to nearby storm sewers, drainage ditches or other appropriate drainage facilities. Install edge drains where site grades slope toward the pavement edge to reduce the potential for water to enter the base course layer. Slope edge drains to the nearest appropriate drainage facility. Water that ponds on the subgrade surface can lead to deterioration of the subgrade soils, reduction of the base course support characteristics and result in pavement heave. Good drainage should help reduce the possibility of the subgrade materials being wet over a long period of time.

In order to help reduce the potential for shallow perched water to develop in areas of the site, install “stub” or “finger” drains around catch basins and in other low-lying areas of the parking lot to reduce the accumulation of water above and within the subgrade soils and aggregate base. Consider installation of pavement edge drains or trench drains to reduce the accumulation of water within the base course and on the subgrade soils.

Pavement Maintenance Considerations: A sound maintenance program should be implemented to help maintain and enhance the performance of pavements and help attain the design service life. A preventative maintenance program should be started early in the pavement life to be effective. The “standard in the industry” supported by research indicates that preventative maintenance should typically begin within 2 to 5 years of the placement of pavement. Failure to perform preventative maintenance will reduce the service life of the pavement and increase the costs for corrective maintenance and full pavement rehabilitation. Seal joints and cracks with elastomeric caulk in a timely manner to help reduce water infiltration thru the pavement section into the base course layer, which may result in softening of the subgrade and deterioration of the pavement. Observe pavements for distresses, such as cracks, depressions, and poor drainage, at least twice a year, typically once in the spring and once in the fall.

Shrinkage cracking is common with asphalt and occurs with age. Development of cracks should be expected with normal exposure to weather, wear and age. These cracks may become larger when exposed to such things as weather and vegetation growth, so should be treated promptly.

Pavement Construction Weather Restrictions: Daily temperatures from mid-November to April can often stay below 40°F, limiting the days that bituminous placement can occur. In this region, bituminous plants may close during the months of December, January, and/or February if particularly cold weather conditions prevail. However, this can change based on year-to-year temperature fluctuations.

5.0 SITE CONSTRUCTION RECOMMENDATIONS

5.1 SUBGRADE PREPARATION

5.1.1 Stripping and Grubbing

The subgrade preparation should consist of stripping all pavement materials, and any soft or unsuitable materials from the 10-foot expanded building and 5-foot expanded pavement limits, and 5 feet beyond the toe of Engineered Fills. Deeper topsoil or organic laden soils may be present in wet, low-lying, and poorly drained areas. In wooded areas, root masses may extend deeper and require additional localized excavation depth to completely remove the organics (root mass). ECS should be retained to observe and document that topsoil and unsuitable surficial materials have been removed prior to the placement of engineered fill or construction of structures.

5.1.2 Highly Plastic Soils

Based on the visual classification and limited laboratory testing of the retrieved soil samples from the test borings and local knowledge of the area, ECS anticipates the soils at the mat foundation, shallow trash enclosure walls/columns subgrade elevation will consist of highly plastic fat clays. Due to the potential for expansive soils in the project site, ECS recommends removing 18 inches of existing 'fat clays' soils below the proposed mat foundation and 24 inches below trash enclosure shallow foundations, and replacing it with low volume change material/low-plastic engineered fill (LVC) to reduce the risk for movement due to subgrade soil shrink-swell behavior. Based on FHWA Figure 5-34 (*Geotechnical Aspects of Pavements Reference Manual Chapter 5.0*), ECS estimated a potential vertical rise (PVR) in the range of 1 to 2 inches.

5.1.3 Proofrolling

After removing all unsuitable surface materials, cutting to the proposed grade, and prior to the placement of any engineered fill or other construction materials, the exposed subgrade should be observed by ECS. The exposed subgrade should be thoroughly proofrolled with previously approved construction equipment having a minimum axle load of 10 tons (e.g., fully loaded tandem-axle dump truck). Proofrolling should be traversed in two perpendicular directions with overlapping passes of the vehicle under the observation of an ECS technician. This procedure is intended to assist in identification of yielding materials.

Where proofrolling identifies areas that are unstable or "pumping" subgrade those areas should be repaired prior to the placement of any subsequent engineered fill or other construction materials. Methods of stabilization include undercutting, moisture conditioning, or chemical stabilization. The situation should be discussed with ECS to determine the appropriate procedure. Test pits may be excavated to explore the shallow subsurface materials to help in determining the cause of the observed unstable materials, and to assist in the evaluation of appropriate remedial actions to stabilize the subgrade.

If construction will occur during wet times of the year (such as during the spring or fall months) or immediately following extended periods of rain, then seasonal reduction of the near surface soil strength will occur. This may cause additional unstable or pumping subgrade areas for constructability concerns. The high moisture content clayey and silty materials, present near surface at several of the boring locations, may not pass a proofroll, and may need to be undercut or repaired. Some undercutting or repair of unstable subgrade soils should be anticipated during slab and pavement subgrade preparation, especially where undocumented fil is present. The actual quantity of the subgrade undercut or stabilization should be determined at the time of construction.

Undercut or repair of unstable subgrades to establish a suitable support condition may be needed. The improvement method chosen may be influenced by several factors such as weather and schedule, as well as the area, depth and nature of the unstable subgrade soils. Depending on the aforementioned and other factors, subgrade repair methods may include:

> **Scarification and Compaction:** Soils can be scarified, moisture conditioned (i.e., dried or wetted) to within a narrow range of the material's optimum moisture content and compacted. Scarification and compaction are generally most applicable where very shallow unstable conditions are encountered and at times when the soil can be properly dried or wetted to within a narrow range of the material's optimum moisture content.

> **Undercut and Replacement:** If any shallow foundation, or grade level slabs and pavements are within 24 inches of the Stratum II Fat Clay soils, <u>ECS recommends undercutting as needed to provide at least 2 feet of separation between the bottom of the foundation/slab/pavement and the underlying Stratum II the site.</u> Any soft or yielding soils should be evaluated in approximately additional 6 to 12-inch intervals to help limit the volume of undercuts. If soft or yielding soils are identified, the contractor should remove only 6 to 12 inches of material at a time in the subject area and then proofroll/evaluate the undercut subgrade to determine if additional undercut is needed. This may take more time but could potentially reduce the removal of more soil than necessary.

5.1.4 Site Temporary Dewatering

Excavation Dewatering: The excavation/foundation contractor should be prepared to dewater during construction. ECS anticipates the removal of accumulated water can be achieved utilizing drainage trenches and a sump and pump system.

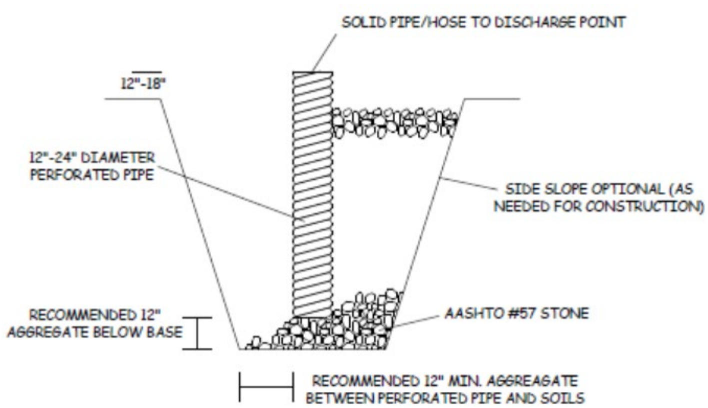
The contractor shall make their own assessment of temporary dewatering needs based upon the limited subsurface groundwater information presented in this report. Soil sampling is not continuous, and thus soil and groundwater conditions may vary between sampling intervals (typically 5 feet). If the contractor believes additional subsurface information is needed to assess dewatering needs, they should obtain such information at their own expense. ECS makes no warranties or guarantees regarding the adequacy of the provided information to determine dewatering requirements; such recommendations are beyond our scope of services.

