CITY OF FOUNTAINS
HEART OF THE NATION
KANSAS CITY
MISSOURI

ADDENDUM NUMBER 2

Project Number 89005566

Project Title Kenneth Road Bridge Replacement
Federal Job #BRO-B048(50)

ISSUE DATE: **10/23/2019**

Bidders are hereby notified that the Bidding and Contract Documents for the above project, for which Bids are to be received on **10/29/2019**, are amended as follows:

Information to Bidders The following is provided to Bidders for information only:

1. The Design Professional has conducted soil investigations and geotech reports for design purposes only. The geotech reports do not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotech reports have been requested by bidders and are included with this addenda. The geotech reports are deemed as not suitable for contractor's use, contractor is using them at their risk and the reports are merely suggestive of the nature of the tested material, not representative of entire site conditions. Acknowledgment of this addenda shows acceptance of all risks associated with any use.

Q1.	Will Stay in Place Metal Decking be allowed as an option of forming for the bridge deck?
A1.	**Yes**
Q2.	Will Precast Concrete Panels be allowed as an option for the bridge deck?
A2.	**No. Cast-in-Place deck only.**
Q3.	Will alternate mix designs be allowed in place of the KCMO SA1 mix for the substructure and superstructure concrete? le. MoDOT Class B, B1, B2?
A3.	**No. Use KCMO SA-1 mix.**
Q4.	Is the estimated quantity for deck concrete figured with the use of concrete panels?
A4.	**The estimated quantity for the deck concrete is in square yard.**

NOTE: Bidders must acknowledge receipt of this Addendum by listing the number and date, where provided, on the Bid Form - Document 00410.

REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION

The Design Professional has conducted a soil investigation and geotech report for design purposes only. The geotech report does not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotech report has been requested by bidders and is included with this addenda. The geotech report is deemed as not suitable for contractor's use, contractor is using it at their risk and the report is merely suggestive of the nature of the tested material, not representative of entire site conditions. Acknowledgement of this addenda shows acceptance of all risks associated with any use.

KENNETH ROAD BRIDGE REPLACEMENT
KANSAS CITY, MISSOURI
TSI PROJECT NUMBER 20152024

SHAFER, KLINE & WARREN, INC.
11250 Corporate Avenue
Lenexa, Kansas 66219

TSi geotechnical, inc.

8248 NW 101st Terrace, #5
Kansas City, Missouri 64153

May 13, 2016

TSi geotechnical, inc.

8248 NW 101st Terr, #5
Kansas City, MO 64153
816.599.7965 (tel)
816.599.7967 (fax)

www.tsigeotech.com

May 13, 2016

Mr. Gary Strack, PE
SHAFER, KLINE & WARREN, INC.
11250 Coroporate Avenue
Lenexa, Kansas 66219

**Re: Report of Subsurface Exploration and
Geotechnical Engineering Evaluation
Kenneth Road Bridge Replacement
Kansas City, Missouri
TSi Project No. 20152024**

Dear Mr. Strack:

TSi Geotechnical, Inc. (TSi) has completed the authorized subsurface exploration and geotechnical engineering evaluation for the referenced project and is pleased to submit this report of our findings to Shafer, Kline & Warren, Inc. (SKW). The purpose of our scope was to determine subsurface conditions at specific exploration locations and to gather data on which to prepare geotechnical recommendations for the design and construction of the proposed replacement of the Kenneth Road Bridge over the Blue River in Kansas City, Missouri and Overland Park, Kansas. This report describes the exploration procedures used, documents the data obtained, and presents our evaluations and recommendations relative to the geotechnical engineering aspects of the project.

We appreciate the opportunity to assist you with this project. If you have any questions, or if we may be of further service to you, please call us.

Respectfully submitted,
TSI GEOTECHNICAL, INC.

