Terracon
GeoReport

Geotechnical Engineering Report

Proposed U-Haul Facility #773053(Abut)
Louisville, Jefferson County, KY
September 9, 2019
Terracon Project No. 57195077

Prepared for:
AMERCO Real Estate/U-Haul International
Phoenix, Arizona

Prepared by:
Terracon Consultants, Inc.
Louisville, KY

September 9, 2019

AMERCO Real Estate/U-Haul International
2727 North Central Avenue, #5N
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Attn: Ms. Sabrina Perez, EIT
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Re: Geotechnical Engineering Report
Proposed U-Haul Facility #773053(Abut)
4626 Preston Highway
Louisville, Jefferson County, KY
Terracon Project No. 57195077

Dear Ms. Perez:

We have completed the Geotechnical Engineering services for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P57195077 dated May 31, 2019. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavement for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Sadra Javadi, Ph.D.
Staff Geotechnical Engineer

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Senior Associate

REPORT TOPICS

Note: This report was originally delivered in a web-based format. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

Note: Refer to each individual Attachment for a listing of contents.

EXECUTIVE SUMMARY

A geotechnical exploration has been performed for the proposed UHAUL facility in Louisville, Kentucky. Terracon's geotechnical scope of work included the advancement of five soil borings to approximate depth of 25 feet below existing ground surface (BGS) or auger refusal. Due to the shallow refusal encountered in all boring locations, one additional boring location was selected at the anomaly location detected by geophysics study. The site generally appears suitable for the proposed construction based upon geotechnical conditions encountered in the borings and our current understanding of the proposed development. The following geotechnical considerations were identified:

- Existing fill was encountered at each boring location to depths of 2½ to 6 feet below existing grade. Existing fill was generally comprised of lean clay with varying amounts of crushed stone, concrete, and asphalt. Boring B-4 encountered 6 feet of fill comprised of asphalt and crushed stone and poorly graded sand. Existing fill was underlain by lean clay overlying shale bedrock. Auger refusal was encountered at each boring location at depths from 9 to 14 feet BGS. Groundwater was encountered at borings B-2 and B-6 at a depth of 4 feet BGS.
- All foundation excavations should extend through existing fill to bear on suitable native soils or lean concrete. Within the proposed pavement areas, the existing fill should be undercut by at least 2 feet and extending 10 feet beyond the lateral limits of the construction area.
- It is understood that a bearing capacity on the order of 3,000 pounds per square foot (psf) for footings is desired for the proposed development at this site. To attain this bearing support, and to restrict total settlement within one inch and differential settlement within 0.75-inch, ground improvement using cut and fill method.
- MASW was utilized to obtain the shear wave velocity throughout the soil profile to the depth of 100 feet to calculate the seismic site class. The results obtained from MASW suggest seismic site classification for this site is C.

Minimum pavement thickness recommendations are provided for both flexible asphalt pavement and rigid Portland cement concrete pavements for light-duty, medium-duty and heavy-duty pavement loading provided by AMERCO/U-Haul. This executive summary should not be separated from or used apart from this report. This report presents recommendations and opinions based on our understanding of the project at the time the report was prepared. The report limitations are described in the GENERAL COMMENTS section of this report. Terracon should be retained to observe and perform tests during site preparation, earthwork, foundation construction, floor slab construction, and paving phases.

Geotechnical Engineering Report
Proposed U-Haul Facility #773053(Abut)
4626 Preston Highway
Louisville, Jefferson County, KY
Terracon Project No. 57195077
September 9, 2019

INTRODUCTION

This report presents the results of our site characterization and geotechnical engineering services performed for the proposed U-Haul facility to be located at 4626 Preston Highway in Louisville, Jefferson County, KY. The purpose of these services is to provide geotechnical engineering recommendations relative to:

- Subsurface soil conditions
- Groundwater conditions
- Site preparation and earthwork
- Pavement design and construction
- Foundation design and construction
- Floor slab design and construction
- Seismic site classification per IBC
- Lateral earth pressures

The exploration services for this project included the advancement of 6 test borings to depths ranging from approximately 9 to 14 feet below existing site grades. Refer to the Site Location and Exploration Plan. The results of the exploration, field and laboratory testing are included on the boring logs and as separate graphs in the Exploration Results section.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The site includes 3 parcels of approximately 1.72 acres. The project is located at 4626 Preston Highway in Louisville, Jefferson County, KY. Approximate Latitude/Longitude: 38.180170°, -85.719225° See Site Location

Item	Description
Existing Improvements	The project-associated parcels are mostly vacant. A billboard is located at the south-west corner of the site. Project site is bordered on south side by Grade Lane and on east side by Preston Highway. Based on email correspondence from Ms. Perez on July 10, 2019, and review of publicly available USGS information we understand that a car wash existed on this site and was demolished in 2004. However, no information regarding the demolition and backfilling of the previous structure was available at the time of issuance of this report. Reviewing the "Closure Assessment Report" prepared by Linebach Funkhouser, Inc. on July 22, 2011 and provided to us by Ms. Perez via email on 6/25/2019, we understand that two 8,000-gallon underground gasoline tanks and associated piping existed at the project site and were removed in 1987. In addition, a former 500-gallon used as oil UST system was removed in 2005.
Current Ground Cover	Generally, is comprised of pavement-, concrete-covered areas. Portions of concrete paved areas could be associated with the slab of previous structures. The south-west and west side of the project site is bordered by a tree-line.
Existing Topography	Based on review of publicly available USGS information, the project site is relatively level, with an approximate ½ percent grade towards the south. Site elevations range from 480 to 482 feet. A topographic map by the project surveyor should be used to verify this information.
Geology [2]	**Name: New Albany, Chattanooga, and Ohio Shales, Boyle Dolomite (Limestone), and Sellersburg Limestone, undivided** [1] Our experience near the vicinity of the proposed development and review of geologic maps from the Kentucky Geologic Survey (KGS) indicates subsurface conditions consisting terrace deposits of fine grain soils ranging from low to high plasticity clays and silts mixed with sand and gravel in the upper 10 to 20 feet. Bedrock underlying the site is expected to be comprised of New Albany Shale underlain Boyle Dolomite (Limestone), Jeffersonville and Sellersburg Limestone. The site is mapped near a contact of New Albany Shale bedrock geology with non-karst potential and an area of Jeffersonville and Sellersburg Limestone which is reported as having a high karst potential. Multiple sinkholes are mapped within 1-mile radius of the project site based on published karst potential maps prepared by the Kentucky Geological Survey.

1. Noger, M.C., compiler, 1988, Geologic map of Kentucky: sesquicenntennial edition of the Kentucky Geological Survey: U.S. Geological Survey and the Kentucky Geological Survey, scale 1:500,000.
2. Geologic descriptions are based on published information from the Kentucky Geological Survey, University of Kentucky, www.uky.edu/KGS, Louisville East Quadrangle, Jefferson County, Kentucky: GQ-1203.

We also collected photographs at the time of our field exploration program. Representative photos are provided in our **Photography Log**.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed during project planning. Aspects of the project, undefined or assumed, are highlighted as shown below. We request the design team verify all information. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Primary project information including the project site area, address, and POC along with "project development, scope of services, design assumptions, and project specifications" were provided by Ms. Perez via email on May 28, 2019. The following documents were provided to Terracon by Ms. Perez via email on June 25, 2019: ■ 773053_ForGE-SiteDev(SNP 2019-06-25) ■ Final Closure Report - Seller DD ■ 4626 Preston Hwy.kmz
Project Description	We have reviewed the "project development, scope of services, design assumptions, and project specifications" dated July 13, 2018. The project will include the construction of a one- to three-story structure and associated pavements.
Finished Floor Elevation	Not known at the issuance of this proposal.
Maximum Loads (Provided by Amerco Real State Company)	■ Columns: 100 to 150 kips ■ Walls: 5 to 10 kips per linear foot (klf) ■ Slabs: 100 pounds per square foot (psf)
Grading/Slopes	We have not been provided with site grading plans at the time of this report. Minimal grading (i.e. less than 2 feet) is anticipated, as the site is relatively level and the access road is near the site's existing grade.
Below-Grade Structures	Below grade loading docks and elevator pits and recreation vehicle (RV) canopies may be anticipated.
Pavements (Provided by Amerco Real State Company)	Paved driveway and parking are planned to be constructed on the parcel. Traffic is assumed to include passenger cars and trucks, Recreational Vehicles (RV) and fire/emergency vehicles. Both rigid (concrete) and flexible (asphalt) pavement sections should be considered. Anticipated traffic is as follows for a 20-year design period: ■ Light Traffic: 50,000 ESAL's ■ Medium Traffic: 110,000 ESAL's ■ Heavy Traffic: 180,000 ESAL's
Estimated Start of Construction	Unknown.

GEOTECHNICAL CHARACTERIZATION

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical calculations and evaluation of site preparation and foundation options. Conditions encountered at each exploration point are indicated on the individual logs. The individual logs can be found in the **Exploration Results** section and the GeoModel can be found in the **Figures** section of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

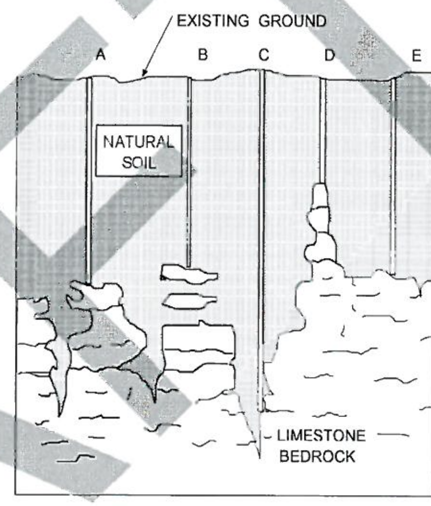
Model Layer	Layer Name	General Description
1	**Surficial Layer**	Asphalt, Concrete, and Aggregate Base Course
2	**Existing FILL**	Existing FILL, Lean Clay (CL), with rock fragments and asphalt, gray with brown/black Poorly Graded Sand (SP), gray
3	**Lean CLAY**	Lean Clay (CL), brown with gray, soft to very stiff
4	**Bedrock**	Shale, black

The boreholes were observed while drilling for the presence and level of groundwater. Groundwater was encountered at depth of approximately 4 feet below the existing ground surface (within the lean clay layer) at boring locations B-2 and B-6, but it was not encountered during drilling at other boring locations. Due to the relatively low permeability of the soils encountered in the boring, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole in these materials. Long-term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.
Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the level at the time of our exploration. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. In particular, this project has potential for trapped/perched water at the overburden/bedrock interface.

All borings were extended to auger refusal at depths of 9 to 14 feet below existing grade. Auger refusal is defined as the depth below the ground surface at which a test boring can no longer be advanced with the soil drilling technique being used. In an area of karst geology, auger refusal can result on slabs of un-weathered bedrock suspended in the residual soil matrix ("floaters"), on rock "pinnacles" rising above the surrounding bedrock surface, in widened joints that may extend well below the surrounding bedrock surface, or on the upper surface of continuous bedrock. Several of these possible auger refusal conditions are illustrated in the figure below.

The site is mapped near a contact of Terrace Deposits underlain by New Albany Shale bedrock geology with non-karst potential and an area of Jeffersonville and Sellersburg Limestone which is reported as having a high karst potential. Multiple sinkholes are mapped within 1-mile radius of the project site based on published karst potential maps prepared by the Kentucky Geological Survey. Soil softening observed in the geotechnical borings and anomalies from geophysical ERI testing can be indicative of karst activity at the project site.