Dewatering systems are a critical component of many construction projects. Dewatering systems must be selected, designed, and maintained by a qualified and experienced (specialty or other) contractor familiar with the succinct geotechnical and other aspects of the project. The failure to properly design and maintain a dewatering system for a given project can result in delayed construction, unnecessary foundation subgrade undercuts, detrimental phenomena such as 'running sand' conditions, internal erosion (i.e., 'piping'), the migration of 'fines' down-gradient towards the dewatering system, localized settlement of nearby infrastructure, foundations, slabs-on-grade and pavements, etc. Water discharged from any site dewatering system shall be discharged in accordance with all local, state and federal requirements.

Surface Water: The surface of the site should be kept properly graded to enhance drainage of the surface water to appropriate discharge or storage areas during construction. We recommend that an attempt be made to enhance the natural drainage without interrupting its pattern.

Subsurface Water: Groundwater observations are described in the **Groundwater Observations** section of this report. The long-term water table elevation is estimated to be below the explored depths. Based upon the results of the subsurface exploration and proposed construction, we believe construction dewatering at this site will be mainly to remove accumulated runoff water and perched water for new shallow foundation systems and basement mat foundation.

Strategies for Addressing Perched Groundwater: The typical primary strategy for addressing perched groundwater seeping into excavations is pumping from trench (or French) and sump pits with sump pumps. A typical sump pump drain (found in a sump pit or along a French drain) is depicted below. The inlet of the sump pump is placed at the bottom of the corrugated pipe and the discharge end of the sump is directed to an appropriate stormwater drain.



Sump Pit/Pump Diagram

A typical French drain consists of an 18 to 24-inch wide by 18- to 24-inch-deep bed of AASHTO No. 57 aggregate (or similar open graded aggregate) wrapped in a medium duty, non-woven geotextile and (sometimes) containing a 6-inch diameter, Schedule 40 PVC perforated or slotted pipe. Actual dimensions should be determined during construction. After installation, the geotextile should be wrapped over the top of the aggregate and pipe followed by placement of backfill. The top of the drain should be positioned at least 3½ feet below the design subgrade elevations. Drains should not be routed within the expanded building limits.

5.2 EARTHWORK OPERATIONS

5.2.1 Engineered Fill Materials

Prior to placement of Engineered Fill, representative bulk samples (about 50 pounds) of on-site and/or off-site borrow should be submitted to ECS for laboratory testing, which will typically include Atterberg limits, natural moisture content, grain-size distribution, and moisture-density relationships (i.e., Proctors) for compaction. Import materials should be tested prior to being hauled to the site to determine if they meet project specifications. Alternatively, Proctor data from other accredited laboratories can be submitted if the test results are within the last 90 days.

Satisfactory Engineered Fill Materials: Engineered fills should consist of materials free of debris with the following engineering properties:

ENGINEERED FILL INDEX PROPERTIES		
Subject		Property
Plasticity	Upper 4 feet in Building Areas and Upper 2 feet in Pavement Areas	LL ≤ 40, PI ≤ 20
	Below 4 feet in Building Areas and Below 2 feet in Pavement Areas	LL ≤ 50, PI ≤ 25
Max. Particle Size		3 inches
Max. Organic Content		5 percent

Open-graded materials, such as coarser sands, and gravels (SP and GP), which contain increased void space in their mass may need to be encapsulated within a filter geotextile. If the fill is to provide low-frost susceptible characteristics, it must be classified as a clean GP or GW (or clean coarser SW or SP) per Unified Soil Classification System (ASTM D-2487) and must be properly drained.

Unsatisfactory Materials: Unsatisfactory engineered fill materials, which do not satisfy the requirements for suitable materials, include topsoil and organic materials (PT, OH, OL), frost susceptible silt (ML), and high plasticity soils elastic silt (MH) and fat clay (CH).

Pea gravel is not recommended to be used as engineered fill. Pea gravel has round/smooth characteristics, no fines and does not interlock when compacted, which makes it more susceptible to future movement and instability resulting in excessive and variable settlement.

On-Site Borrow Suitability:
On-site low plastic possible fill soils may be feasible to use as engineered fill (meeting the engineered fill criteria discussed in the Table above) but should be further evaluated by ECS prior to its use. The existing highly plastic ‘fat’ clays (CH) are not recommended to be used as engineered fill. On-site soil used as engineered fill must not contain more than 5 percent organic matter as determined by ASTM D2974, and must be free of frozen matter, deleterious materials, over-sized material (maximum 3-inch particle diameter), or chemicals that may result in the material being classified as “contaminated.”

Some conditions at the time of construction, such as wet or freezing weather, reuse of existing soils having elevated moisture content is often a point of contention and a source of delays and change orders. From a technical standpoint, soils with moisture contents wet of optimum can be reused provided the moisture is properly adjusted to within a workable range of the material optimum moisture content. From a practical standpoint, wet soil can be difficult to dry within small or congested areas or during unfavorable weather, and such difficulties should be considered during planning and budgeting. A clear understanding by the general contractor and grading subcontractor regarding the reuse of excavated soils will be important to reduce delays and unexpected cost overruns. It is important to establish as part of the contract whether soils having elevated moisture content will be considered suitable for reuse.

5.2.2 Compaction

Subgrade Benching: Place fill material in horizontal lifts. Where fill materials will be placed up against sloping ground, the soil subgrade should be scarified, and the new fill benched and keyed into the existing material. Place and compact fill on a 3 (H):1 (V) or flatter slope, or step or bench as required to flatten.

Engineered Fill Compaction: Place and compact engineered fill in appropriate thickness loose lifts as recommended below. Give as much importance to the moisture content requirements of the material as the density requirements during placement and compaction considering the moisture sensitivity of the soil.

ENGINEERED FILL COMPACTION RECOMMENDATIONS		
Subject		Recommendation
Compaction Standard		Modified Proctor, ASTM D1557
Recommended Compaction		≥ 95 percent of Max. Dry Density
Moisture Content	Fine-grained	-1 to +3 % points of the material's optimum value
	Coarse-grained	-3 to +3 % points of the material's optimum value

Compaction Equipment: Compaction equipment appropriate for the soil type being compacted should be used to compact the subgrades and fill materials. Sheepsfoot compaction equipment is typically used for the fine-grained soils (clays). A vibratory steel drum roller is typically used for compaction of coarse-grained soils (sands and gravels) as well as to help seal compacted surfaces. **Vibratory compaction methods should be done with caution near the water table/perched groundwater because an unstable subgrade condition could develop**. Static compaction, smaller equipment and thinner lifts may be needed in the basement excavation near the water table.

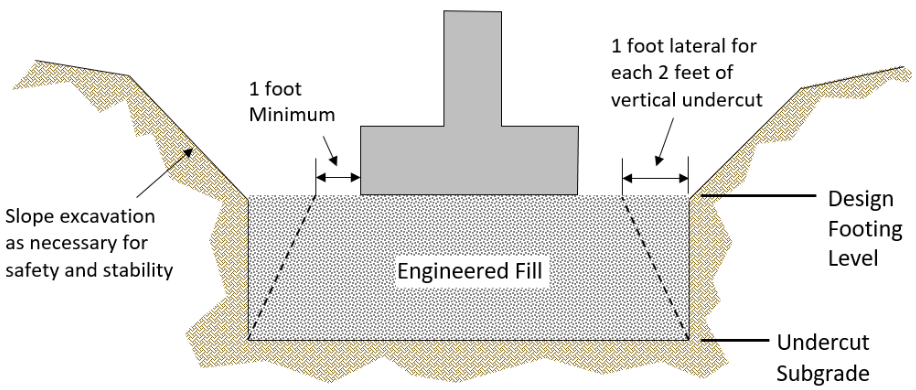
The maximum loose lift thickness depends upon the type of compaction equipment used. For isolated excavations around footing locations or within utility excavations, a hand tamper will likely be required. Listed in the Table below are recommended maximum loose lift thicknesses for compaction based on the utilized compaction equipment.

