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GEOTECHNICAL ENGINEERING REPORT  
**HERC GRAVEL EQUIPMENT YARD REHABILITATION**

1406 SE HAMBLER RD.  
LEE'S SUMMIT, MISSOURI  
(AOG 22-398E)

Date: November 9, 2022

Submitted to: Meyer Companies, Inc.  
Rob Heise  
800 East 101<sup>st</sup> Terrace, Ste 120  
Kansas City, MO. 64131

Submitted by: ALPHA-OMEGA GEOTECH, INC.

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(AOG 22-398E)

Rob,

Alpha Omega Geotech, Inc. (AOG) has completed its geotechnical engineering investigation for the above-referenced project.

Attached are the following items that were utilized in the analysis and evaluation of the subsurface conditions at this site; a sketch giving the approximate location of the five (5) auger borings completed during this investigation with reference to the existing site features, detailed laboratory results of five (5) moisture contents (ASTM D2216), five (5) dry density (ASTM D7263), five (5) sets of Atterberg limits (ASTM D4318), and five (5) unconfined compression soil (ASTM D2166) tests, five (5) calibrated pocket penetrometer readings, and five (5) auger boring (ASTM D1452) logs that describe the materials encountered, their approximate thicknesses, and the sampling depths where Shelby tube, thin-walled steel, samplers (ASTM D1587) and Standard Penetration (ASTM D1586) tests were performed

Representatives of AOG located each of the selected borings by measuring from the existing site features, and these measurements should be considered accurate only to the extent implied by the method of measurement. Elevations were not determined in the field at the time of drilling. Each of the borings was completed by AOG using a CME 55 high-torque drill rig.

## 1.0 PROJECT DESCRIPTION

Based on provided information and a discussion with Meyer Co. and provided information It is understood that the intent is to rehabilitate the existing gravel equipment parking and storage yard to the west of the existing building. It is understood that this will be constructed as a gravel surface.

The current lot covers an area of approximately 1.4 acres and that original gravel storage yard covers an area of 37,500 sqft. The old gravel area has not been maintained and has vegetation growing through-out.

At this time a grading plan was not provided. AOG assumes that the finished grade will be close to the existing grade and that cuts and fills will be in the range of one (1) foot to achieve construction grade.

## 2.0 SUBSURFACE INVESTIGATION

Based on the information provided, as well as discussions with design team, AOG drilled five (5) auger borings at the proposed site. Each of building borings were advanced to planned depths or auger refusal.

The following table summarizes the depth of auger refusal in each of these test borings:

Table #1: Auger Refusal Depth (FT)

Boring	Location	Top of Weathered Rock (FT)	Depth of Refusal (FT)(*)
B1	NWC	N/A	~ 15.0 (NONE)
B2	NEC	~ 11.8	~ 12.7*
B3	MID SITE	~ 14.0	~ 14.4*
B4	SWC	N/A	~ 15.0 (NONE)
B5	SEC	~ 13.5	~ 13.8*

(\*) Very hard, weathered shale that was penetrable using our high-torque drilling equipment was encountered above the auger refusal depths shown above (see the boring logs enclosed in Appendix).

It should be understood that the depth of boring, split-spoon refusal or auger refusal reported, herein, applies to the type of drilling equipment used. As such, it might be possible to extend some of these borings deeper using different drilling equipment and/or techniques. Conversely, residual sandstone, shale, chert and limestone materials through which AOG's drill rig penetrated, without achieving refusal, may be difficult to excavate depending upon the equipment being used. As such, Alpha-Omega Geotech, Inc. shall not be responsible, for the determination of Others, regarding the rippability, or ease of excavation, of the in-situ subgrade, bedrock and/or geo-intermediate materials.