AUGER REFUSAL ILLUSTRATION



THIS FIGURE IS FOR ILLUSTRATIVE PURPOSES ONLY AND DOES NOT NECESSARILY DEPICT THE SPECIFIC BEDROCK CONDITIONS AT THIS SITE

Based on the Kentucky Geological Survey database, it appears that the project site is located on a relatively thin layer of Terrace deposits underlain a thin layer of New Albany Shale followed by Sellersburg and Jeffersonville Limestone formations. Karst bedrock, such as the Boyle Dolomite (Limestone), Sellersburg and Jeffersonville Limestone formations are known for producing several obstructions that can cause the augers to refuse above sound bedrock. These obstructions can range from floaters to rock pinnacles as illustrated in Examples A, B, C, and D in the figure. Depth to competent bedrock can vary greatly over short distances. The possibility of varying depths to bedrock should be considered when developing the design and construction plans for this project. Rock core operations were performed to better explore the refusal materials.

Specific conditions encountered at the exploration locations are indicated by the **Exploration Results**. Stratification boundaries on the boring log represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual.

GEOTECHNICAL OVERVIEW

The following sections describe pertinent geotechnical considerations identified by the exploration and laboratory testing. Site preparation recommendations, including subgrade improvement, fill placement, and excavations are provided in the **Site Preparation** section.

Karst Potential

The site is mapped near a contact of Terrace Deposits underlain by New Albany Shale bedrock geology with non-karst potential and an area of Jeffersonville and Sellersburg Limestone which is reported as having a high karst potential. Multiple sinkholes are mapped within 1-mile radius of the project site based on published karst potential maps prepared by the Kentucky Geological Survey.

Anomalies from geophysical ERI testing can be indicative of karst activity at the project site. Buried utilities and other abandoned cultural features from past usage of the site caused significant interference during ERI data collection. Interference zones are indicated by half-circle shapes and extreme data values, low and high. The data provided possible anomaly areas for the geotechnical boring exploration, but the level of interference prevents an accurate interpretation of the top of bedrock.

Additional indications of potential karst activity such as soil softening, which is the decrease of strength with depth, and free groundwater levels were observed in the overburden soil below depths of 6 feet at boring locations B-2 and B-6 and about 8 feet at boring location B-3.

Any construction in karst topography is accompanied by some degree of risk for future internal soil erosion and ground subsidence that could affect the stability of structures situated above the karst features. The risks associated with karst geology are common for the project vicinity and are not unique to this site.

During the site grading and foundation excavations, a geotechnical engineer or representative should be present to evaluate the subsurface soil conditions and investigate for the presence of karst features or associated subsurface voids.

Existing Fill

Existing fill was encountered at each boring location to depths of 2½ to 6 feet below existing grade. Existing fill was generally comprised of lean clay with varying amounts of crushed stone, concrete, and asphalt. Boring B-4 encountered 6 feet of fill comprised of asphalt and crushed stone and poorly graded sand, suspected backfill from UST removal. Support of floor slabs and pavements on or above existing fill materials is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report. All below grade structures such as slabs, foundations, and associated underground utilities remaining from former structure(s) should be removed. If underground utilities are to remain abandoned in-place, they should be cut/capped and filled to prevent possible future subsidence due to raveling backfill material. This risk can be remediated by complete removal of the line or filling it in.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork is anticipated to include clearing and grubbing, excavations, and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Earthwork activities on the project should be observed and evaluated by Terracon. The evaluation of earthwork should include observation of the removal of existing fill, the observation and testing of newly placed engineered fill, and other geotechnical conditions exposed during the construction of the project.

Site Preparation

Site preparation should consist of removal of unsuitable and deleterious material from the proposed construction areas. Prior to placing fill, existing surficial layers including asphalt, aggregate base course, and concrete should be removed. Utilities should be properly capped at the site perimeter, and the trenches should be backfilled in accordance with engineered fill recommendations presented in the following sections of this report.

The subgrade should be proof-rolled with an adequately loaded vehicle such as a fully-loaded tandem-axle dump truck (minimum 20 tons). The proof-rolling should be performed under the direction of the Geotechnical Engineer. Areas excessively deflecting under the proof-roll should be delineated and subsequently addressed by the Geotechnical Engineer. Such areas should either be removed, scarified and recompacted, or stabilized chemically. Excessively wet or dry material should either be removed, or moisture conditioned and recompacted.

Existing Fill

As noted in **Geotechnical Characterization**, existing fill was encountered at all boring locations to depths ranging from about 2½ to 6 feet, we have no records to indicate the degree of control during placement and compaction of fill. Therefore, the fill should be considered undocumented and not suitable for direct support of foundations. Support of floor slabs and pavements, on or above existing fill soils, is discussed in this report. However, even with the recommended construction procedures, there is inherent risk for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report.

All foundation excavations should extend through existing fill to bear on suitable native soils or lean concrete placed within the over-excavation in accordance with the **Shallow Foundations** section. If the owner elects to construct pavements on the existin fill, the following protocol should be followed. Within the proposed floor slab and pavement areas, the existing fill should be undercut by at least 2 feet and extending 10 feet beyond the lateral limits of the construction area. Once materials have been removed, the entire area should be proof-rolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. Once unsuitable materials have been remediated, and the subgrade has passed the proof-roll test, the existing and undocumented fill that was removed can be evaluated for reuse as engineered fill.

Subgrade Stabilization

Based on the outcome of the proof-rolling operations, some undercutting or subgrade stabilization should be expected, especially during wet periods of the year. Methods of stabilization, which are outlined below, could include scarification and re-compaction and/or removal of unstable materials and replacement with granular fill (with or without geotextiles). Suitable method of stabilization, if required, will be dependent upon factors such as schedule, weather, size of area to be stabilized and the nature of the instability.

- **Scarification and Re-compaction** - It may be feasible to scarify, dry, and re-compact the exposed lean clay soils at the site during periods of dry weather. The success of this procedure would depend primarily upon the extent of the disturbed area. Stable subgrades may not be achievable if the thickness of the unstable soil is greater than about 1 to 1½ feet.
- **Granular Fill** - The use of crushed stone or gravel could be considered to improve subgrade stability. Typical undercut depths would range from about ½ foot to 2 feet. The use of high modulus geotextiles i.e., engineering fabric, should be limited to outside of the building area. The particle size of granular material placed immediately over geotextile fabric or geogrid should be in accordance with the manufacturer's requirements.
- **Chemical Stabilization** - Improvement of subgrades with Portland cement or lime could be considered for unstable soils. Chemical modification should be performed by an experienced contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions.

Over-excavations should be backfilled with engineered fill material placed and compacted in accordance with the **Fill Material Types** and **Fill Compaction Requirements** sections of this report. Subgrade preparation and selection, placement, and compaction of engineered fill should be performed under engineering-controlled conditions in accordance with the project specifications.

Fill Material Types

Fill required to achieve design grade should be classified as engineered fill. Engineered fill is material used below, or within 10 feet of structures, pavements or constructed slopes or the material used to achieve grade outside of these areas. Earthen aterials used for engineered fill should meet the following material property requirements:

Soil Type [1]	USCS Classification	Acceptable Parameters
Lean Clay / Low Volume Change Material [2]	CL, GM-GW, GM (LL<40% & 5<PI<15)	All locations and elevations.
Well-graded granular and silty gravel	GW, GM, GM-GW [3]	All locations and elevations.
On-Site Existing Soils (Lean clay)	CL	The existing fill material suitability should be evaluated by a geotechnical engineer or representative at time of construction.

1. Engineered fill should consist of approved materials free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the Geotechnical Engineer for evaluation prior to use on this site.
2. Low plasticity cohesive soil or granular soil having at least 18% low plasticity fines.
3. Crushed limestone aggregate, limestone screenings, or granular material such as sand, gravel or crushed stone containing at least 18% low plasticity fines.

Fill Compaction Requirements

Engineered fill should meet the following compaction requirements.

Item	Structural Fill
Maximum Lift Thickness	8 inches or less in loose thickness when heavy, self-propelled compaction equipment is used 4 to 6 inches in loose thickness when hand-guided equipment (i.e. jumping jack or plate compactor) is used
Minimum Compaction Requirements [1, 2]	98% of max. below foundations and within 1 foot of finished pavement subgrade 95% of max. above foundations, below floor slabs, and more than 1 foot below finished pavement subgrade
Water Content Range [1]	Low plasticity cohesive: -2% to +3% of optimum moisture content (OMC) as determined by the standard Proctor test at the time of placement and compaction Granular: Within ±2% of OMC / Within workable moisture levels [3]

Item	Structural Fill

1. Maximum density and optimum water content should be measured as determined by the standard Proctor test (ASTM D 698). We recommend that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.
2. If the granular material is a coarse gravel, or of a uniform size, or has a low fines content, compaction comparison to relative density may be more appropriate. In this case, granular materials should be compacted to at least 70% relative density (ASTM D 4253 and D 4254).
3. Specifically, moisture levels should be maintained low enough to allow for satisfactory compaction to be achieved without the cohesionless fill material pumping when proof rolled with suitable rubber tire equipment.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of compacted cohesive fill to reduce the infiltration and conveyance of surface water through the trench backfill.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for engineered fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

As mentioned previously, existing fill was encountered at all boring locations to depths ranging from about 2½ to 6 feet. Due to considerable inconsistency and variable geomaterial mixed with remained structural elements, prediction of an infiltration rate range for fill layer is not feasible. Once existing fill layer is removed completely and replaced with engineered fill following instructions provided in **Fill Material Types** and **Fill Compaction Requirements**, in-situ infiltration test should be performed within the new engineered fill to obtai the infiltration rate.

Based on published typical infiltration rates and soil types, the following infiltration rates ranges are recommended for undisturbed, native soils based on the unified soil classification system (USCS) soil type. The values provided in the table are based on the material types encountered in the test borings and are not based on field infiltration testing. We are available to perform field infiltration testing upon request, as an addition to our current scope of work.

USCS Soil Type	Recommended Infiltration Rate (in/hr)
Existing, undocumented Fill (Lean clay with aggregate base course and asphalt, poorly graded sand)	No recommendation can be provided
Native soil (Lean clay)	0.015 to 0.0000015

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

The groundwater table could affect over-excavation efforts, especially for over-excavation and replacement of lower strength soils. A temporary dewatering system consisting of sumps with pumps could be necessar to achieve the recommended depth of over-excavation.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of surficial layers including asphalt, aggregate base course, concrete, possible vegetation and topsoil, and underground structural elements and utilities remained from the previous development in the project area, proof-rolling, and mitigation of areas delineated by the proof-roll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test should be performed for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. If unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

SHALLOW FOUNDATIONS

If the site has been prepared in accordance with the requirements noted in **Earthwork**, the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description
Maximum Net Allowable Bearing pressure [1, 2]	3,000 psf
Required Bearing Stratum [3]	All foundation excavations should extend through existing fill to bear on at least stiff native lean clay, lean concrete, or engineered fill as described in **Earthwork.**

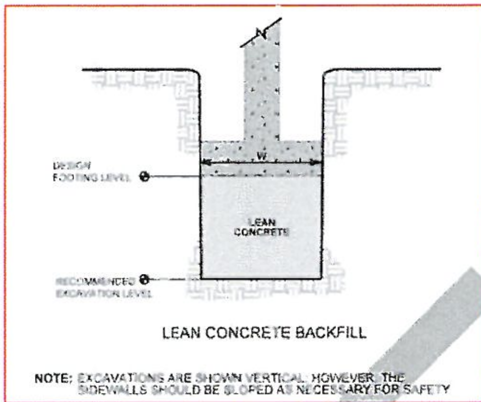
Item	Description
Minimum Foundation Dimensions	Columns: 24 inches Continuous: 18 inches
Ultimate Passive Resistance [4] (equivalent fluid pressures)	350 pcf (below 3 feet)
Ultimate Coefficient of Sliding Friction [5]	0.3 (native lean clay) 0.4 (granular backfill)
Minimum Embedment below Finished Grade [6]	24 inches
Estimated Total Settlement from Structural Loads [2]	About 1 inch
Estimated Differential Settlement [2, 7]	About 3/4 of total settlement

1. The maximum net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. Factor of safety of 3 has been applied in this calculation. Values assume that exterior grades are no steeper than 20% within 10 feet of structure.
2. Values provided are for maximum loads noted in Project Description.
3. Unsuitable or soft soils should be over-excavated and replaced per the recommendations presented in the Earthwork.
4. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted engineered fill be placed against the vertical footing face.
5. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Should be neglected for foundations subject to net uplift conditions.
6. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
7. Differential settlements are as measured over a span of 40 feet.