STATE OF MISSOURI
JAMES A. JACOBE
NUMBER PE-2015017008
PROFESSIONAL ENGINEER
5/13/16

Denise Hervey /JAJ 5/13/16

Jim Jacobe, PE
Project Manager

Denise B. Hervey, PE
Principal

CONTENTS

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING EVALUATION
KENNETH ROAD BRIDGE REPLACEMENT
KANSAS CITY, MISSOURI

1.0 SCOPE OF SERVICES

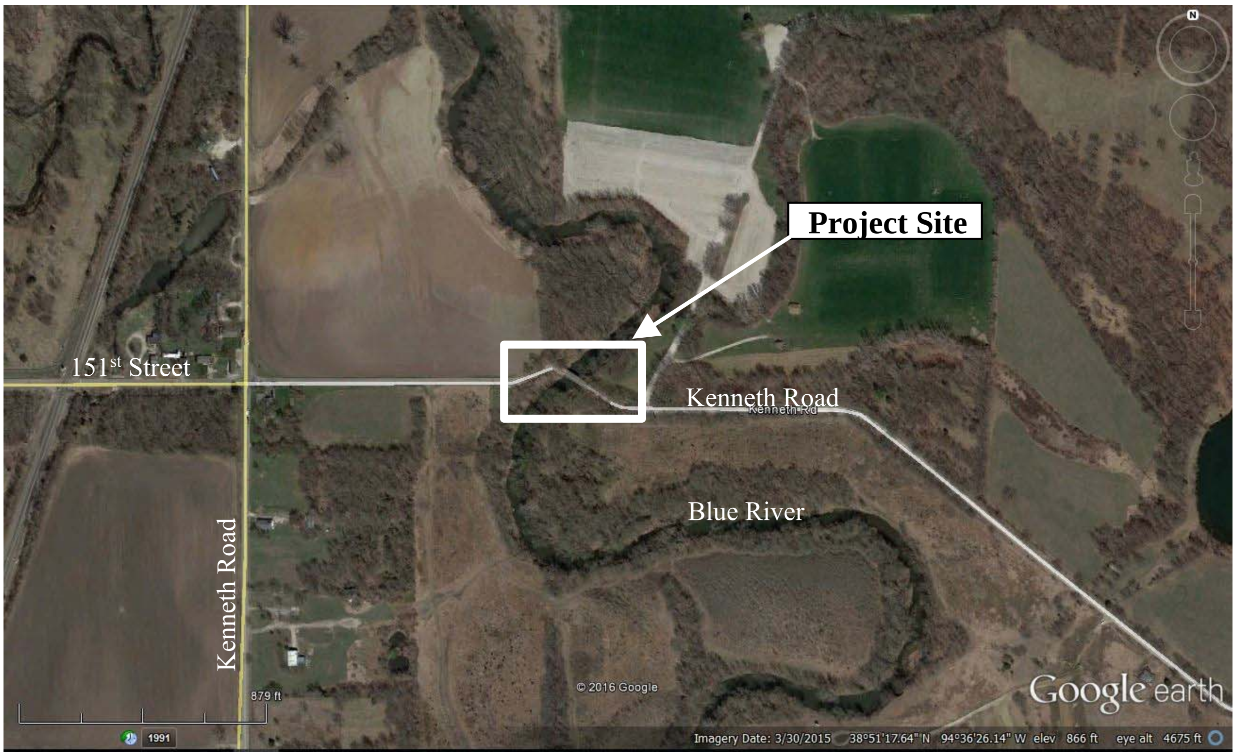
This report summarizes the results of a geotechnical study performed for the proposed replacement of the Kenneth Road Bridge over Blue River in Kansas City, Missouri and Overland Park, Kansas. The study was performed in general accordance with TSi's proposal to SKW, dated December 23, 2014, which identified the following items for inclusion in this study report:

- Subsurface conditions at the boring locations;
- Laboratory test results;
- Influence of groundwater on the project;
- Pavement subgrade recommendations;
- Recommendations for fill materials, placement, and compaction;
- Slope stability recommendations;
- Foundation recommendations for the bridge structure; and,
- Seismic site classification per MoDOT guidelines.