RECOMMENDED LOOSE LIFT THICKNESSES (1)	
Equipment	Maximum Loose Lift Thickness (inches)
Large/Heavy, Self-Propelled Equipment	8
Small, Self-Propelled or Remote Controlled (Rammax, etc.)	6 to 8
Hand Operated (Plate Tamps, Jumping Jacks, Wacker-Packers)	4 to 6

Note 1: Density testing during fill placement is important to check and document that the specified compaction is being achieved. Thinner lifts and/or more compactive energy may be needed to achieve the required degree of compaction.

In confined areas such as utility trenches, portable compaction equipment and thin lifts of 4 inches or less may be required to achieve specified degrees of compaction.

Engineered Fill Below Foundations: Recompact unsuitable bearing soils encountered at the proposed foundation bearing grade or within the foundation influence zone, if feasible, or removed to a suitable bearing subgrade and to a lateral extent, as conceptually shown below. The Engineered Fill below the new building footings should consist of well-graded crushed aggregate material that is placed and compacted as recommended herein.



Fill Placement: Fill materials should not be placed on frozen soils, on frost-heaved soils, and/or on excessively wet soils. Borrow fill materials should not contain frozen materials at the time of placement, and all frozen or frost-heaved soils should be removed prior to placement of Engineered Fill or other fill soils and aggregates. Excessively wet soils or aggregates should be scarified, aerated, and moisture conditioned.

5.3 FOUNDATION AND SLAB OBSERVATIONS

Protection of Foundation Excavations: Exposure to the environment may weaken the soils at the footing bearing level if the foundation excavations remain open for too long a time. Therefore, foundation concrete should be placed the same day that excavations are made. If the bearing soils are softened by surface water intrusion or exposure, the softened soils must be removed from the foundation excavation bottom immediately prior to placement of concrete. If the excavation must remain open overnight, or if rainfall becomes imminent while the bearing soils are exposed, a 1 to 3-inch thick “mud mat” of “lean” concrete should be placed on the bearing soils before the placement of reinforcing steel.

Footing Subgrade Observations: Most of the soils at the foundation bearing elevation are anticipated to be suitable for support of the proposed structure. It is important to have ECS observe the foundation subgrade prior to placing foundation concrete, to confirm the bearing soils are what was anticipated.

Slab Subgrade Observation and Testing: ECS should be retained to observe and test the exposed subgrade within the expanded building limits prior to engineered fill placement and slab construction to check that adequate subgrade preparation has been achieved as recommended in the **Subgrade Preparation** section.

5.4 UTILITY INSTALLATIONS

Utility Subgrades: The soils encountered within upper 3½ to 5 feet are expected to be suitable for support of Utility pipes. However, if utility pipes are bearing within the highly plastic fat clays, ECS recommends undercutting to a depth of about 12 to 18 inches and replacing with low volume change material (LVC). The pipe subgrades should be observed and probed for stability by ECS. Any loose or unsuitable materials encountered should be removed and replaced with suitable compacted Engineered Fill, or pipe stone bedding material.

Utility Backfilling: The granular bedding material should be at least 4 inches thick, but not less than that specified by the civil engineer's project drawings and specifications. We recommend that the bedding materials be placed up to the springline of the pipe. Fill placed for support of the utilities, as well as backfill over the utilities, should satisfy the requirements for Engineered Fill and Fill Placement.

5.5 GENERAL CONSTRUCTION CONSIDERATIONS

Existing Utilities: Prior to construction, we recommend all utilities in the proposed construction areas be positively identified and marked. Active utilities to remain in the construction areas should be exposed and protected during construction to reduce the potential for damage or interruption of service. Abandoned utilities should be removed and backfilled with compacted engineered fill or grouted full of lean concrete if left in-place.

Subgrade Protection: Measures should also be taken to limit site disturbance, especially from rubber-tired heavy construction equipment, and to control and remove surface water from development areas, including structural and pavement areas. It would be advisable to designate a haul road and construction staging area to limit the areas of disturbance and to prevent construction traffic from excessively degrading sensitive subgrade soils and existing pavement areas. Haul roads and construction staging areas could be covered with excess depths of aggregate to protect those subgrades. The aggregate can later be removed and used in pavement areas.

Surface Drainage: Surface drainage conditions should be properly maintained. Surface water should be directed away from the construction area, and the work area should be sloped away from the construction area at a gradient of 1 percent or greater to reduce the potential of ponding water and the subsequent saturation of the surface soils. At the end of each workday, the subgrade soils should be sealed by rolling the surface with a smooth drum roller to minimize infiltration of surface water.

Excavation Safety: All excavations and slopes should be constructed and maintained in accordance with OSHA excavation safety standards. The contractor is solely responsible for designing, constructing, and maintaining stable temporary excavations and slopes. The contractor's responsible person, as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. ECS is providing this information solely as a service to our client. ECS is not assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

Bidding/Estimating Considerations: Contractors bidding or undertaking any work at the site should examine the results of the subsurface exploration, satisfy themselves as to the adequacy of the information for bidding and construction, make their own interpretation of the data, and consider the effect it may have on their cost proposal, construction techniques, schedule, and equipment capabilities. Furthermore, contractors should complete any additional fieldwork and investigation they deem necessary to properly prepare a cost proposal for the site work. Soil borings do not provide the same wide-scale view of the subsurface conditions that is obtained during site grading, excavation or other aspects of earthwork construction. Additional scope may be required to obtain more detailed subsurface information needed for earthwork bid preparation, which could include test pits to better understand the lateral and vertical extents of the subsurface materials of concern such as existing undocumented fill. Even with this additional information, budget contingencies should be carried in construction to help cover potential variations in subsurface conditions.

6.0 CLOSING

ECS has prepared this report to guide the geotechnical-related design and construction aspects of the project. We performed these services in accordance with the standard of care expected of professionals in the industry performing similar services on projects of like size and complexity at this time in the region. No other representation express or implied, and no warranty or guarantee is included or intended in this report.

The description of the proposed project is based on information provided to ECS. If this information is inaccurate or changes, either because of our interpretation of the documents provided or site or design changes that may occur later, ECS should be contacted so we can review our recommendations and provide additional or alternate recommendations that reflect the proposed construction.