Above the depth at which auger refusal occurred, predominantly lean clay soils were encountered in the borings. Thin-walled, steel, Shelby tube samplers (ASTM D1587) were used to collect relatively undisturbed samples from these borings for laboratory analysis. Standard Penetration tests (SPT) (ASTM D1586) were also used to sample and evaluate the consistency of the in-situ subgrade materials encountered in these test borings. Standard Penetration Tests are conducted by advancing a hollow, split spoon sampler into the base of the auger hole by means of dropping a 140-pound hammer a distance of 30 inches onto the drill rods. Each drop of the hammer is one blow, and these blow counts are recorded for each of three, 6-inch advances of the sampler. The first 6-inch advance is the seating drive, and the summation of the blow counts of the final two, 6-inch advances is taken as the standard penetration resistance. The standard penetration resistance, or N-value, as it is known, along with the soil classification, can be used to estimate the density, shear strength and other engineering properties of the materials encountered.

The N-values obtained from each of the SPT's completed in these borings using a CME automatic hammer are included on the boring logs and summarized in the Summary of Laboratory Testing sheet found in Appendix B. Samples retrieved during drilling efforts were returned to AOG's laboratory for testing and evaluation.

### **3.0 LABORATORY TESTING PROGRAM**

Laboratory testing on materials collected during drilling was performed on samples selected by AOG. Results from these tests can be found in Appendix B and on the boring logs in Appendix C. The following laboratory tests were performed by qualified AOG personnel in accordance with ASTM specifications to determine pertinent engineering properties of the soils:

- Visual classification (ASTM D2488)
- Moisture content tests (ASTM D2216)
- Atterberg limits tests (ASTM D4318)
- Dry Unit Weight (ASTM D7263)
- Unconfined compression tests on soil (ASTM D2166)

The dry unit weights of specimens cut from the Shelby tube samples were found to be medium at 100.3 to 105.1 pounds per cubic foot (pcf). Depending upon the material composition and depth below existing grade, the moisture content of the specimens cut from these tube samples ranged from 19.0 to 22.1 percent. The unconfined compressive strength of the specimen cut from the Shelby tube sample ranged from 3592 to 5180 pounds per square foot (psf). It should be noted that some of the maximum unconfined compressive strength values were obtained at high strain rates nearing 10 percent. As a result, given the onsite soil types, these high strain rates typically indicate that larger settlements could occur unless a lower allowable bearing capacity value is used than otherwise indicated by the unconfined compressive strength test results. Calibrated pocket penetrometer readings ranging from 2.75 tons per square foot (tsf) (5500 psf) to 4.50 tsf (9000 psf) were obtained on the recovered Shelby tube samples. However, it should be noted that the pocket penetrometer values tend to over-estimate the strength of in-situ subgrade materials relative to the actual unconfined compressive strength test



The Atterberg consistency limits were determined for eight (8), generally, representative sample taken at relatively shallow to intermediate depths from within the proposed structures' footprints. Based on the Atterberg limits, the samples were classified in accordance with the Unified Soil Classification System (USCS) as Lean Clay (CL) and Fat Clay (CH) classification materials.

The results of these laboratory analyses are presented in the following table:

Table #3: Atterberg Limits Results

ATTERBERG LIMITS TESTS					
Sample	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	USCS Classification
B1 ST-2	3.0-5.0	38	19	19	Lean Clay (CL)
B2 ST-2	3.0-5.0	43	19	24	Lean Clay (CL)
B3 ST-2	3.0-5.0	38	19	19	Lean Clay (CL)
B4 ST-2	3.0-5.0	44	20	24	Lean Clay (CL)
B5 ST-2	3.0-15.0	41	19	22	Fat Clay (CH)

Based on the Atterberg limits, it is anticipated that onsite soil materials generally possess a moderate to high swelling potential. The swelling potential of a clay soil is an indication of the volume changes that may take place with variations in the soil moisture content.

Except for the samples for which the Atterberg limits were determined, all of the other soil classifications given throughout the laboratory test data, as well as, the boring logs, were made using the visual and tactile techniques described in ASTM D2488. As a result, additional analyses could reveal other soil types of different classification and potentially higher plasticity and swelling potential both onsite and within the nearby vicinity.

#### 4.0 GROUNDWATER

Free water was not encountered at the time of drilling. However, a twenty-four-hour water level was not established in these borings due to time restrictions, as well as, potential safety hazards associated with open bore holes.