2.0 SITE AND PROJECT DESCRIPTIONS

The existing bridge is located along West Kenneth Road near the Kansas and Missouri State Line. The existing bridge is currently closed to traffic over the Blue River. The project will include the replacement of the existing bridge and the realignment of Kenneth Road.

The general location of the project site is shown below. The Site and Boring Location Plan, Figure 1 in Appendix A, provide a more detailed plan of the project area.



3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

TSi conducted an exploration program from December 11, 2015 to December 16, 2015 consisting of ten soil borings designated as Borings B-01 to B-10. The logs from this exploration are included in Appendix B. The approximate locations of the borings are indicated on the Site and Boring Location Plans, Figure 1 in Appendix A. The boring locations were selected by SKW and staked in the field by the project surveyor prior to TSi mobilization.

All of the borings were drilled using a CME-550 ATV-mounted drill rig to advance hollow stem auger drilling tools to the requested depth or auger refusal. A geotechnical specialist from TSi directed the exploration procedures in the field, maintained a field log of the conditions encountered in the borings, and collected and classified the samples recovered. Split-spoon samples were recovered from the borings using a 2-inch outside-diameter, split-barrel sampler, driven by an automatic hammer in accordance with ASTM D 1586. The split-spoon samples were placed in plastic bags for later testing in the laboratory. Three-inch Shelby tube samples were obtained in accordance with ASTM D 1587. The Shelby tube samples were preserved by sealing the entire sample in the tube. Borings were backfilled with auger cuttings and the pavement replaced with quick setting concrete. Any excess cuttings were removed from the site.

Borings B-02, -04,-06, and -07 were advanced below auger refusal, and 10 to 30 feet of the underlying rock was sampled using NX size diamond-bit rock coring methods. The rock core recovered was placed in a cardboard box and taken to the laboratory for examination and testing. Percent recovery and Rock Quality Designation (RQD) values were calculated for each rock core sample and are noted on the boring logs. The RQD is the percentage of the total length of rock cored that consists of sound pieces that are a minimum of 4.0 inches in length. The RQD is a general indication of the integrity of the in-situ rock mass. Based on RQD, rock quality can be described as excellent (90 to 100), good (75 to 90), fair (50 to 75), poor (25 to 50), or very poor (0 to 25). TSi photographed the rock core samples and have included the photographs in Appendix D of this report.

The results of the field tests and measurements were recorded on field logs and appropriate data sheets by TSi's geotechnical specialist. Those data sheets and logs contain information concerning the exploration methods, samples attempted and recovered, indications of the presence of various subsurface materials, and the observation of groundwater. The field logs and data sheets contain the engineer's interpretations of the conditions between samples, based on the performance of the exploration equipment and the cuttings brought to the surface. The final logs included in this report were based on the field logs, modified as appropriate based on the results of laboratory testing of soil samples. A copy of the final logs are included in Appendix B.

3.2 Laboratory Testing

A laboratory testing program was conducted by TSi to determine selected engineering properties of the obtained soil samples. The following laboratory tests were performed on the samples recovered from the borings:

- Visual description by color and texture of each sample (ASTM 2488);
- Natural moisture content of each sample (ASTM D 2216);
- Atterberg limits on selected cohesive samples (ASTM D 4318);
- Grain size analysis using hydrometer of selected granular samples (ASTM D 422);
- Unit weight on selected cohesive samples (ASTM D 7263);
- Unconfined compression on selected cohesive samples (ASTM D 2166);
- Direct shear (ASTM D 698);
- Standard Proctor compaction of selected samples (ASTM D 698); and
- California Bearing Ratio (CBR) (ASTM D 1883).

The results of select laboratory tests are summarized on the Boring Logs. Results of the standard Proctor, CBR, direct shear, and sieve analyses are included in Appendix C. The analyses and conclusions contained in this report are based on field and laboratory test results and on the interpretations of the subsurface conditions as reported on the logs. Only data pertinent to the objectives of this report have been included on the logs; therefore, these logs should not be used for other purposes.