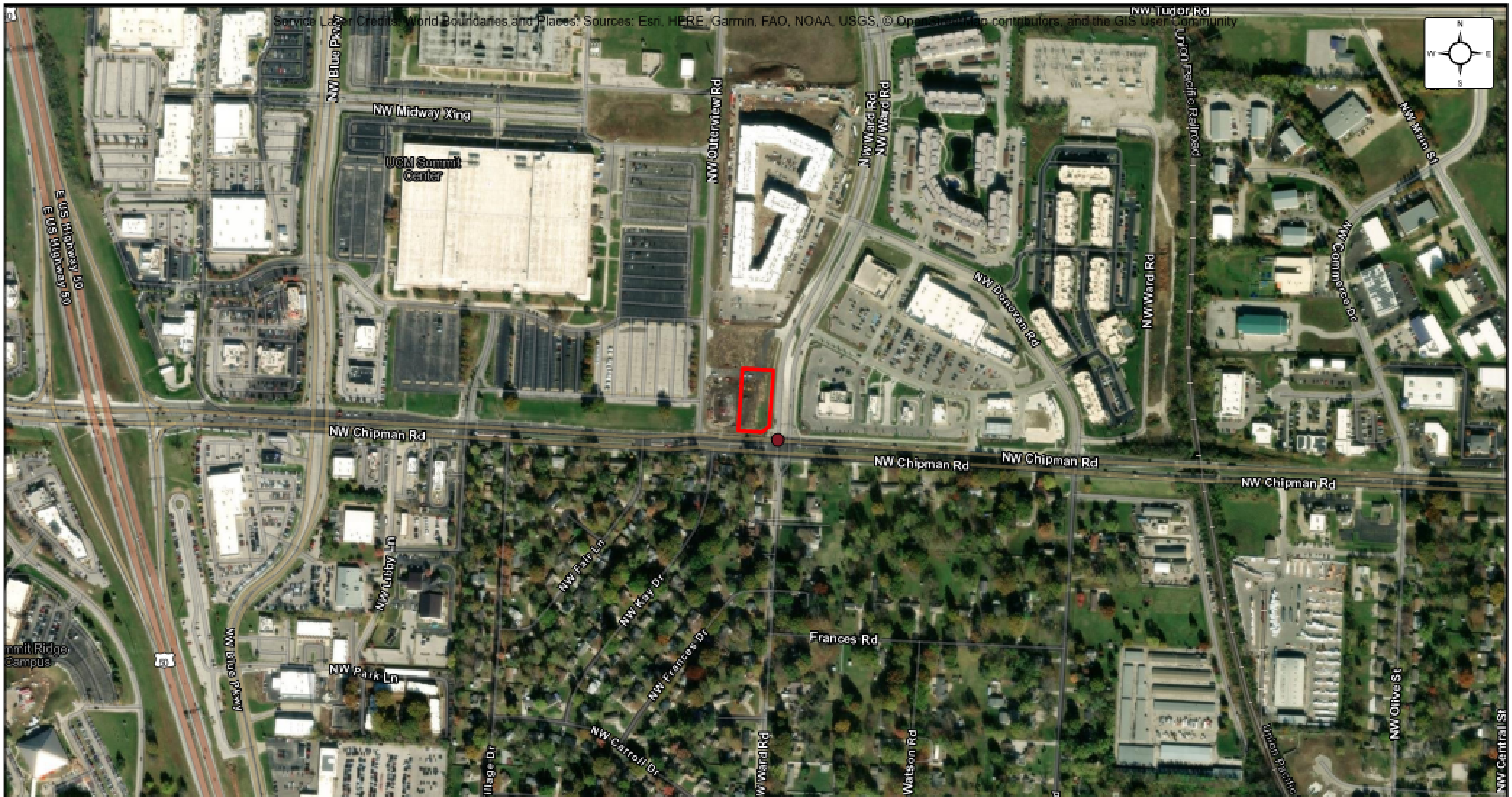
We recommend that ECS review the project plans and specifications so we can confirm that those plans/specifications are in accordance with the recommendations of this geotechnical report.

Field observations, and quality assurance testing during earthwork and foundation installation are an extension of, and integral to, the geotechnical design. We recommend that ECS be retained to apply our expertise throughout the geotechnical phases of construction, and to provide consultation and recommendation should issues arise.

ECS is not responsible for the conclusions, opinions, or recommendations of others based on the data in this report.

Appendix A - Drawings and Reports

Site Location Diagram
Boring Location Diagram(s)
Subsurface Cross-Section(s)