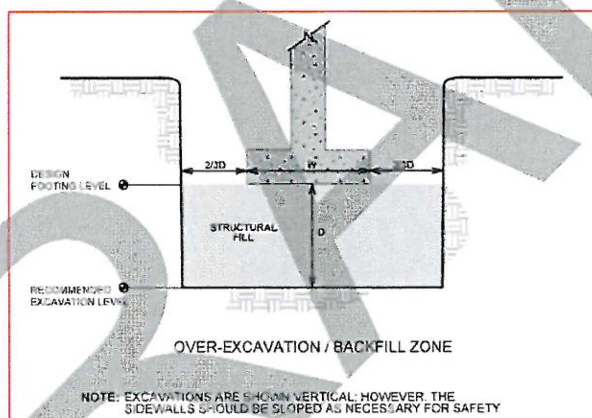
Foundation Construction Considerations

As noted in Earthwork, the footing excavations should be evaluated under the direction of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/soft/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are encountered at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete backfill placed in the excavations. This is illustrated on the sketch below.



Over-excavation for structural fill placement below footings should be conducted as shown below. The over-excavation should be backfilled up to the footing base elevation, with approved on-site soil or engineered fill, as recommended in the **Earthwork** section.



SEISMIC CONSIDERATIONS

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). To calculate the seismic site class, we utilized MASW to obtain the shear wave velocity throughout the soil profile to the depth of 100 feet. The shear wave velocity cross-sections are displayed on **Exploration Results**. The images are representations of the shear wave velocity of the subsurface. A 1-D Profile was modeled to produce a seismic site class of the site. The Vs 100' for the site is 2408 ft/s, indicating a **Site Class C** may be appropriate for design.

FLOOR SLABS

Depending upon the finished floor elevation, existing fill, unsuitable, weak, soft to medium stiff soils may be encountered at the floor slab subgrade level. Within the proposed floor slab areas, the existing fill should be undercut by at least 2 feet and extending 10 feet beyond the lateral limits of the construction area. Once materials have been removed, the entire area should be proof-rolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. These removed soils should be replaced with engineered fill, so the floor slab is supported on at least 2 feet of compacted suitable natural soils or structural fill.

Design parameters for floor slabs assume the requirements for **Earthwork** have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Floor Slab Design Parameters

Item	Description
Floor Slab Support [1]	Minimum 6 inches of free-draining (less than 6% passing the U.S. No. 200 sieve) crushed aggregate compacted to at least 95% of ASTM D 698 [2, 3] At least 18 inches of low plasticity cohesive or granular soils with at least 18% passing the U.S. No. 200 sieve material should be present below floor slabs where lean to fat clay or fat clay soils are present
Estimated Modulus of Subgrade Reaction [2]	100 pounds per square inch per inch (psi/in) for point loads

1. Floor slabs should be structurally independent of building footings or walls to reduce the possibility of floor slab cracking caused by differential movements between the slab and foundation.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in **Earthwork**, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.
3. Free-draining granular material should have less than 5% fines (material passing the No. 200 sieve). Other design considerations such as cold temperatures and condensation development could warrant more extensive design provisions.

The use of a vapor retarder should be considered beneath concrete slabs on grade covered with wood, tile, carpet, or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder.

Saw-cut control joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations refer to the ACI Design Manual. Joints or cracks should be sealed with a water-proof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in **Existing Fill** within **Earthwork**, are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams and/or post-tensioned elements.

Floor Slab Construction Considerations

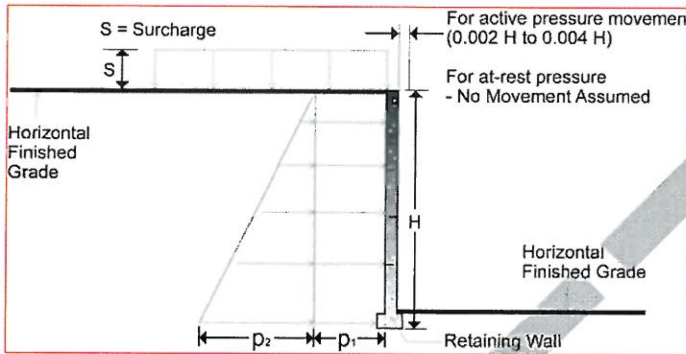
Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and engineered fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

The Geotechnical Engineer should approve the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

LATERAL EARTH PRESSURES

Design Parameters

Structures with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



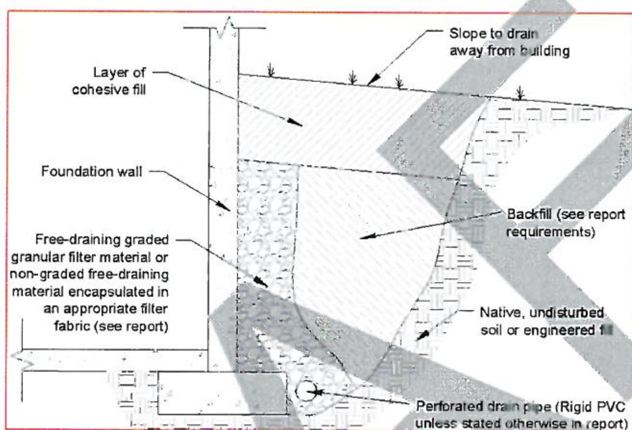
Lateral Earth Pressure Design Parameters				
Earth Pressure Condition [1]	Coefficient for Backfill Type [2]	Surcharge Pressure [3, 4, 5] p_1 (psf)	Effective Fluid Pressures (psf) [2, 4, 5]	
			Unsaturated [6]	Submerged [6]
Active (Ka)	Granular - 0.33	(0.33)S	(40)H	(80)H
	Fine Grained - 0.41	(0.41)S	(50)H	(85)H
At-Rest (Ko)	Granular - 0.50	(0.50)S	(60)H	(90)H
	Fine Grained - 0.58	(0.58)S	(70)H	(95)H
Passive (Kp)	Granular - 3.00	---	(360)H	(235)H
	Fine Grained - 2.46	---	(295)H	(205)H

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H for loose cohesionless soils and 0.02 H to 0.05 H for soft cohesive soils, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, compacted to at least 95% of the ASTM D 698 maximum dry density, rendering a maximum unit weight of 120 pcf.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. No safety factor is included in these values.
6. To achieve "Unsaturated" conditions, follow guidelines in **Subsurface Drainage for Below-Grade Walls** below. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.

Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of walls and extends below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area or exterior retaining wall should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a pre-fabricated drainage structure may be used. A pre-fabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

PAVEMENTS

General Pavement Comments

Pavement designs are provided for the traffic conditions and pavement life conditions as noted in **Project Description** and in the following sections of this report. A critical aspect of pavement performance is site preparation. Pavement designs noted in this section must be applied to the site which has been prepared as recommended in the **Earthwork** section.

Pavement Design Parameters

Designs for minimum thicknesses for new pavement sections for this project have been based on the procedures outlined Design of Hot Mix Asphalt Pavements (flexible pavements) by AASHTO and ACI for Portland cement pavement (rigid pavement). Pavement design methods are intended to provide structural sections with adequate thickness over a particular subgrade such that wheel loads are reduced to a level the subgrade can support. The anticipated criteria used for the pavement thickness design are 50,000 - 18-kip equivalent axle loads (ESAL's) for planned light-duty, 110,000 ESAL's for medium-duty areas and 180,000 EASAL's for heavy-duty and any dumpster pad areas. Within the pavement areas, the existing fill should be undercut by at least 2 feet. Once materials have been removed, the entire area should be proof-rolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. Once unsuitable materials have been remediated, and the subgrade has passed the proof-roll test, the existing and undocumented fill that was removed can be evaluated for reuse as engineered fill. These values are based on a 20-year design life, a California Bearing Ratio (CBR) of **3** for flexible pavement and a modulus of subgrade reaction of 100 pci for rigid pavement. The values were empirically derived based upon our experience with the describe soil type subgrade soils and our understanding of the quality of the subgrade as prescribed by the **Site Preparation** conditions as outlined in **Earthwork**. The subgrade support values are based upon the lean clay soils anticipated to be present at the pavement subgrade elevation and past experience with similar soils and should be confirmed prior to construction. No CBR testing has been performed. Actual design traffic loading should be confirmed by the owner's representative. Re-evaluation of the recommended pavement sections may be necessary, if the actual traffic varies from the assumed criteria outlined above.

Pavement Section Thicknesses

The following table provides options for AC and PCC Sections:

Traffic Area	Pavement Type	Minimum Recommended Pavement Section Thickness (inches)				
		Asphalt Concrete Surface Course	Asphalt Concrete Base Course	Portland Cement Concrete [1]	Aggregate Base Course [2]	Total Thickness [3]
Light Duty Areas	AC	1½	2½	–	6	10
	PCC	–	–	5	4	9
Medium Duty Areas	AC	1½	2½	–	8	12
	PCC	–	–	6	5	11
Heavy Duty Areas	AC	2½	2½	–	8	13
	PCC	–	–	8	5	13

1. 4,000 psi compressive strength at 28 days, Concrete materials and placement requirements should follow ACI 330.1. PCC pavements are recommended for trash container pads and in any other areas subject to heavy wheel loads and/or turning traffic such as entrance aprons.
2. Crushed limestone base material such as KYTC DGA.
3. Based on an assumed CBR value of 3.0.

Portland cement concrete pavements are preferable in areas subject to repeated truck traffic, such as truck turning areas and within any loading docks or dumpster areas. Portland cement concrete should conform to the material and placement requirements of ACI 330.1. The air-entrained concrete should have a 28-day compressive strength of 4,000 psi or greater.

The following comments should be considered for a concrete pavement design option:

- Control/contraction joints should have a maximum spacing as per the American Concrete Institute (ACI) recommendations and should be placed in a roughly square pattern (where possible).
- At construction joints, an adequately-designed butt end construction joint is recommended. An adequate number of dowels or plates should be provided for load transfer support.
- Tie bars are also recommended along the first longitudinal joint from the pavement edge to keep the outside slab from separating from the pavement.
- Isolation joints are recommended for concrete pavement areas that abut fixed objects such as around light poles curb, inlets, etc.

For asphalt pavements, construction methods, drainage, and materials will have a significant long-term effect on the pavement life. We recommend the following be included in the pavement specifications.