Although the ground water levels given on the boring logs reflect the conditions observed at the time the borings were made, they should not be construed to represent an accurate or permanent condition. There is uncertainty involved with short-term water level observations in bore holes especially in clay soils of relatively low permeability. The groundwater level should be expected to fluctuate with variations in precipitation, site grading and drainage conditions. In addition, it is also possible that seasonal perched ground water may be encountered within these soil deposits and bedrock formations at different depths during other times of the year based on drainage conditions, seasonal snowmelt and rainwater infiltration.



## 5.0 GEOTECHNICAL CONSIDERATIONS

The following considerations are given based on observations made by AOG at the time of drilling, during reconnaissance trips, and based on the project requirements and description as stated above:

1. Undocumented Fill: Undocumented fill, in general, consists of foreign materials with unknown densities and consistencies. Undocumented fill is typically unsuitable beneath pavements unless measures are taken to stabilize the materials prior to loading. When encountered, undocumented fill beneath pavements should be addressed in accordance with Section 6.2, "Undocumented Fill," this report.

## 6.0 SITE DEVELOPMENT

### 6.1 Site Preparation

AOG anticipates minimal amounts of cut/fills less than 1-foot (+/-), will be required to achieve construction grade. It is assumed that any new fill required would consist of additional aggregate similar to MoDOT Type 5 base rock.

Appropriate erosion control measures, such as proper site contouring during grading activities, as well as, silt fences, should be maintained to help keep any eroded materials onsite.

Within the footprint of the proposed new aggregate surfaces, it is recommended that any topsoil, vegetation, utility backfill, and other deleterious material (i.e. concrete slabs, relic foundations, utilities, etc.) should be stripped and removed prior to the placement of any fill required to achieve the final grade. In accordance with the local building code, this should be verified by a representative of Alpha-Omega Geotech, Inc. prior to the placement of fill.

Once initial site stripping operations have been completed and prior to the placement of any engineered fill in this area, it is recommended that the exposed subgrade be moisture conditioned and recompacted, as needed, and be thoroughly evaluated by means of a proof-roll with a fully loaded, tandem-axle dump truck to locate any soft, compressible areas within the proposed project site. Any soft, compressible areas identified on the proposed project site must be corrected by over-excavation to a suitable subgrade and replaced with an acceptable material. Although it is not anticipated that any extensive removal and replacement would be necessary, it is possible that some effort may be required to develop a stable platform on which to place the necessary fill material and address any other existing site conditions that become known during construction. It is generally anticipated that the extent of these efforts would strongly depend upon the ground moisture conditions at the time the site work begins. In the event that the ground is generally dry, it is possible that only a minimal amount of stabilization would be required, which may be possible to accomplish by simple moisture conditioning and recompaction efforts. Nevertheless, it is recommended that a representative of Alpha-Omega Geotech, Inc. should be onsite to witness this proof-rolling and offer recommendations, as needed, to correct any problem areas identified.

### 6.2 Undocumented Fill

Undocumented fill is a foreign material, of which no records of testing or evaluation by a qualified professional during the time of placement exist. Undocumented fill is, generally, unsuitable beneath pavements. Undocumented fill beneath pavements should be thoroughly evaluated by a registered professional engineer.



### 6.3 Drainage Considerations

Fluctuations of the ground water level can occur due to seasonal variations in the amount of rainfall and other climatic factors that were not evident at the time the borings were made. The possibility of ground water level fluctuations should be considered when developing the design and construction plans for the project. In spring and late fall, soil moisture contents may be abnormally high and drying of the soils that are exposed and/or undercutting may be required to develop a suitable base for the placement and compaction of engineered fill. Disking and aeration of the exposed soils may be sufficient to develop a stable base. However, if site grading begins during the summer or early fall, moisture contents may be abnormally low and the plastic clay soils encountered during this exploration may undergo significant volume changes with subsequent increases in their moisture content. Therefore, when these conditions exist, disking and moisture conditioning of the exposed subgrade soils may be required.