ECS

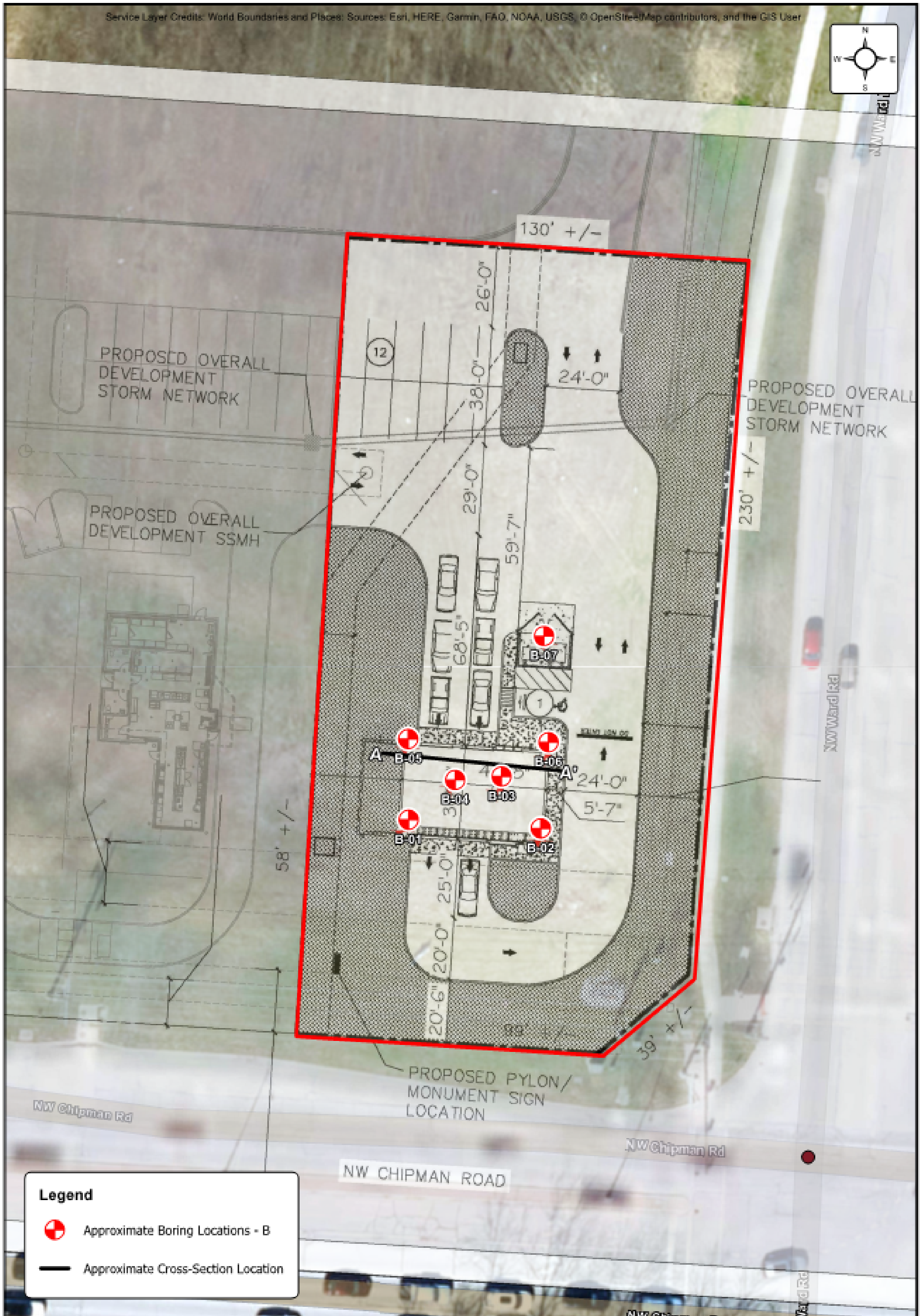
SITE LOCATION DIAGRAM

Proposed Valvoline Instant Oil Change - Lee's Summit

NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri

Valvoline Instant Oil Change

ENGINEER	EI
SCALE	1" = 400'
PROJECT NO.	16:15951
SHEET	1
DATE	10/14/2025



BORING LOCATION DIAGRAM

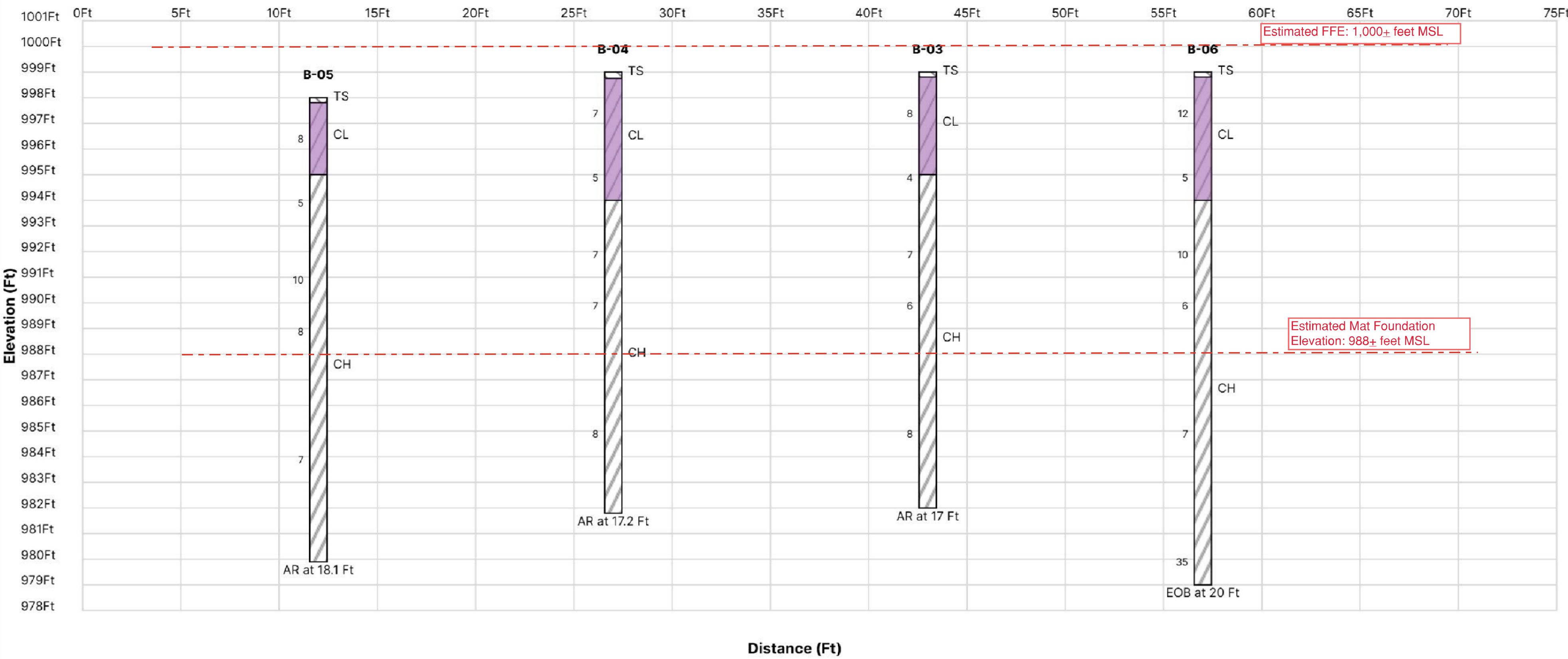
Proposed Valvoline Instant Oil Change - Lee's Summit

NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri

Valvoline Instant Oil Change

ENGINEER	EI
SCALE	1" = 30'
PROJECT NO.	16:15951
SHEET	1
DATE	10/16/2025

Generalized Subsurface Cross Section A-A'



CLIENT:	Valvoline Instant Oil Change	PROJECT:	Proposed Valvoline Instant Oil Change - Lee's Summit
DRAWN DATE:	10/16/2025	PROJECT NO.:	16:15951
CHECKED DATE:	10/16/2025	SCALE:	AS SHOWN

Notes:
1-EOB: END OF BORING AR: AUGER 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 SYMBOLOGY 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		

Appendix B – Field Operations

Reference Notes
Exploration Procedures
Boring Logs

REFERENCE NOTES FOR BORING LOGS

MATERIAL[1,2]

	Material	
	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	<2	Very Soft
0.25 - <0.50	2 - 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 LEVELS[6]

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

FILL AND ROCK

FILL | POSSIBLE FILL | PROBABLE FILL | ROCK

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

[2]To 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.

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

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

[5]Standard 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.

[6]The 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.

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

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

SUBSURFACE EXPLORATION PROCEDURE: STANDARD PENETRATION TESTING (SPT) ASTM D 1586 Split-Barrel Sampling

Standard Penetration Testing, or **SPT**, is the most frequently used subsurface exploration test performed worldwide. This test provides samples for identification purposes, as well as a measure of penetration resistance, or N-value. The N-Value, or blow counts, when corrected and correlated, can approximate engineering properties of soils used for geotechnical design and engineering purposes.

SPT Procedure:

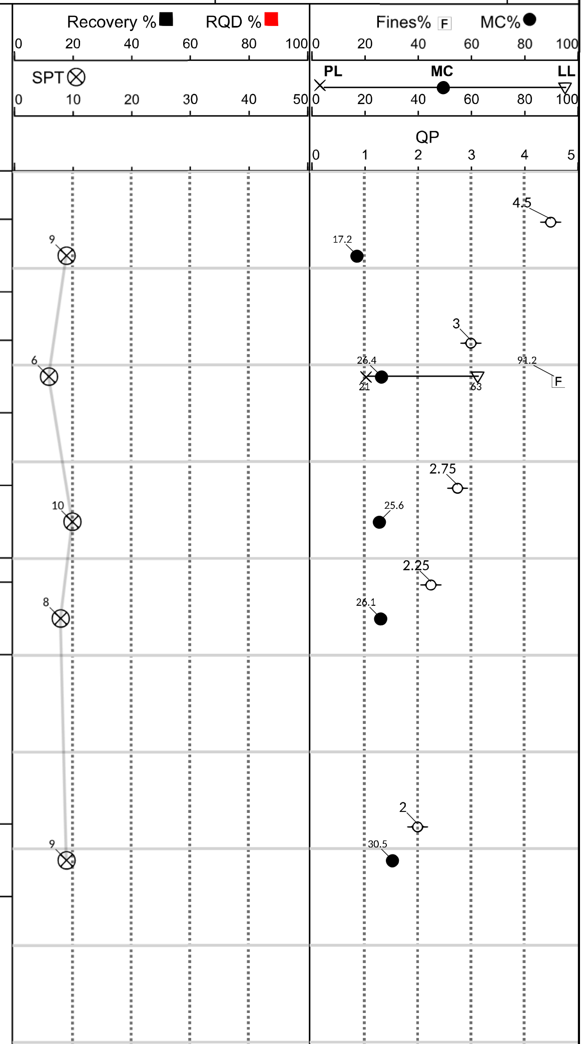
- Involves driving a hollow tube (split-spoon) into the ground by dropping a 140-lb hammer a height of 30-inches at desired depth
- Recording the number of hammer blows required to drive split-spoon a distance of 18-24 inches (in 3 or 4 Increments of 6 inches each)

- Auger is advanced* and an additional SPT is performed
- One SPT typically performed for every two to five feet. An approximate 1.5 inch diameter soil sample is recovered.

Drilling Methods May Vary— The predominant drilling methods used for SPT are open hole fluid rotary drilling and hollow-stem auger drilling.

CLIENT: **Valvoline Instant Oil Change**	PROJECT NO.: **16:15951**	BORING NO.: **B-01**	SHEET: **1 OF 1**	ECS
PROJECT NAME: **Proposed Valvoline Instant Oil Change - Lee's Summit**	DRILLER/CONTRACTOR: **Reynolds Drilling Corporation**			
SITE LOCATION: **NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086**			LOSS OF CIRCULATION	
LATITUDE: **38.925941**	LONGITUDE: **-94.394505**	STRUCTURE:	SURFACE ELEVATION: **998**	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)*
					Topsoil [Thickness=±2"].				
	S-1	SS	18	4	POSSIBLE FILL - (CL) LEAN CLAY WITH SAND - trace gravel, dark brown, moist, hard.				6-5-4 (9)
								995	
	S-2	SS	18	9	(CH) FAT CLAY - brown and gray mottled, moist, very stiff.				2-3-3 (6)
5.0									
	S-3	SS	18	16					3-5-5 (10)
								990	
	S-4	SS	18	18					3-4-4 (8)
10.0									
								985	
	S-5	SS	18	18					3-4-5 (9)
15.0									
								980	
					AUGER REFUSAL AT 18.2 Ft				



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered):	Not Observed	BORING STARTED:	09/22/2025	CAVE IN DEPTH:	Not Observed
WL (Completion):	Not Observed	BORING COMPLETED:	09/22/2025	HAMMER TYPE:	Automatic
WL (Seasonal High Water):		EQUIPMENT:	LOGGED BY:	DRILLING METHOD:	
WL (Stabilized):		CME-45 Truck Rig	RB	Hollow Stem Auger (0'-18.2')	