- All crushed materials should be provided by a State qualified quarry/pit. Construction methods should be in accordance with KYTC DGA construction and material specifications. Tack coats should be included in accordance with KYTC DGA specifications.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Maintenance consists of both localized maintenance (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Preventive maintenance is usually the priority when implementing a pavement maintenance program. Additional engineering observation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.
- Install below pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

CORROSIVITY

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. Additional corrosivity testing results are included in the **Exploration Results** section. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary						
Boring	**Sample Depth (feet)**	**Soil Description**	**Soluble Sulfate (%)**	**Soluble Chloride (%)**	**Electrical Resistivity (Ω-cm)**	**pH**
B-2	0-3	Fill-Lean Clay	91	37	1843	7.99
B-5	0-3	Fill-Lean Clay	28	37	2813	8
B-6	0-3	Fill-Lean Clay	66	50	1940	8.18

Results of soluble sulfate testing indicate samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 4.3.1 of the ACI Design Manual. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

GENERAL COMMENTS

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

FIGURES

Contents:

GeoModel

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Geotechnical Borings

Number of Borings	Exploration Depth (feet)	Explored Location
3	10 to 14	Proposed U-Haul Building
3	9 to 12½	Driveway / utilities / RV fenced areas

Boring Layout and Elevations: Unless otherwise noted, Terracon personnel provided the boring layout. Coordinates were obtained with a handheld GPS unit (estimated horizontal accuracy of about ±20 feet) and approximate elevations were obtained by interpolation from the publicly available Google Earth database. If elevations and a more precise boring layout are desired, we recommend borings be surveyed following completion of fieldwork.

Subsurface Exploration Procedures: We advanced the borings with a truck-mounted, track-mounted, ATV-mounted rotary drill rig using continuous flight augers (solid stem and/or hollow stem, as necessary, depending on soil conditions). Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. We observed and recorded groundwater levels during drilling and sampling. For safety purposes, all borings were backfilled with auger cuttings after their completion.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Seismic Refraction (MASW)

Our method of investigation utilized a seismograph and a linear array of twenty-four 4.5Hz geophones to collect MASW data. MASW is performed by collecting surface waves created by a seismic source consisting of a sledge hammer striking an aluminum ground plate. The recorded data is then processed using dispersion analysis software (SurfSeis©, developed by the Kansas Geological Survey) that extracts the fundamental-mode dispersion curve(s). The curves are inverted and modeled to yield a 1D shear-wave velocity profile along the array for a corresponding depth. Using subsets of 12 geophones, many 1D profiles are created along an array and then combined to yield a 2D profile. These 2D profiles are then examined for changes in shear wave velocities to indicate soil conditions, the top of bedrock, and bedrock characteristics.

Two survey lines were conducted within the project area (see Site Location). The line labels on the exhibit represent the beginning of the line. A description of each line is listed in the table below.

MASW Survey Line No.	Approximate Orientation	Array Length (feet)	Geophone Spacing (feet)
1	North to South	299	13
2	Northwest to Southeast	299	13

The shear wave velocity cross-sections are displayed on Exploration Results. The images are representations of the shear wave velocity of the subsurface. In general, the data is interpreted based on the following:

- Higher velocity zones (green to red on the color scale) are indicative of competent bedrock (e.g., limestone). Competent rock is typically above 2,500 ft/sec.
- Lower velocity zones (blue to light green on the color scale) are indicative of overburden, weathered/fractured rock, or weaker rock units (e.g., shale, claystone). Soft rock typically begins at 1,200 ft/sec but stiff soils can exceed that value.
- Potential anomalies would consist of low velocity features within or below higher velocity units. The seismic results do indicate a variability in seismic velocity, but the data does not appear to display significant velocity inversions that would indicate voids.

Electrical Resistivity Imaging (ERI)

The ERI survey used an Electrical Resistivity system consisting of an Advanced Geosciences Inc. (AGI) SuperSti g R8 control unit. The method uses an array of potential and current electrodes, driven into the ground, that collects resistivity measurements as a 2D section below the survey array. After field collection, the resistivity data was processed using Earth Imager 2D (engineered by AGI), an inversion and modeling software package. Changes in the earth resistivity can indicate changes in lithology, saturation, and amount of fracturing.

Five ERI survey lines were conducted within the project area (see **Site Location**). The line labels on the exhibit represent the beginning of the line. A description of each survey line is listed in the table below.

ERI Survey Line No.	Approximate Orientation	Array Length (feet)	Number of Electrodes	Electrode Spacing (feet)
1	West to East	240	25	10
2	West to East	240	25	10
3	West to East	240	25	10
4	North to South	270	28	10
5	North to South	270	28	10

The cross-sectional images generated from the ERI survey are displayed on **Exploration Results**. The images are representations of the electrical resistivity of the subsurface. In general, the data is interpreted based on the following:

- High resistivity values (red, orange, and yellow) are indicative of competent bedrock (e.g., limestone) or dry granular material (e.g., sandy soils).
- Lower resistivity values (green, blue, and purple) are indicative of soil overburden or bedrock with high clay content (e.g., claystone, siltstone).
- Potential anomalies within the ERI data would consist of isolated very high or very low resistivity areas within bedrock.

Limitations of Geophysical Testing Methods

All geophysical testing methods rely on instrument signals to indicate physical conditions in the field. Signal information can be affected by on-site conditions beyond the control of the operator, such as, but not limited to, cultural features, standing water, high subsurface moisture content, and other buried objects. Interpretation of those signals is based on a combination of known factors combined with the experience of the operator and geophysical scientist evaluating the results.

This report has been prepared for the application discussed and in accordance with generally accepted geophysical practices. No warranties, expressed or implied, are intended or made. The findings presented in this report are based upon the data obtained from the geophysical surveys and from other information discussed in this report. This report does not reflect variations that may occur in areas not tested or inaccessible to the geophysical equipment, across the site, or due to the modifying effects of construction or weather.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests to understand the engineering properties of the various soil strata, as necessary, for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods were applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D2166/D2166M Standard Test Method for Unconfined Compressive Strength of Cohesive Soil

The laboratory testing program often included examination of soil samples by an engineer. Based on the material's texture and plasticity, we described and classified the soil samples in accordance with the Unified Soil Classification System.

PHOTOGRAPHY LOG

Figure 1: Looking east

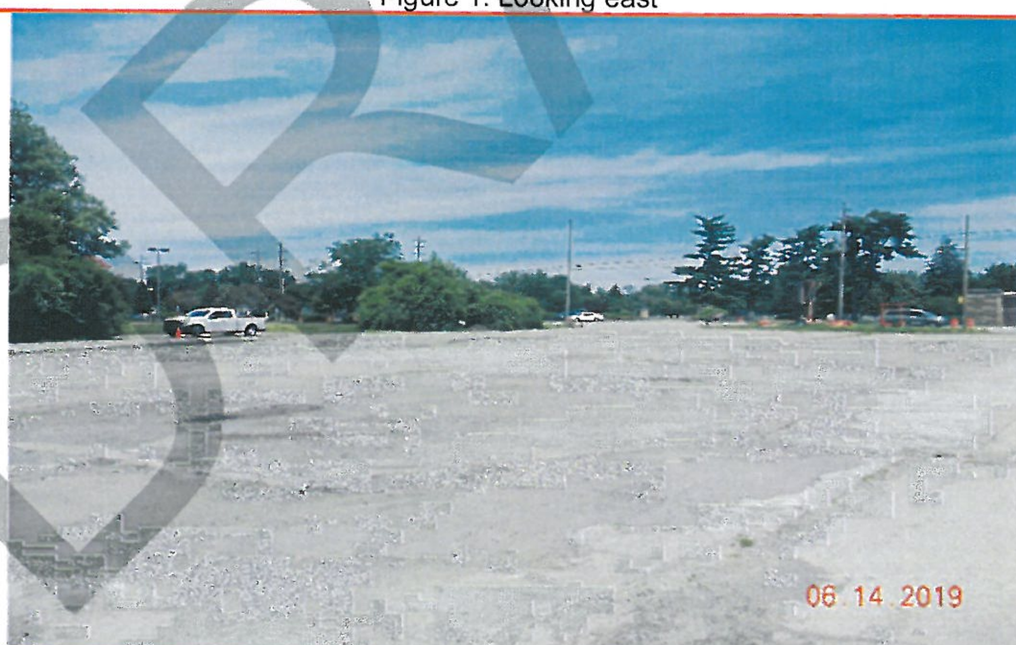


Figure 2: Looking north-west

Figure 3: Looking west

Figure 4: Looking north-west

Figure 5: Construction equipment staged at the east corner of project site

Figure 6: Buried structural elements remained from previous development

Figure 7: Buried structural elements remained from previous development

Figure 8: Looking south

Figure 9: Structural elements remained from previous development

SITE LOCATION AND EXPLORATION PLANS

Contents:

Note: All attachments are one page unless noted above.

SITE LOCATION

Proposed U-Haul Facility #773053(Abut) ■ Louisville, Jefferson County, KY
September 9, 2019 ■ Terracon Project No. 57195077