It is important to consider drainage and construction elements that will help to inhibit future slab on grade problems, foundation cracks, as well as, intolerable settlements due to volume changes of the onsite soils. The surface drainage must be designed to prevent ponding and effectively move water away from both the new and existing buildings, pavements and other structures. It is also very important to place all materials under carefully controlled conditions of moisture and density to inhibit significant soil volume changes.

### 7.0 PAVEMENTS (AGGREGATE SURFACING)

It is understood that the site will utilize the existing aggregate surface as the main focus of this project. At the time of this report, it is unknown if there will be any future paving on the site or a formal anticipated traffic volume/wheel counts/vehicle size. Based on our borings, there is about 12-inches of existing aggregate base for the pavement section. We recommend leaving the existing aggregate in-place and placing additional aggregate as needed for improved drainage, new surfacing and stabilizing any soft areas.

#### 7.1 General Subgrade Preparation

Please note, a formal pavement design is beyond AOG's scope of service. Standard asphaltic concrete and concrete pavement designs for a given service life requires evaluation of the soil by means of a California Bearing Ratio (CBR) test or other methods, estimates of traffic volumes and axle weights, drainage requirements, and the desired level of maintenance. As such, some standard pavement design options based on assumptions made for materials of this nature are included in this section.

It is recommended that any untreated aggregate base subgrade layers should extend at least 2 feet beyond the utilized pavement area. Any additional fill that is required to develop the paved areas should also be placed in loose lifts not exceeding 8 inches in thickness and compacted to a minimum density of 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content within  $\pm 3$  percent of the optimum moisture content. The subgrade should be proof-rolled with a loaded tandem-axle dump truck after the final subgrade elevation has been established throughout the paved area. A representative of Alpha-Omega Geotech, Inc. should witness this proof-rolling.





Please note, the quality of the aggregates and drainage conditions can have a profound effect upon the durability of the pavement section.

## 7.2 Pavement Sections

Given the assumptions set forth herein, the following minimum aggregate pavement sections are recommended for this site.

TRAFFIC CATEGORY	
AGGREGATE SURFACE PAVEMENT (RE-GRADE)	
Category 1	Heavy Duty/ Trucks/Storage

Pavement Type			
Pavement	Subgrade	Traffic Cat.	Base Rock
Aggregate Surface Re-Grade	Proof-rolled w/ Suitable tandem axle truck	1	12"(*)
(*) Based on borings, there is an estimated 12-inches of gravel existing that should remain in-place and be considered "Base Rock" for pavements.			

Given our understanding of the project requirements, the aggregate pavement section thickness recommendations given above were developed based on ACI 330R "Guide for Design and Construction of Concrete Parking Lots" and the Asphalt Institute guidelines for parking lot construction. However, alternate pavement sections utilizing geogrids, granular base and/or subbase courses and chemically stabilized subgrades may also be considered. Nevertheless, it is recommended that Alpha-Omega Geotech, Inc. should be consulted regarding different pavement options, service life periods and/or traffic loading conditions.

The following recommendations apply for the planned Aggregate Pavement Section.

**Proof-Rolled Existing Base Rock:** It is recommended that the existing base rock section should be proof-roll with a loaded tandem-axle dump truck to locate any overly-soft, compressible areas that must be corrected by over-excavation and replacement with an acceptable material. It is recommended that a representative of Alpha-Omega Geotech, Inc. should be onsite to witness this proof-rolling and offer recommendations, as needed, to correct any problem areas that are identified.

Once the existing aggregate base rock subgrade has been proof-rolled to these specifications, in failing areas, the subgrade should be subcut a minimum of 6-inches up to 2-feet, then a single layer of Tensor TX-160 geogrid should be placed and overlapped in accordance with the manufacturer's recommendations, which should be verified during construction by representative of Alpha-Omega Geotech, Inc.