GEOTECHNICAL BOREHOLE LOG

CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Valvoline Instant Oil Change	**16:15951**	**B-02**	**1 OF 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Proposed Valvoline Instant Oil Change - Lee's Summit	**Reynolds Drilling Corporation**

SITE LOCATION:	
NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086	LOSS OF CIRCULATION

LATITUDE:	LONGITUDE:	STRUCTURE:	SURFACE ELEVATION:	
38.925933	**-94.394352**		**999**	BOTTOM OF CASING

Recovery % ■ RQD % ■ (0 20 40 60 80 100); SPT ⊗ (0 10 20 30 40 50); Fines% [F] MC% ● (0 20 40 60 80 100); PL MC LL; QP (0 1 2 3 4 5)

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT-N VALUE)*	MC%	QP
					Topsoil [Thickness=±2"].				
	S-1	SS	18	5	POSSIBLE FILL - (CL) LEAN CLAY WITH SAND - trace gravel, dark brown, moist, very stiff.		3-3-4 (7)	16.5	2.75
	S-2	SS	18	6	(CH) FAT CLAY - trace gravel and sand, gray and brown mottled, moist, stiff to very stiff.	995	WoH-3-2 (5)	25.5	2.75
5.0									
	S-3	SS	18	16			4-4-3 (7)	25.6	3
	S-4	SS	18	18		990	3-3-4 (7)	28.2	2
10.0									
	S-5	SS	18	18		985	3-3-4 (7)	28.7	1.5
15.0									
	S-6	SS	17	18		980	5-10-50/5" (50/5)	16.4	4.5
					(WR) WEATHERED ROCK sampled as dark gray, [Weathered SHALE].				
					END OF BORING AT 20 Ft				

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered):	**Not Observed**	**BORING STARTED:**	**09/22/2025**	**CAVE IN DEPTH:**	**Not Observed**
WL (Completion):	**Not Observed**	**BORING COMPLETED:**	**09/22/2025**	**HAMMER TYPE:**	**Automatic**
WL (Seasonal High Water):		**EQUIPMENT:**	**LOGGED BY:**	**DRILLING METHOD:**	
WL (Stabilized):		**CME-45 Truck Rig**	**RB**	**Hollow Stem Auger (0'-20')**	

GEOTECHNICAL BOREHOLE LOG

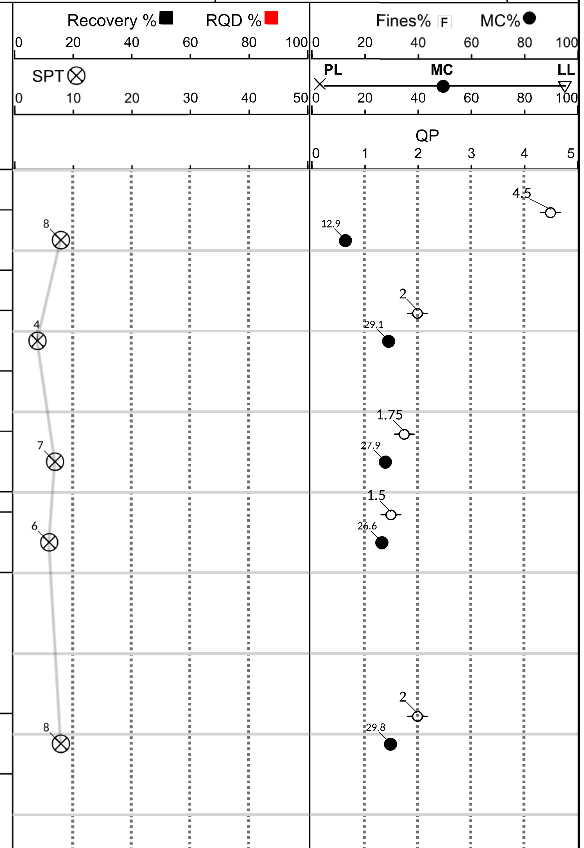
CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Valvoline Instant Oil Change	**16:15951**	**B-03**	**1 OF 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Proposed Valvoline Instant Oil Change - Lee's Summit	**Reynolds Drilling Corporation**

SITE LOCATION:	
NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086	LOSS OF CIRCULATION

LATITUDE:	LONGITUDE:	STRUCTURE:	SURFACE ELEVATION:	
38.92598	**-94.394397**		**999**	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)*
					Topsoil [Thickness=±2"].				
	S-1	SS	18	2	POSSIBLE FILL - (CL) LEAN CLAY WITH SAND - trace gravel, dark brown, moist, hard.				5-4-4 (8)
	S-2	SS	18	10	(CH) FAT CLAY - trace gravel and sand, gray and brown mottled, moist, stiff to very stiff.			995	3-2-2 (4)
5.0									
	S-3	SS	18	18					3-3-4 (7)
	S-4	SS	18	18				990	3-3-3 (6)
10.0									
	S-5	SS	18	18				985	3-4-4 (8)
15.0									
					AUGER REFUSAL AT 17 Ft				



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered):	**Not Observed**	**BORING STARTED:**	**09/22/2025**	**CAVE IN DEPTH:**	**Not Observed**
WL (Completion):	**Not Observed**	**BORING COMPLETED:**	**09/22/2025**	**HAMMER TYPE:**	**Automatic**
WL (Seasonal High Water):		**EQUIPMENT:**	**LOGGED BY:**	**DRILLING METHOD:**	
WL (Stabilized):		**CME-45 Truck Rig**	**RB**	**Hollow Stem Auger (0'-17')**	

GEOTECHNICAL BOREHOLE LOG

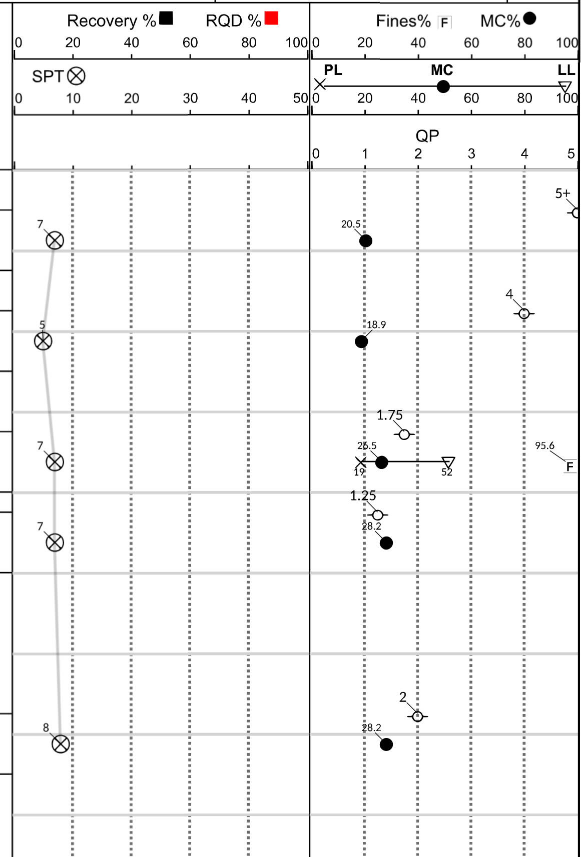
CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Valvoline Instant Oil Change	**16:15951**	**B-04**	**1 OF 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Proposed Valvoline Instant Oil Change - Lee's Summit	**Reynolds Drilling Corporation**

SITE LOCATION:	
NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086	LOSS OF CIRCULATION

LATITUDE:	LONGITUDE:	STRUCTURE:	SURFACE ELEVATION:	
38.925977	**-94.394451**		**999**	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)*
					Topsoil [Thickness=±3"].				
	S-1	SS	18	4	POSSIBLE FILL - (CL) LEAN CLAY WITH SAND - trace gravel, dark brown, moist, hard.				4-3-4 (7)
	S-2	SS	18	2				995	3-2-3 (5)
5.0					(CH) FAT CLAY - trace gravel and sand, gray and brown mottled, moist, very stiff.				
	S-3	SS	18	18					3-3-4 (7)
	S-4	SS	18	18				990	3-3-4 (7)
10.0									
	S-5	SS	18	18				985	3-3-5 (8)
15.0									
					AUGER REFUSAL AT 17.2 Ft				