Terracon GeoReport

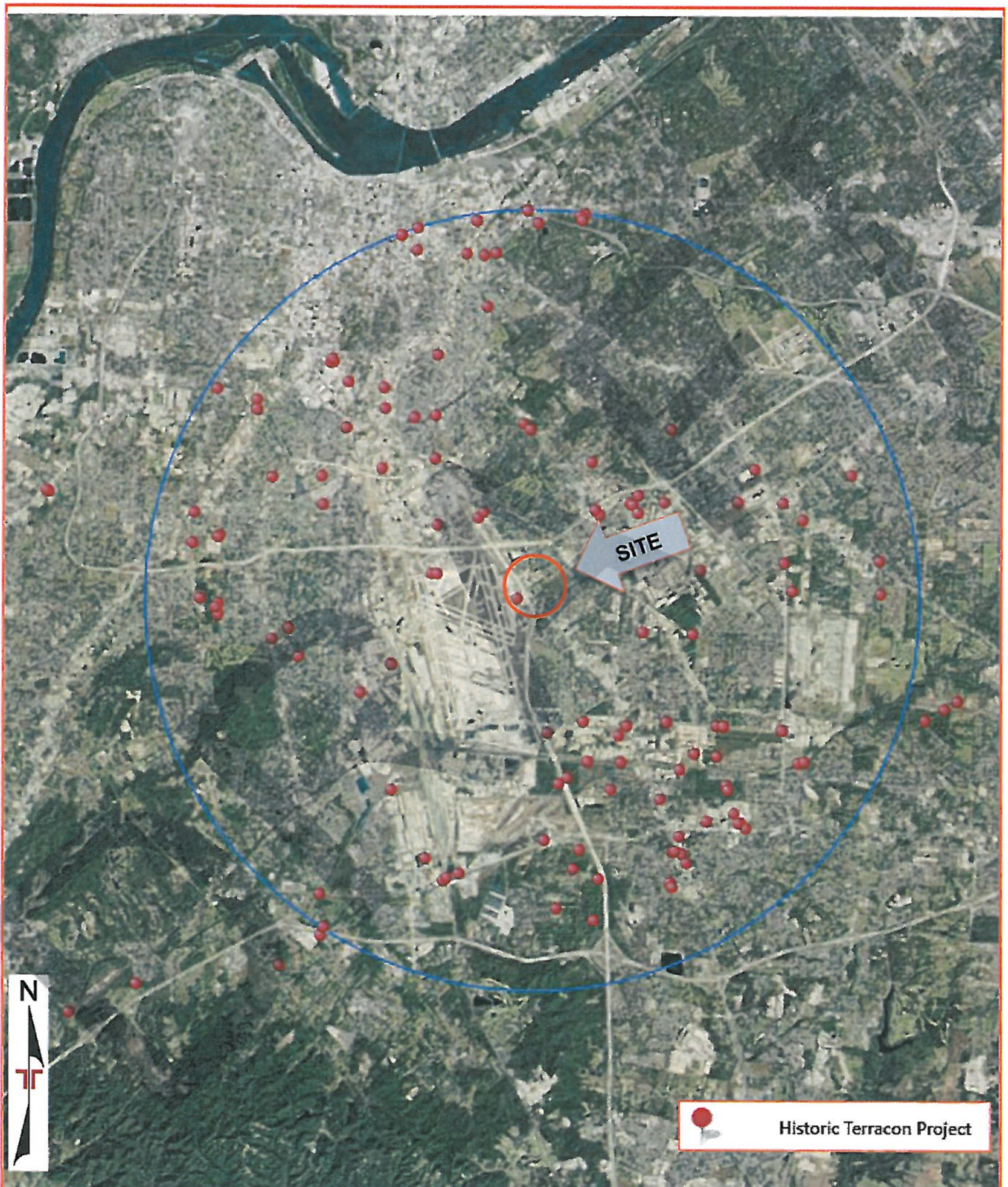


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

SITE LOCATION

Proposed U-Haul Facility #773053(Abut) ▪ Louisville, Jefferson County, KY

September 9, 2019 ▪ Terracon Project No. 57195077

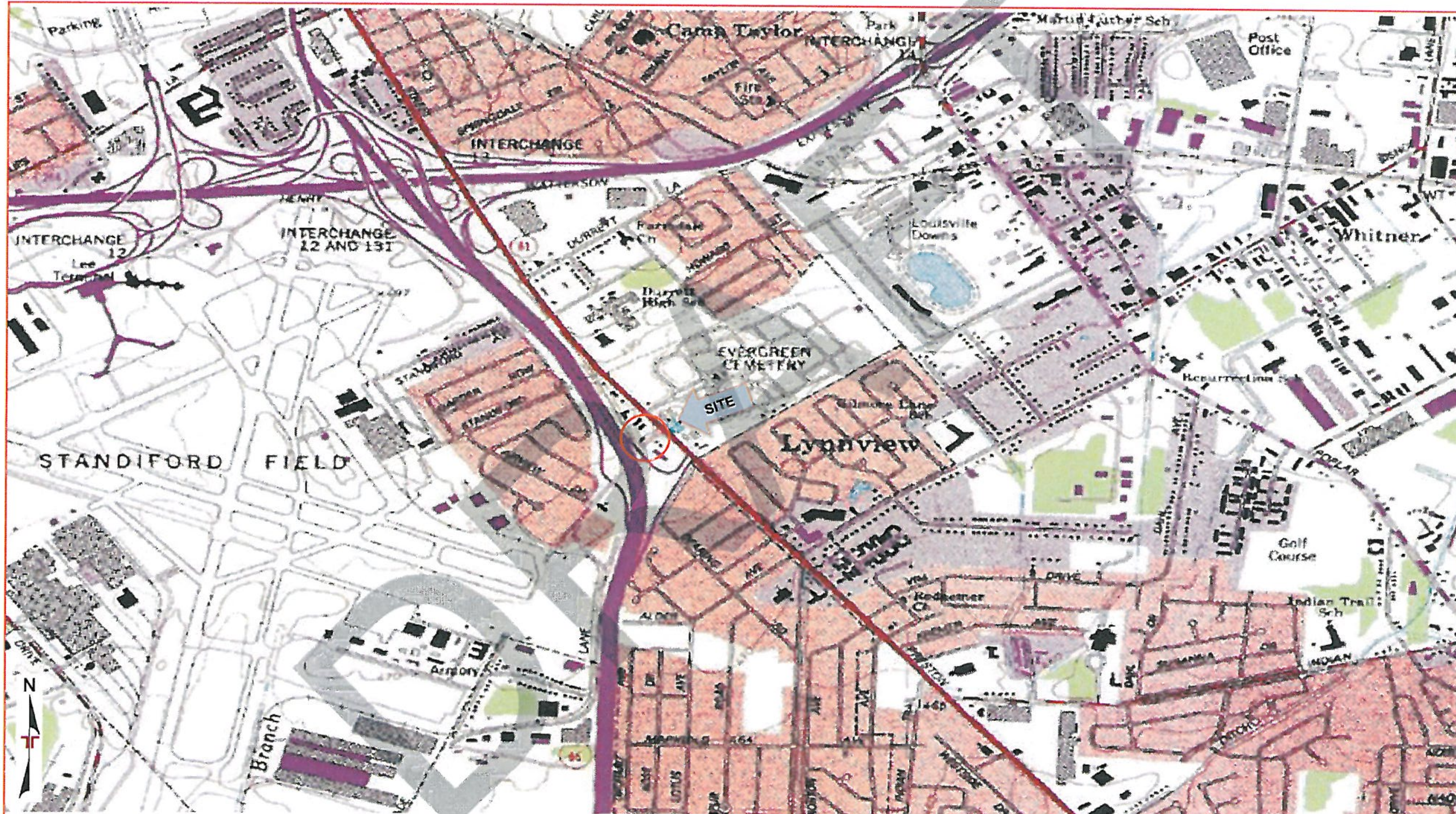


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

Proposed U-Haul Facility #773053(Abut) ▪ Louisville, Jefferson County, KY

September 9, 2019 ▪ Terracon Project No. 57195077

Terracon GeoReport

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

GEOPHYSICS SURVEY LINE LOCATIONS
Proposed U-Haul Facility #773053(Abut) ■ Louisville, Jefferson County, KY
September 9, 2019 ■ Terracon Project No. 57195077

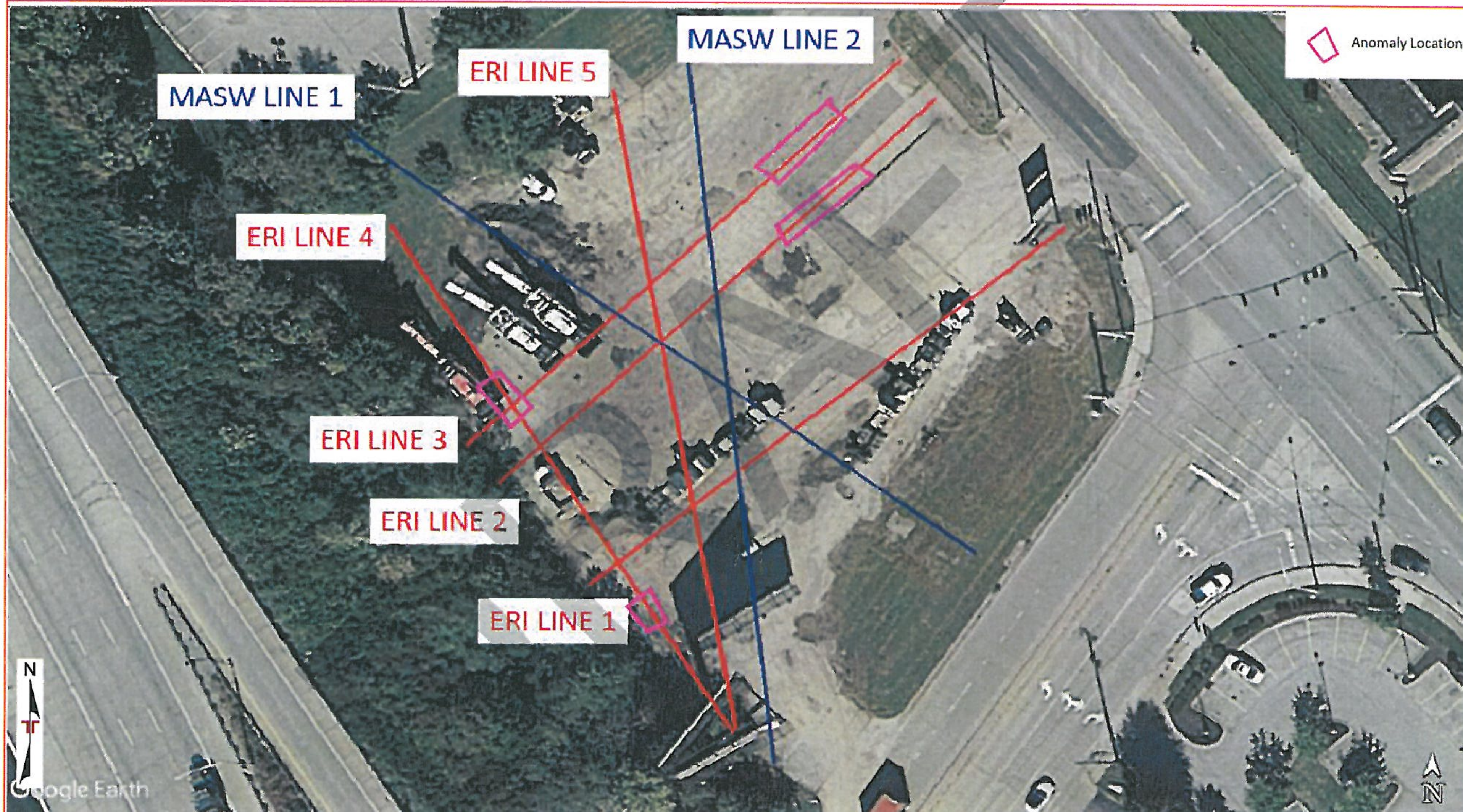


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

Contents:

Boring Logs (B-1 through B-6)
Atterberg Limits
Unconfined Compressive Strength (2)
Corrosivity
MASW Cross-Sections
Seismic Site Class
ERI Cross-Section

Note: All attachments are one page unless noted above.

BORING LOG NO. B-1

PROJECT: check

CLIENT: AMERCO Real Estate Company
Phoenix, AZ

SITE: 4624 Preston Highway
Louisville, KY

LOCATION See Exploration Plan

Latitude: 38.1803° Longitude: -85.7192°

Approximate Surface Elev.: 482 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.2	FILL - ASPHALT	482+/-												
	0.3	FILL - CONCRETE	481.5+/-												
	0.6	FILL - AGGREGATE BASE COURSE	481.5+/-												
2		FILL - LEAN CLAY (CL), trace crushed stone, gray with brown				X	17	2-2-2 N=4	4.5+ (HP)				19		
	3.5		478.5+/-												
3		LEAN CLAY (CL), brown, medium stiff to very stiff		5		X	18	3-3-3 N=6	2.75 (HP)				20		
						X	15	1-5-6 N=11	1.5 (HP)				21		
	8.5		473.5+/-												
4	9.0	SHALE, black	473+/-			X	6	50/5"							

Auger Refusal at 9 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from the publicly available Google Earth database.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

Boring Started: 07-17-2019	Boring Completed: 07-17-2019
Drill Rig: Geoprobe MPDH	Driller: ESI
Project No.: 57195077	

BORING LOG NO. B-2

PROJECT: check

CLIENT: AMERCO Real Estate Company
Phoenix, AZ

SITE: 4624 Preston Highway
Louisville, KY

LOCATION See Exploration Plan

Latitude: 38.1802° Longitude: -85.7195°

Approximate Surface Elev.: 482 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.3	**FILL - ASPHALT**	482+/-												
2	0.5	**FILL - AGGREGATE BASE COURSE**	481.5+/-												
2	3.5	**FILL - LEAN CLAY (CL)**, trace crushed stone, gray	478.5+/-			Split spoon	8	6-3-3 N=6					21		
3		**LEAN CLAY (CL)**, brown, soft to stiff			▽	Shelby tube				UC	1.51	3.8	21	109	28-21-7
3	8.5		473.5+/-	5		Split spoon	14	1-1-1 N=2	2.75 (HP)				21		
4		**SHALE**, black				Split spoon	9	30-50/3"							
4	13.8		468.5+/-	10		Split spoon	2	50/2"							
		Auger Refusal at 13.75 Feet													

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from the publicly available Google Earth database.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