4.0 SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered at the boring locations are shown on the logs in Appendix B. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at these locations on the dates shown; the reported conditions may be different at other locations or at other times.

4.1 GENERALIZED SUBSURFACE PROFILE

Four borings were drilled on the west side of the bridge, with six borings being drilled on the east side. Borings B-01, -02 and -07 encountered asphaltic concrete pavement at the surface. Beneath the pavement, borings B-01 and B-02, encountered lean to fat clay (CL or CH, in accordance with the Unified Soil Classification System) to depths of 19.0 feet. Borings B-03 and B-04 encountered fill at the surface, consisting of gravel and sand with varying amounts of clay which continued to a depth of approximately 19.0 feet. Underlying the fill, lean clay was encountered to an approximate depth of 23.0 feet. Borings B-05, -06, -08, -09, and -10 encountered clayey soils with organics at the surface, and underlying the surficial soils lean clays with varying amounts of sand and gravel were encountered to depths ranging from 15.0 to 17.0 feet. All borings encountered bedrock at depths ranging from 15.0 to 23.5 feet. Borings on the east side of Blue River encountered lean clay underlying surface top soil or asphaltic concrete, the clay continued to depths of 15.0 to 18.0 feet.

The standard penetration test (N) values in the clay ranged from weight of hammer to 10 blows per foot (bpf). Moisture content of the clay ranged from 22% to 37%. Atterberg limits tests on samples of clay resulted in liquid limits (LL) of 38 to 51, and plasticity indexes (PI) of 23 to 37. Dry unit weights of the clay range from 84 to 103 pounds per cubic feet (pcf). Undrained shear strengths of the clay range from 0.14 to 0.74 tons per square feet (tsf). N values in the fill ranged from 10 to 16 bpf. Moisture content of the fill ranged from 2% to 9%.

Two standard penetration tests were performed in shale with values of 39 and 40 bpf. Limestone and shale bedrock was encountered in all borings except B-08 and B-10. Limestone encountered was moderately hard to hard, and moderately to slightly weathered, with intermitted shale bands of varying thickness. Shale encountered was moderately weathered, and moderately hard. Table 1 below contains the apparent depth and elevation where bedrock was first encountered as well as the depth and elevation of auger refusal. Approximately 10 feet of bedrock core was recovered from borings B-02 and B-07, and approximately 30 feet of bedrock core was recovered from borings B-04 and B-06. Recoveries in the bedrock cored ranged from 96 to 100%. Rock Quality Designation (RQD) of the bedrock cored ranged from 85 to 100%.

TABLE 1.
BEDROCK AND AUGER REFUSAL DEPTHS AND ELEVATIONS

Boring Location	Bedrock Depth (ft.)	Bedrock Elevation (ft.)	Auger Refusal Depth (ft.)	Auger Refusal Elevation (ft.)
B-01	19.0	852.9	22.5	849.4
B-02	19.0	851.9	22.0	848.9
B-03	23.5	847.9	24.0	847.4
B-04	22.8	847.1	22.8	847.1
B-05	16.0	848.5	16.0	848.5
B-06	15.5	848.0	15.5	848.0
B-07	18.5	850.4	18.5	850.4
B-08	15.0	850.5	15.0	850.5
B-09	15.5	852.3	16.0	851.8
B-10	17.0	851.8	17.0	851.8

Three pavement cores, B-01, -02, and -07 are summarized in Table 2 below. All cores were drilled in the roadway. Photographs of the pavement cores are included in Appendix D.

TABLE 2.
PAVEMENT THICKNESS

Boring Location	Asphalt (in)
B-01	9.5
B-02	10.8
B-07	7.5

4.2 GROUNDWATER

Groundwater was observed in all borings except B-06 during drilling. Table 3 below lists the groundwater depths and elevations observed while drilling. The presence or absence of groundwater at a particular location does not necessarily mean that groundwater will be present or absent at that location at other times. Seasonal variations, water levels in the adjacent Blue River, and other unknown considerations will cause fluctuations in water levels and the presence of water in the soils.