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered):	**Not Observed**	**BORING STARTED:**	**09/22/2025**	**CAVE IN DEPTH:**	**Not Observed**
WL (Completion):	**Not Observed**	**BORING COMPLETED:**	**09/22/2025**	**HAMMER TYPE:**	**Automatic**
WL (Seasonal High Water):		**EQUIPMENT:**	**LOGGED BY:**	**DRILLING METHOD:**	
WL (Stabilized):		**CME-45 Truck Rig**	**RB**	**Hollow Stem Auger (0'-17.2')**	

GEOTECHNICAL BOREHOLE LOG

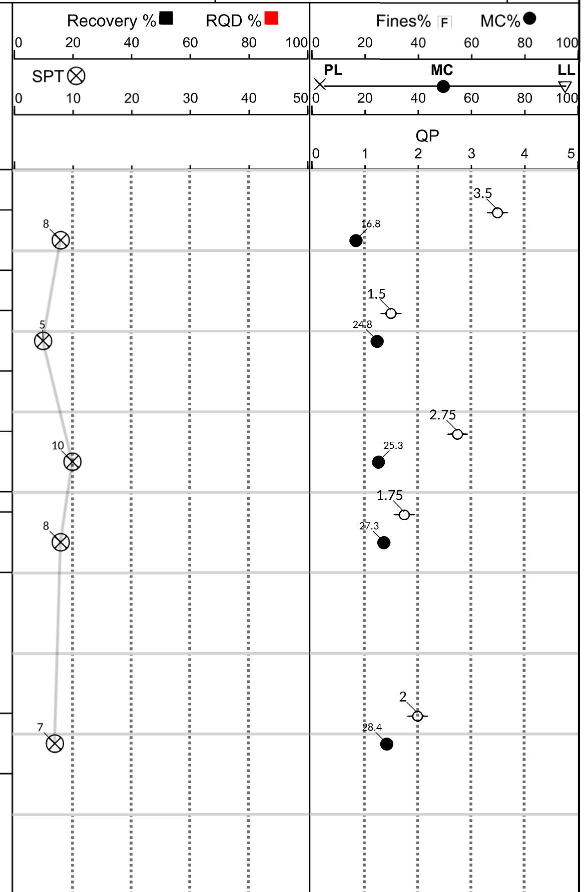
CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Valvoline Instant Oil Change	**16:15951**	**B-05**	**1 OF 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Proposed Valvoline Instant Oil Change - Lee's Summit	**Reynolds Drilling Corporation**

SITE LOCATION:	
NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086	LOSS OF CIRCULATION

LATITUDE:	LONGITUDE:	STRUCTURE:	SURFACE ELEVATION:	
38.926014	**-94.394505**		**999**	BOTTOM OF CASING

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT-N VALUE)*
					Topsoil [Thickness=±2"].		
	S-1	SS	18	5	POSSIBLE FILL - (CL) LEAN CLAY WITH SAND - trace gravel, dark brown, moist, very stiff.		4-4-4 (8)
	S-2	SS	18	8	(CH) FAT CLAY - trace gravel and sand, gray and brown mottled, moist, stiff to very stiff.	995	3-2-3 (5)
5.0							
	S-3	SS	18	18			3-5-5 (10)
	S-4	SS	18	18		990	3-4-4 (8)
10.0							
	S-5	SS	18	18		985	3-3-4 (7)
15.0							
					AUGER REFUSAL AT 18.1 Ft		



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered):	**Not Observed**	**BORING STARTED:**	**09/22/2025**	**CAVE IN DEPTH:**	**Not Observed**
WL (Completion):	**Not Observed**	**BORING COMPLETED:**	**09/22/2025**	**HAMMER TYPE:**	**Automatic**
WL (Seasonal High Water):		**EQUIPMENT:**	**LOGGED BY:**	**DRILLING METHOD:**	
WL (Stabilized):		**CME-45 Truck Rig**	**RB**	**Hollow Stem Auger (0'-18.1')**	

GEOTECHNICAL BOREHOLE LOG

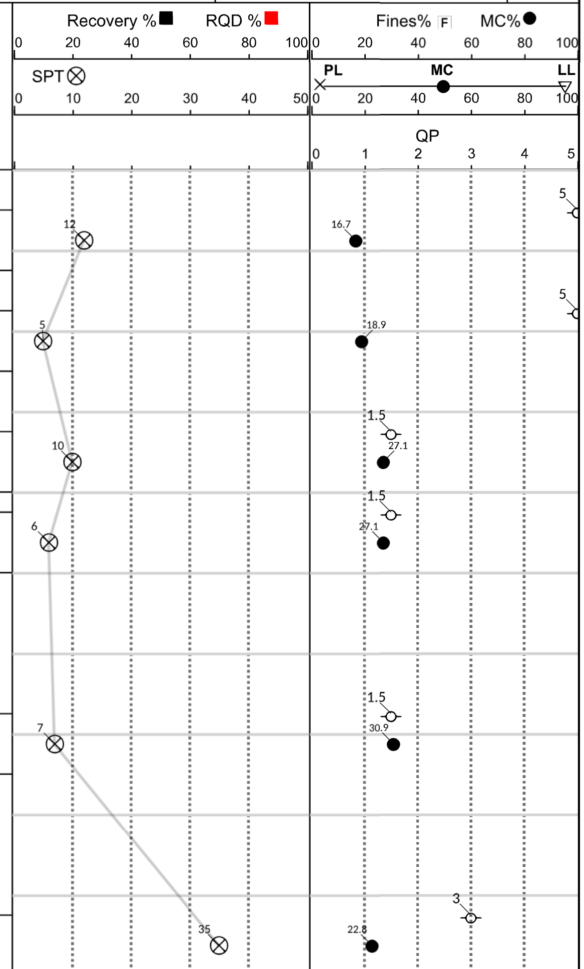
CLIENT:	PROJECT NO.:	BORING NO.:	SHEET:
Valvoline Instant Oil Change	**16:15951**	**B-06**	**1 OF 1**

PROJECT NAME:	DRILLER/CONTRACTOR:
Proposed Valvoline Instant Oil Change - Lee's Summit	**Reynolds Drilling Corporation**

SITE LOCATION:	
NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086	LOSS OF CIRCULATION

LATITUDE:	LONGITUDE:	STRUCTURE:	SURFACE ELEVATION:	
38.926011	**-94.394343**		**999**	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)*
					Topsoil [Thickness=±2"].				
	S-1	SS	18	4	POSSIBLE FILL - (CL) LEAN CLAY WITH SAND - trace gravel, dark brown, moist, hard.				4-6-6 (12)
	S-2	SS	18	5				995	3-2-3 (5)
5.0					(CH) FAT CLAY - trace gravel and sand, gray and brown mottled, moist, stiff to very stiff.				
	S-3	SS	18	18					6-6-4 (10)
	S-4	SS	18	18				990	3-3-3 (6)
10.0									
	S-5	SS	18	18				985	3-3-4 (7)
15.0									
	S-6	SS	18	18				980	6-17-18 (35)
					END OF BORING AT 20 Ft				



THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered): Not Observed		BORING STARTED: 09/22/2025		CAVE IN DEPTH: Not Observed	
WL (Completion): Not Observed		BORING COMPLETED: 09/22/2025		HAMMER TYPE: Automatic	
WL (Seasonal High Water):		EQUIPMENT:	LOGGED BY:	DRILLING METHOD:	
WL (Stabilized):		CME-45 Truck Rig	RB	Hollow Stem Auger (0'-20')	