Boring Started: 07-17-2019	Boring Completed: 07-17-2019
Drill Rig: Geoprobe MPDH	Driller: ESI
Project No.: 57195077	

BORING LOG NO. B-3

PROJECT: check

CLIENT: AMERCO Real Estate Company Phoenix, AZ

SITE: 4624 Preston Highway Louisville, KY

LOCATION See Exploration Plan

Latitude: 38.1804° Longitude: -85.7192°

Approximate Surface Elev.: 482 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1		0.3	**FILL - ASPHALT**	482+/-												
2		0.5	**FILL - AGGREGATE BASE COURSE**	481.5+/-												
2		2.5	**FILL - LEAN CLAY (CL)**, with crushed stone and concrete, gray	479.5+/-				12	22-19-8 N=27							
3			**LEAN CLAY (CL)**, brown, medium stiff					12	1-1-3 N=4	2.25 (HP)				24		
3					5			18	1-2-4 N=6	3.5 (HP)				25		
3		9.5		472.5+/-				14	4-2-40 N=42	0.75 (HP)				31		
4		12.3	**SHALE**, black	470+/-	10			3	50/3"							

Auger Refusal at 12.25 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Hollow Stem Auger

Abandonment Method: Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from the publicly available Google Earth database.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

Boring Started: 07-17-2019	Boring Completed: 07-17-2019
Drill Rig: Geoprobe MPDH	Driller: ESI
Project No.: 57195077	

BORING LOG NO. B-4

PROJECT: check

CLIENT: AMERCO Real Estate Company
Phoenix, AZ

SITE: 4624 Preston Highway
Louisville, KY

LOCATION See Exploration Plan
Latitude: 38.1802° Longitude: -85.719°
Approximate Surface Elev.: 482 (Ft.) +/-

MODEL LAYER	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1	0.9	**FILL - AGGREGATE BASE COURSE**	481+/-												
1	3.5	**FILL - ASPHALT**, with crushed stone, black	478.5+/-			X	11	4-3-3 N=6							
2	6.0	**FILL - POORLY GRADED SAND (SP)**, gray	476+/-	5		X	11	1-1-2 N=3					5		
3	9.5	**LEAN CLAY (CL)**, brown, medium stiff	472.5+/-			X	12	2-3-4 N=7	2.75 (HP)				20		
						X	13	2-38-50/1"	0.75 (HP)						
4	12.5	**SHALE**, black	469.5+/-	10											

Auger Refusal at 12.5 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from the publicly available Google Earth database.

Notes:

WATER LEVEL OBSERVATIONS
Groundwater not encountered

Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

Boring Started: 07-17-2019	Boring Completed: 07-17-2019
Drill Rig: Geoprobe MPDH	Driller: ESI
Project No.: 57195077	

BORING LOG NO. B-5

PROJECT: check

CLIENT: AMERCO Real Estate Company
Phoenix, AZ

SITE: 4624 Preston Highway
Louisville, KY

LOCATION See Exploration Plan
Latitude: 38.1798° Longitude: -85.7194°
Approximate Surface Elev.: 481 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1		0.9	**FILL - AGGREGATE BASE COURSE**	480+/-												
2		3.5	**FILL - LEAN CLAY**, with asphalt, gray	477.5+/-			X	12	4-7-4 N=11					18		
3		9.5	**LEAN CLAY (CL)**, brown with gray, soft to stiff	471.5+/-	5		X	8	1-1-1 N=2	1.5 (HP)				22		
							X	0	3-3-4 N=7							
							X	16	4-18-50/4"							
4		11.9	**SHALE**, black	469+/-	10											
			Auger Refusal at 11.9 Feet					0	50/0"							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from the publicly available Google Earth database.

Notes:

WATER LEVEL OBSERVATIONS
Groundwater not encountered

Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

Boring Started: 07-17-2019	Boring Completed: 07-17-2019
Drill Rig: Geoprobe MPDH	Driller: ESI
Project No.: 57195077	

BORING LOG NO. B-6

PROJECT: check

CLIENT: AMERCO Real Estate Company
Phoenix, AZ

SITE: 4624 Preston Highway
Louisville, KY

LOCATION See Exploration Plan

Latitude: 38.1801° Longitude: -85.7196°

Approximate Surface Elev.: 481 (Ft.) +/-

MODEL LAYER	GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI
1		0.3	**FILL - ASPHALT**	481+/-												
2		0.5	**FILL - AGGREGATE BASE COURSE**	480.5+/-												
			FILL - LEAN CLAY (CL), with crushed stone, gray					9	6-6-4 N=10					8		
		3.5		477.5+/-												
3			**LEAN CLAY (CL)**, brown, soft to very stiff			▽										
					5						UC	2.09	3	19	109	34-22-12
								20	0-0-3 N=3					28		
		9.5		471.5+/-				12	2-38-50/5"					26		
4		10.3	**SHALE**, black	471+/-	10											
			Auger Refusal at 10.25 Feet													

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations were interpolated from the publicly available Google Earth database.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

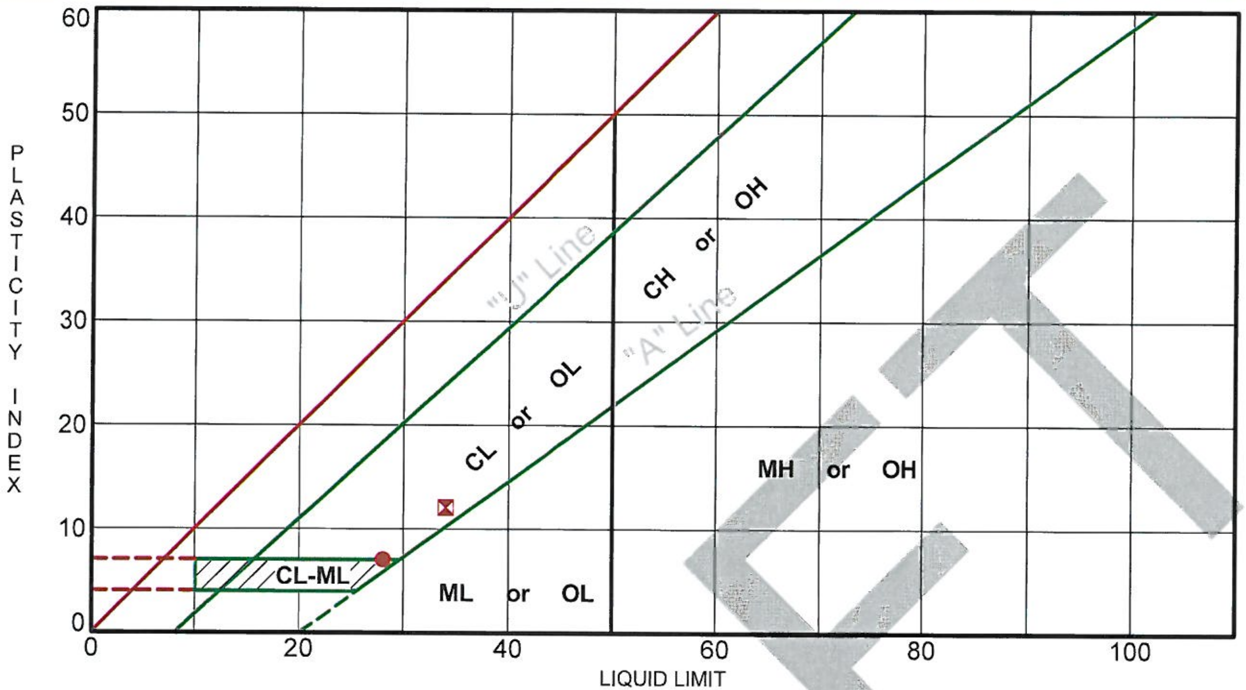
Boring Started: 07-17-2019 | Boring Completed: 07-17-2019

Drill Rig: Geoprobe MPDH | Driller: ESI

Project No.: 57195077

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B-2	3.5 - 5.5	28	21	7		CL	Lean Clay (CL), brown
⊠	B-6	4 - 6	34	22	12		CL	Lean Clay (CL), brown

PROJECT: U-Haul Storage Facility

SITE: 4624 Preston Highway
Louisville, KY

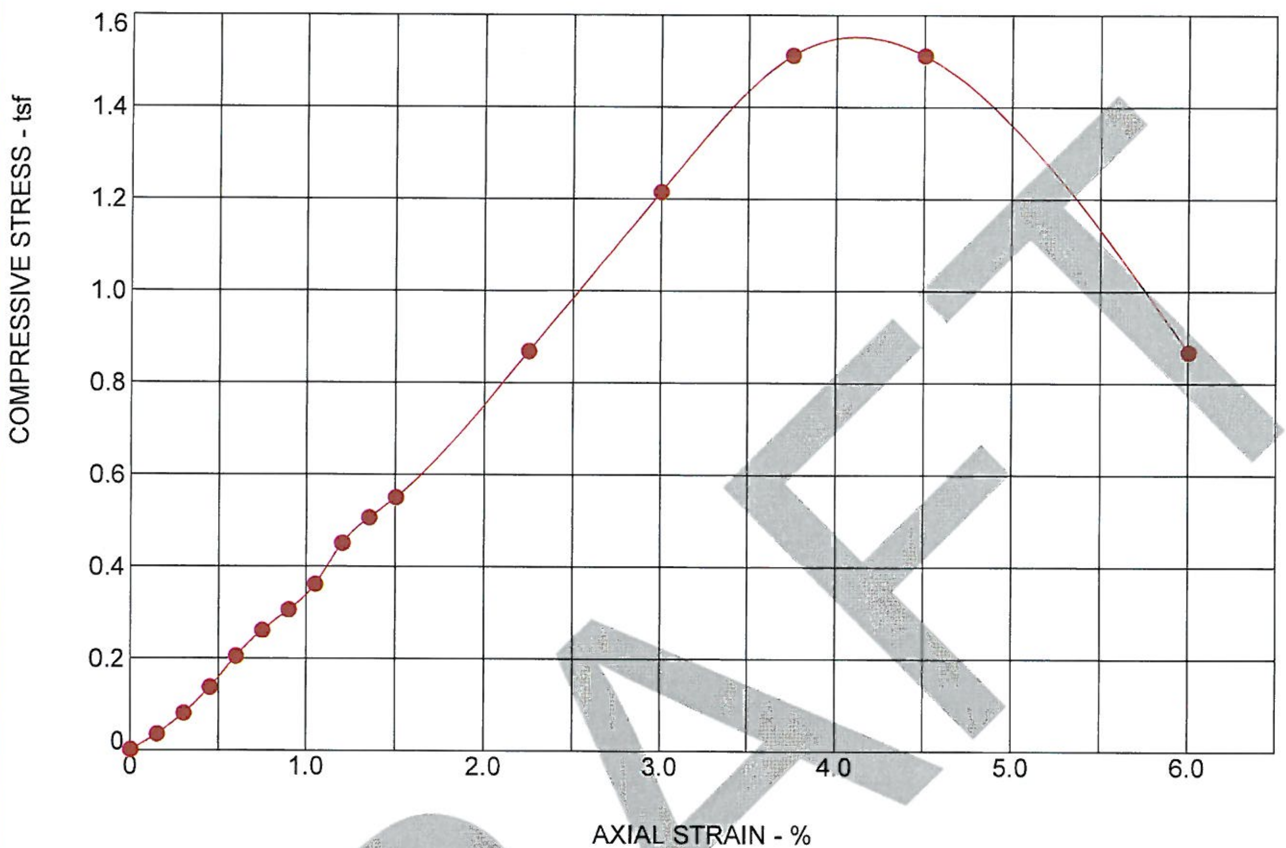
Terracon
13050 Eastgate Park Way, Ste 101
Louisville, KY