*It is recommended the layer of untreated aggregate base and geogrid should extend at least 2 feet beyond the utilized aggregate surface.*



**Base Rock:** Crusher-run limestone aggregate similar to MoDOT Type 5 should be compacted to at least 95 percent of the Standard Proctor (ASTM D698) maximum dry density at a moisture content sufficient to achieve the required level of compaction. The initial layer of base rock, if placed over the geogrid, must be thick enough to support construction traffic and paving equipment so the geogrid does not become exposed. In general, the crushed limestone base rock should not be less than approximately 6 inches in thickness.

### 7.3 General

Periodic maintenance including, but not limited to re-grading (for aggregate surfaces), should be anticipated. In addition, the quality of the aggregates as well as drainage conditions can have a profound effect upon the durability of the pavement section.

Where engineered controlled fill is placed beneath paved areas, it is recommended the compacted fill should extend a minimum distance of two (2) feet beyond the pavement edge.

Pavements/Aggregate Surfaces should be sloped to inhibit ponding and provide rapid surface drainage. If water is allowed to pond on or adjacent to the pavement, the subgrade could become saturated and lose its bearing capacity which would contribute to premature pavement deterioration under a single cycle of heavy wheel loads or a number of cycles of lighter wheel loads.

### 8.0 TESTING AND INSPECTION RECOMMENDATIONS

Unless Alpha-Omega Geotech, Inc. is retained to provide the construction observation, monitoring and testing services for this project, we cannot accept any responsibility for any conditions that deviate from those identified in this subsurface investigation nor for the performance of the pavements that are a part of this project. Alpha-Omega Geotech, Inc. is accredited by AASHTO and we are experienced in construction quality control and have a fully-equipped soil, concrete, aggregate, rock and asphalt testing laboratory, as well as, qualified field technicians to provide these field services.

It is not economically practical to perform enough exploratory borings on any site to identify all subsurface conditions. Some conditions affecting the design and/or construction may not become known until the project is underway. The boring logs, field SPT and laboratory test results depict subsurface conditions only at the specified locations and depths at the site. The boundaries between soil and rock layers indicated on the boring logs are based on observations made during drilling and an interpretation of the laboratory testing results. The exact depths of these boundaries are approximate and the transitions between soil and rock types may be gradual rather than being clearly defined. Also, due to the prior development at this site, as well as, the natural conditions of the formation of soils and rock, it is possible that unanticipated subsurface conditions may be encountered during construction. Monitoring of the subsurface conditions that are revealed during construction is needed to verify that subsurface conditions are consistent with those conditions identified in this preliminary geotechnical investigation. If variations in subsurface conditions are encountered, it will be necessary for Alpha-Omega Geotech, Inc. to re-evaluate the recommendations that have been made in this report.



*Special Inspections should be performed in accordance with the local building code under which the project is designed, as adopted by Lee's Summit, MO.*

Prior to filling, it is recommended that a representative of Alpha-Omega Geotech, Inc. should verify that the site has been properly stripped of all topsoil and other deleterious material, benched as needed and prepared for the placement of fill. The compaction of any structural fill beneath the new structure, pavements, and any other areas where settlement control is necessary should be tested lift-by-lift by a representative of Alpha-Omega Geotech, Inc. as it is being placed. This should include the prepared subgrade layers beneath the building's slab-on-grade, as well as, any other fill material relied upon to provide passive resistance. Also, in accordance with the local building code, any fill that is used to construct slopes steeper than 4:1 (H:V) must be placed as engineered controlled fill and the compaction tested lift-by-lift during placement.

Assuming that uniform fill material is used, nuclear density gauges (ASTM D2922/D3017) should be used to test compaction wherever necessary. However, if fill material of non-uniform consistency is used, other evaluation methods may be required. Such methods may include, but not be limited to, the use of a GeoGauge Stiffness meter, Dynamic Cone Penetrometer (DCP), proof-rolling or other visual inspection techniques.