GEOTECHNICAL BOREHOLE LOG

CLIENT: Valvoline Instant Oil Change	PROJECT NO.: 16:15951	BORING NO.: B-07	SHEET: 1 OF 1
PROJECT NAME: Proposed Valvoline Instant Oil Change - Lee's Summit	DRILLER/CONTRACTOR: Reynolds Drilling Corporation		

SITE LOCATION: NW Chipman Rd & NW Ward Rd, Lees Summit, Missouri, 64086

LOSS OF CIRCULATION

BOTTOM OF CASING

LATITUDE:	LONGITUDE:	STRUCTURE:	SURFACE ELEVATION:
38.926107	-94.394348		999

DEPTH (FT)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE DISTANCE (IN)	SAMPLE RECOVERY (IN)	DESCRIPTION OF MATERIAL	ELEVATION (FT)	BLOWS/6" (TCP/RS/MC/SPT-N VALUE)*
					Topsoil [Thickness=±2"].		
	S-1	SS	18	6	POSSIBLE FILL - (CL) LEAN CLAY - trace gravel, dark brown, moist, hard.		6-6-5 (11)
	S-2	SS	18	3	(CH) FAT CLAY - trace gravel and sand, gray and brown mottled, moist, stiff to very stiff.	995	WoH-2-3 (5)
5.0							
	S-3	SS	18	18		990	3-2-3 (5)
					END OF BORING AT 10 Ft		

THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY LINES BETWEEN SOIL TYPES. IN-SITU THE TRANSITION MAY BE GRADUAL

WL (First Encountered): Not Observed	BORING STARTED: 09/22/2025		CAVE IN DEPTH: Not Observed
WL (Completion): Not Observed	BORING COMPLETED: 09/22/2025		HAMMER TYPE: Automatic
WL (Seasonal High Water):	EQUIPMENT:	LOGGED BY:	DRILLING METHOD:
WL (Stabilized):	CME-45 Truck Rig	RB	Hollow Stem Auger (0'-10')

GEOTECHNICAL BOREHOLE LOG

Appendix C – Laboratory Testing

Laboratory Testing Procedures
Plasticity Chart(s)

LABORATORY PROCEDURES:

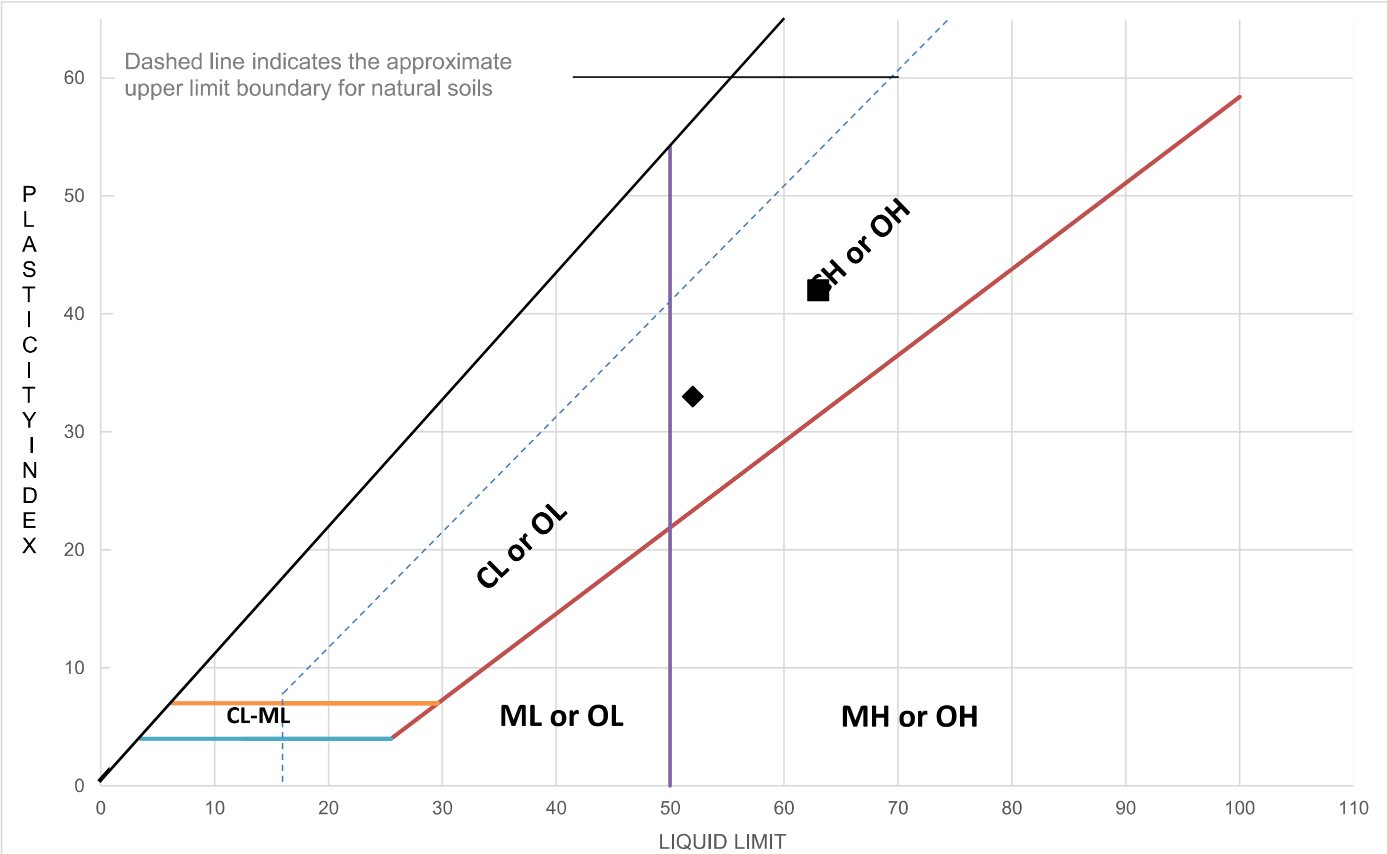
Moisture content determination was performed on select fine-grained soil samples in accordance with ASTM D 2216.

Calibrated hand penetrometer tests (Qp) were performed on select cohesive soil samples. In the hand penetrometer test, the unconfined compressive strength of a soil sample is estimated, to a maximum of 4.5 or 6 tons per square foot (tsf), by measuring the resistance of a soil sample to penetration by a small, calibrated, spring-loaded cylinder.

Percent Passing US Standard Sieve #200 tests were performed in accordance with ASTM D1140 on select soil samples.

Atterberg limits determination was performed on select fine-grained soil samples in accordance with ASTM D 4319. The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil: its liquid limit, plastic limit, and shrinkage limit. Atterberg limits can also be used to help distinguish between silt and clay, and to distinguish between different types of silts and clays.

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-01	S-2	3.50-5.00	63	21	42		91.2			CH
◆	B-04	S-3	6.50-8.00	52	19	33		95.6			CH

Project: Proposed Valvoline Instant Oil Change - Lee's Summit
Client: Valvoline Instant Oil Change

Project No.: 16:15951
Date Reported: 10/8/2025

ECS

Office / Lab	Address	Office Number / Fax
ECS Midwest LLC - Chicago	1575 Barclay Boulevard Buffalo Grove, IL 60089	(847)279-0366 (847)279-0369

Tested by	Checked by	Approved by	Date Received
OTorres	JSutton	JSutton	

Appendix D – Other Information

GBA - Geotechnical Engineering Report Information Sheet

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, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them 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 herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences 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.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:
- for a different client;
- for a different project or purpose;
- 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, the reliability of a geotechnical-engineering report can be 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 you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:
- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site 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.*

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

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement 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 through project completion to obtain 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 <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed 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 continuing 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 available 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-phase observations.

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 information 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. 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. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. 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 <u>Not</u> 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 provide 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 obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

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, the engineer's services were not designed, conducted, or intended to prevent 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 <u>not</u> 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 <u>not</u> building-envelope or mold specialists.***

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