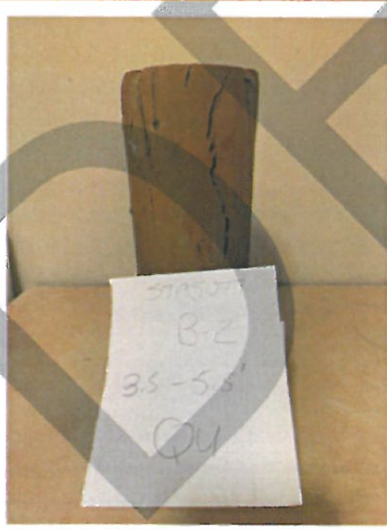
PROJECT NUMBER: 57195077

CLIENT: AMERCO Real Estate Company
Phoenix, AZ

UNCONFINED COMPRESSION TEST

ASTM D2166



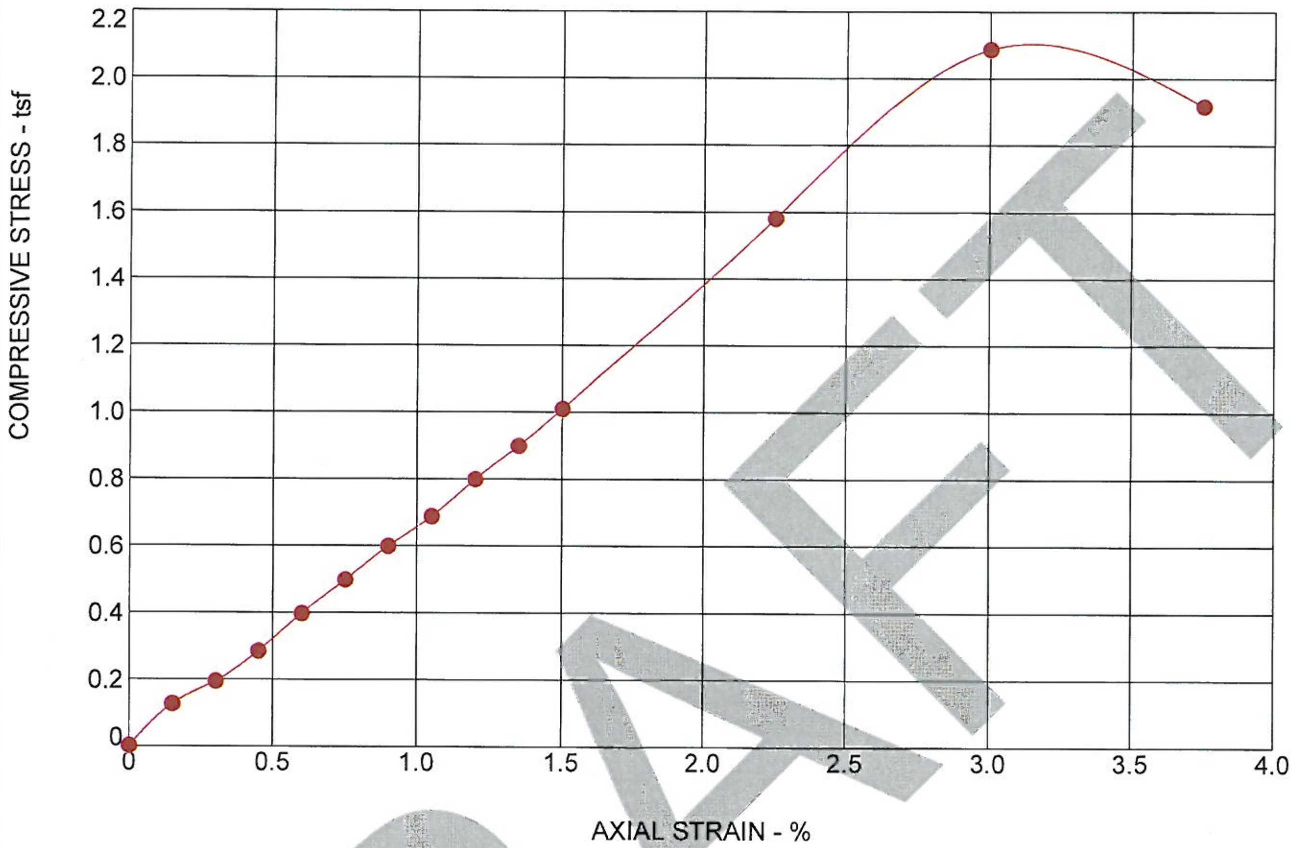
SPECIMEN FAILURE PHOTOGRAPH	SPECIMEN TEST DATA		
	Moisture Content:	%	21
	Dry Density:	pcf	109
	Diameter:	in.	2.84
	Height:	in.	5.65
	Height / Diameter Ratio:		1.99
	Calculated Saturation:	%	
	Calculated Void Ratio:		
	Assumed Specific Gravity:		
	Failure Strain:	%	3.75
	Unconfined Compressive Strength	(tsf)	1.51
	Undrained Shear Strength:	(tsf)	0.76
	Strain Rate:	in/min	0.0848
	Remarks:		

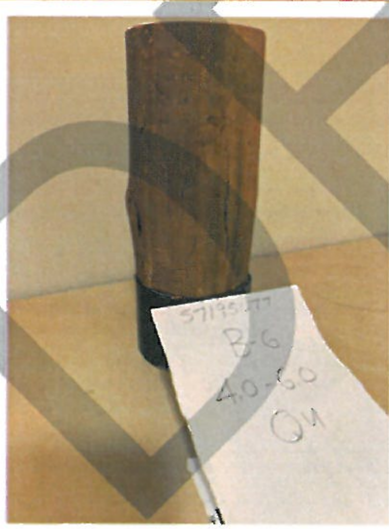
SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-2 @ 3.5 - 5.5 feet			
DESCRIPTION: Lean Clay (CL), brown	LL 28	PL 21	PI 7	Percent < #200 Sieve

PROJECT: U-Haul Storage Facility	Terracon	PROJECT NUMBER: 57195077
SITE: 4624 Preston Highway Louisville, KY	13050 Eastgate Park Way, Ste 101 Louisville, KY	CLIENT: AMERCO Real Estate Company Phoenix, AZ

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE PHOTOGRAPH	SPECIMEN TEST DATA		
	Moisture Content	%	19
	Dry Density:	pcf	109
	Diameter:	in.	2.84
	Height:	in.	5.61
	Height / Diameter Ratio:		1.98
	Calculated Saturation:	%	
	Calculated Void Ratio:		
	Assumed Specific Gravity:		
	Failure Strain:	%	3.00
	Unconfined Compressive Strength	(tsf)	2.09
	Undrained Shear Strength:	(tsf)	1.04
	Strain Rate:	in/min	0.0842
	Remarks:		

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-6 @ 4 - 6 feet			
DESCRIPTION: Lean Clay (CL), brown	LL	PL	PI	Percent < #200 Sieve
	34	22	12	

PROJECT: U-Haul Storage Facility	Terracon	PROJECT NUMBER: 57195077
SITE: 4624 Preston Highway Louisville, KY	13050 Eastgate Park Way, Ste 101 Louisville, KY	CLIENT: AMERCO Real Estate Company Phoenix, AZ

CHEMICAL LABORATORY TEST REPORT

Project Number: 57195077
Service Date: 08/08/19
Report Date: 08/14/19
Task:

Terracon
750 Pilot Road, Suite F
Las Vegas, Nevada 89119
(702) 597-9393

Client
AMERCO Real Estate Company

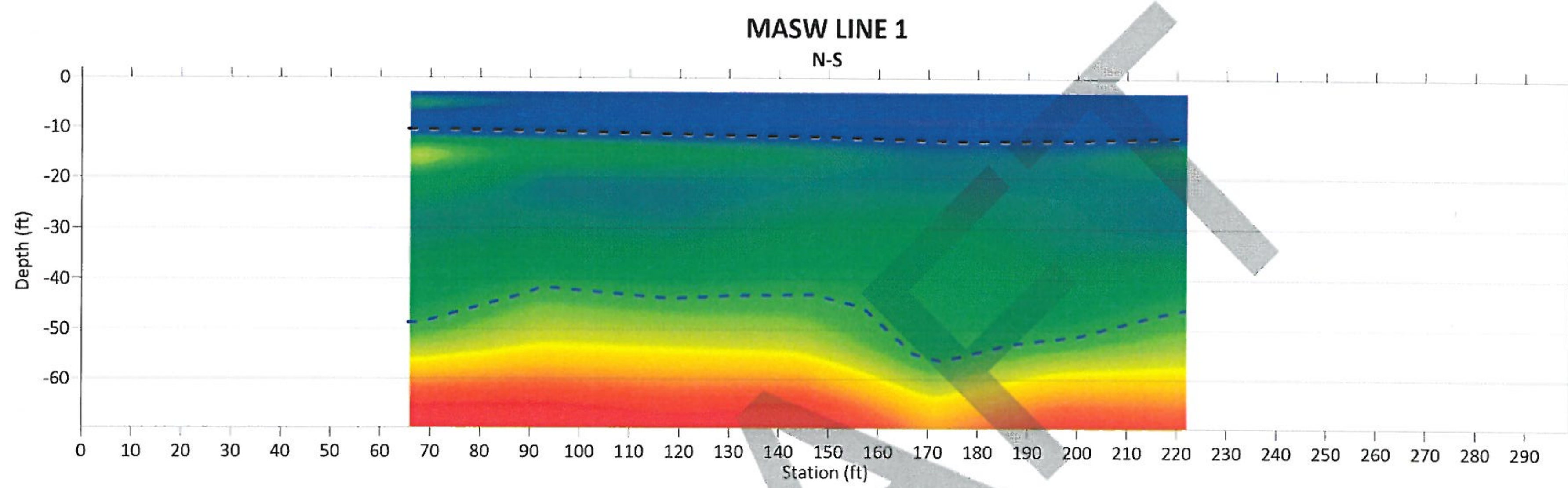
Project
U-Haul Storage Facility

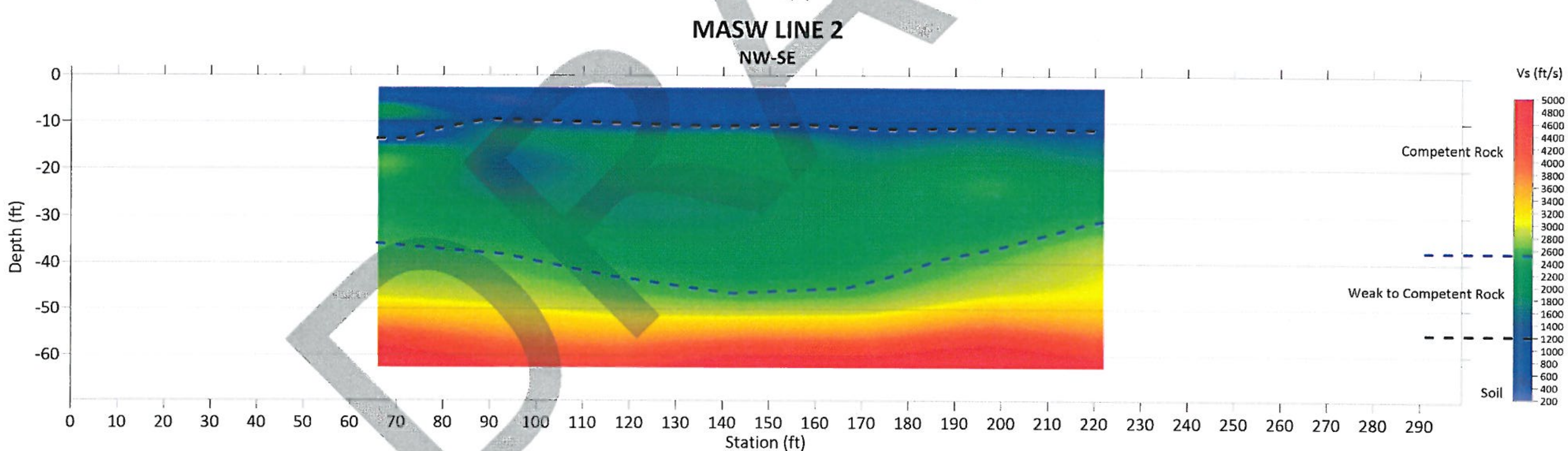
Sample Submitted By: Terracon (57) **Date Received:** 8/6/2019 **Lab No.:** 19-0868