Any geogrid reinforcement that is utilized should be placed and overlapped as needed in accordance with the manufacturer's recommendations, which should be verified by a representative of Alpha-Omega Geotech, Inc. Proper placement of the reinforcing steel for drilled piers, grade beams, pier caps, foundation walls and other structural elements including any necessary wing walls and retaining walls should be verified prior to the placement of concrete. The subgrade under the slabs on grade and pavements should be checked to verify they are in compliance with the density and moisture requirements. Wherever possible, in addition to compaction testing, cut and fill areas should be proof-rolled with a loaded tandem-axle dump truck to identify soft areas that will need to be corrected. A representative of Alpha-Omega Geotech, Inc. should observe this proof-rolling. Checks should also be made of the subbases, concrete and any pavement materials.

Finally, the inspection and testing services listed herein are given as a minimum and it should be understood that additional inspection and testing services might also be required or otherwise beneficial.

## **9.0 LIMITATIONS**

This report is presented in broad terms to provide a comprehensive assessment of the interpreted subsurface conditions and their potential effect on the adequate design and economical construction of the proposed project located in Lee's Summit, MO, as discussed herein. This report has been prepared for the exclusive use of our client for specific application to the project discussed herein and has been prepared within our client's directive and budgetary constraints and in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

It should be noted that the concept of risk is an important aspect of the geotechnical engineering evaluation and report since the recommendations given in this report are not based on exact science but rather analytical tools and empirical methods in conjunction with engineering judgment and experience. Therefore, the recommendations given herein should not be considered risk-free and, more importantly, are not a guarantee that the interaction between the soil materials and the proposed structures will perform as planned. Nevertheless, the geotechnical



engineering recommendations presented herein are Alpha-Omega Geotech, Inc.'s professional opinion of those measures that are necessary for the proposed structures to perform according to the proposed design based on the information provided to Alpha-Omega Geotech, Inc., the referenced information gathered during the course of this investigation and our experience with these conditions.

Any significant structural changes to the proposed new structure or its location on this site relative to where these test borings were completed shall be assumed to invalidate the conclusions and recommendations given in this report until we have had the opportunity to review these changes and, if necessary, modify our conclusions and recommendations accordingly. It is also strongly suggested that Alpha-Omega Geotech, Inc. should review your plans and specifications dealing with the earthwork, foundations, as well as, any pavements prior to construction to confirm compliance with the recommendations given herein. Particular details of foundation design, construction specifications or quality control may develop, and we would be pleased to respond to any questions regarding these details.

*If Alpha-Omega Geotech, Inc. is not retained to review the project plans and specifications, address to the proposed building and parking structure or their location on the site relative to where these test borings were completed, provide the recommended construction phase observation, monitoring and testing services and respond to any subsurface conditions that are identified during construction to evaluate whether or not changes in the recommendations given in this report are needed, we cannot be held responsible for the impact of those conditions on the project or the future performance of the buildings, pavements and/or structures that may be involved.*

The scope of our services did not include any environmental assessment or investigation for the presence of hazardous or toxic materials in the soil, surface water, ground water or air, either on, below or adjacent to this site. In addition, no determination regarding the presence or absence of wetlands was made. Furthermore, it should be understood that the scope of geotechnical services for this project does not include either specifically or by implication any biological (i.e., mold, fungi or bacteria) assessment of the site or the proposed construction. Any statements in this report or included on the boring logs regarding odors, colors and unusual or suspicious items or conditions are strictly for informational purposes only.

We appreciate the opportunity to be of service to Meyer Companies, Inc., as well as Herc Equipment and look forward to working with you throughout the construction process. We are prepared to provide the Special Inspection services that will be required by the local building code under which this project is designed, as adopted by the Lee's Summit, MO, as well as the other necessary construction observation, monitoring and testing services discussed in this report. If you have any questions concerning this report, or if we may be of further assistance, please call us at (913) 371-0000.

Sincerely,  
ALPHA-OMEGA GEOTECH, INC.



Garic Abendroth, P.E.  
Director of Engineering

Enclosures



**Appendix Section A**




**SITE SKETCH**

**Site and Boring Location Plans**



# Gravel Lot Rehabilitation

## Legend

-  Boring Locations
-  Meyer Brothers Building
-  Polygon Measure



Meyer Brothers