Results of Corrosion Analysis

Sample Number			
Sample Location	B-2	B-5	B-6
Sample Depth (ft.)	0.0-3.0	0.0-3.0	0.0-3.0
pH Analysis, AWWA 4500 H	7.99	8.00	8.18
Water Soluble Sulfate (SO4), ASTM C 1580 (mg/kg)	91	28	66
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil	Nil
Chlorides, ASTM D 512, (mg/kg)	37	37	50
Red-Ox, AWWA 2580, (mV)	+684	+681	+682
Total Salts, AWWA 2540, (mg/kg)	923	660	918
Resistivity, ASTM G 57, (ohm-cm)	1843	2813	1940

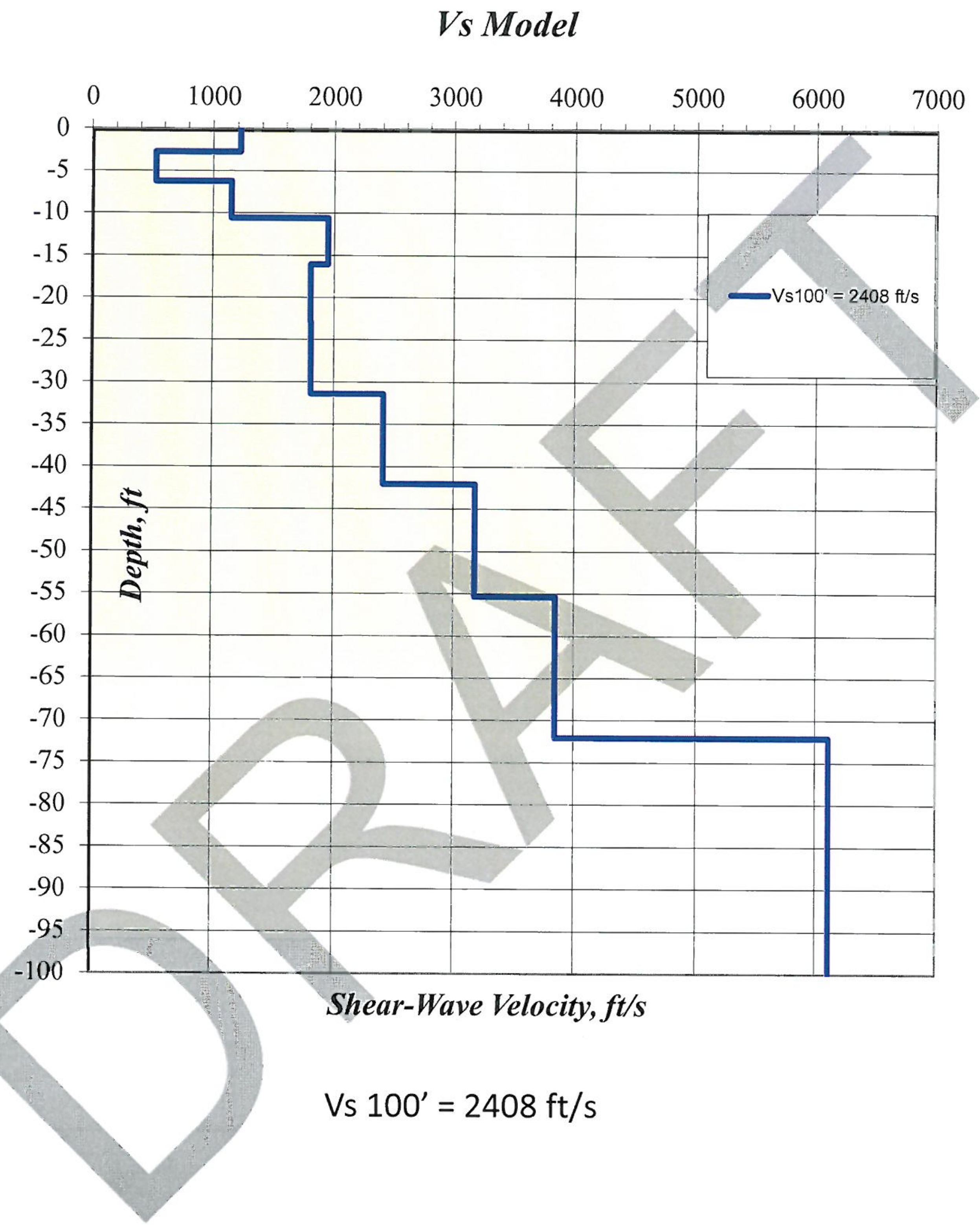
Analyzed By: Trisha Campo
Trisha Campo
Chemist





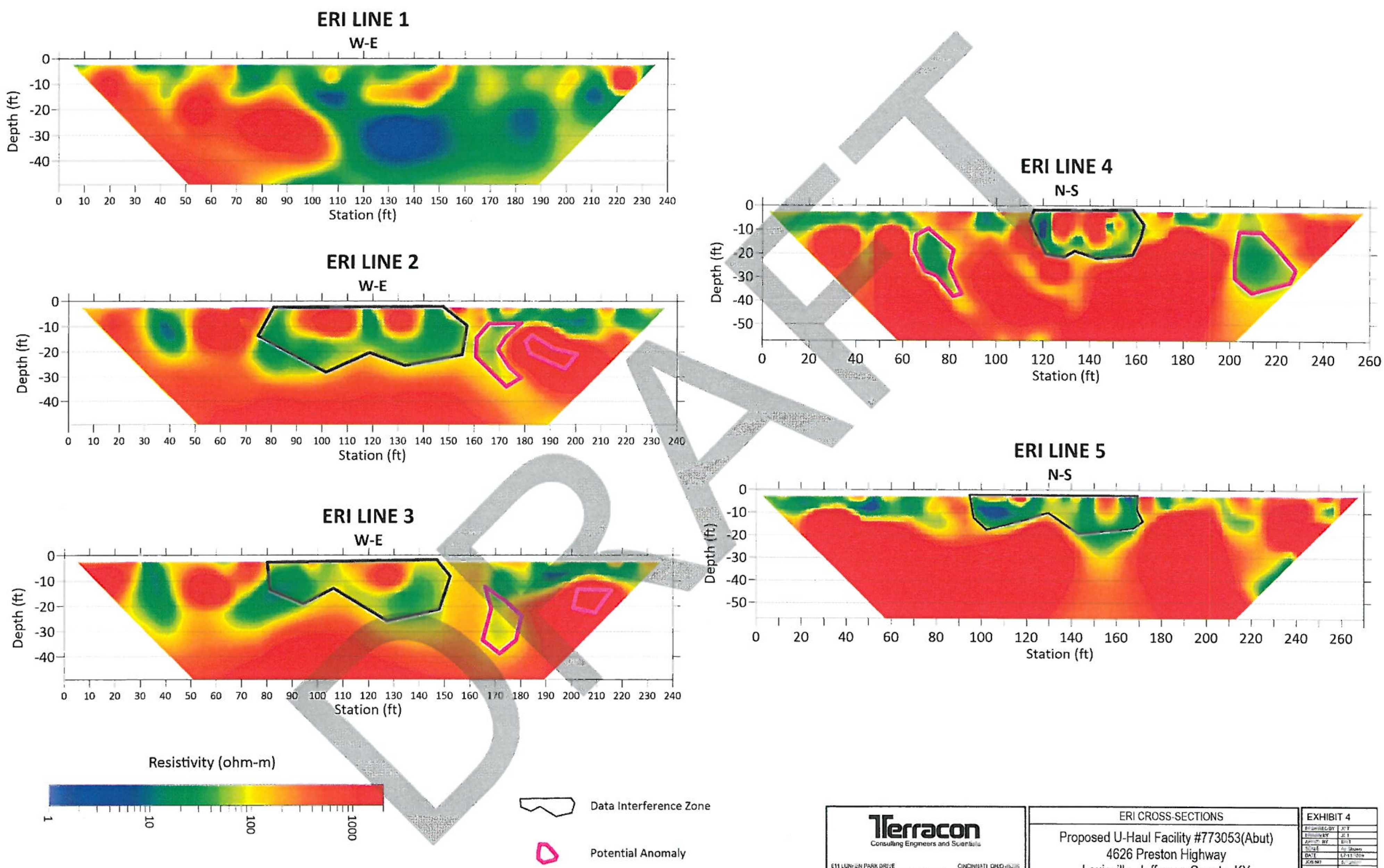
- - - Approximate Top of Rock
- - - Approximate Top of Competent Rock

Terracon Consulting Engineers and Scientists 611 LUNKEN PARK DRIVE CINCINNATI OHIO 45226	MASW CROSS-SECTIONS Proposed U-Haul Facility #773053(Abut) 4626 Preston Highway Louisville, Jefferson County, KY	EXHIBIT 2



Vs 100' = 2408 ft/s

Project Manager:	Project No. 57195077	Terracon Consulting Engineers & Scientists	Seismic Site Class	Exhibit
Drawn by: JCT	Scale: N.T.S.	611 Lunken Park Dr Cincinnati, OH 45226	Proposed U-Haul Facility #773053(Abut)	
Checked by: KJS	File Name: Exhibits.pdf		4626 Preston Highway	
Approved by: KJS	Date: 8/15/2019		Louisville, Jefferson County, KY	



Terracon
Consulting Engineers and Scientists

ERI CROSS-SECTIONS

Proposed U-Haul Facility #773053(Abut)
4626 Preston Highway
Louisville, Jefferson County, KY

EXHIBIT 4

SUPPORTING INFORMATION

Contents:

Note: All attachments are one page unless noted above.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

Proposed U-Haul Facility #773053(Abut) ■ Louisville, Jefferson County, KY
September 9, 2019 ■ Terracon Project No. 57195077

Terracon GeoReport

SAMPLING	WATER LEVEL	FIELD TESTS
Shelby Tube; Split Spoon	▽ Water Initially Encountered ▽ Water Level After a Specified Period of Time ▼ Water Level After a Specified Period of Time Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** Standard Penetration Test Resistance (Blows/Ft.) **(HP)** Hand Penetrometer **(T)** Torvane **(DCP)** Dynamic Cone Penetrometer **UC** Unconfined Compressive Strength **(PID)** Photo-Ionization Detector **(OVA)** Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL	
Descriptive Term(s) of other constituents	**Percent of Dry Weight**
Trace	<15
With	15-29
Modifier	>30

RELATIVE PROPORTIONS OF FINES	
Descriptive Term(s) of other constituents	**Percent of Dry Weight**
Trace	<5
With	5-12
Modifier	>12

GRAIN SIZE TERMINOLOGY	
Major Component of Sample	**Particle Size**
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

PLASTICITY DESCRIPTION	
Term	**Plasticity Index**
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Terracon GeoReport

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or [Cc<1 or Cc>3.0] [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or [Cc<1 or Cc>3.0] [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay.

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.