TABLE 3.
GROUNDWATER DEPTH AND ELEVATION

Boring Location	Groundwater Depth (ft.)	Groundwater Elevation (ft.)
B-01	17.5	854.4
B-02	16.5	854.4
B-03	17.5	853.9
B-04	17.0	852.9
B-05	12.5	852.0
B-06	NE	NE
B-07	16.0	852.9
B-08	12.0	853.5
B-09	13.5	854.3
B-10	14.0	854.8

NE = Not Encountered

5.0 ENGINEERING ASSESSMENTS AND RECOMMENDATIONS

5.1 DRIVEN STEEL PILES

TSi understands that the abutments of the replacement bridge may be supported on steel H piles driven to practical refusal on bedrock. The capacity of piles driven to practical refusal in limestone will be controlled by the structural capacity of the pile. Table 4 presents structural capacities of common pile sections as presented in the MoDOT EPG 751.36.3:

TABLE 4.
STRUCTURAL STEEL HP PILE CAPACITIES

Section	End Area (in2)	GRADE 50		GRADE 36	
		Structural Nominal Resistance (kips)	Structural Factored Compression Resistance (ϕ=0.5) (kips)	Structural Nominal Resistance (kips)	Structural Factored Compression Resistance (ϕ=0.5) (kips)
HP 10x42	12.4	620	310	446	220
HP 12x53	15.5	775	380	558	275
HP 14x73	21.4	1070	535	770	385

Based on previous experience, we expect that all of the H-piling will penetrate through the on-site soils and weathered bedrock and achieve refusal in the less weathered portions of the underlying bedrock. We anticipate pile tip elevations will vary from approximately 846.0 to 848.5 feet across the bridge. Piles installed with a minimum center-to-center spacing of three diameters do not require a reduction in individual axial pile capacity due to group action.

For pile groups, a spacing of at least three pile diameters, center-to-center, is recommended so that the axial capacity of the pile group will be equivalent to the sum of the individual pile capacities. A minimum pile length of 10 feet is required below the bottom of the pile cap or below the natural ground surface, whichever is lower.

Pile driving resistance should be closely monitored. We recommend PDA testing of the piles. If PDA testing is not performed, TSi should be notified to provide driving criteria based on project specific hammer and cap properties. Because the piling will be driven into bedrock, we recommend driving the piling with protective points to reduce the potential for damage to the pile during driving.

The structural loads will result in some compression of the bedrock beneath the driven piles. Based on the general character of bedrock on the site and assuming the foundations are properly installed, the maximum anticipated settlement of these foundations due to the structural loads should be less than 0.5 inch, not including elastic settlement of the steel pile itself. Differential settlements across the structure should be less than 0.3 inch. The majority of this settlement should take place during construction as the structural loads are applied to the foundations.

5.2 FOUNDATION – DRILLED SHAFTS

TSi understands that the bents may be supported by drilled shafts. TSi anticipates that little or no grading will be performed adjacent to the abutment locations. As such, downdrag loading has not been considered.

Based on the MoDOT EPG 751.37, drilled shafts in the limestone can be supported by a combination of side-friction and end-bearing resistance. Table 5 below summarizes the factored geotechnical resistances that could be used for proportioning the abutments and intermediate bent drilled shafts for this project. Per MoDOT standards, tip resistance is based on strength of rock extending twice the shaft diameter below the tip of the shaft. Resistance factors are based on a component of resistance, strength of material and testing method as outlined in the MoDOT EPG 751.37. Resistance factors are also based on the number of field or laboratory tests performed and a structure classification of "Bridges on Major Roads."

TABLE 5
DRILLED SHAFT DESIGN PARAMETERS

Material	End Bearing Resistance (ksf)		Side Resistance (ksf)	
	Nominal	Factored	Nominal	Factored
Fill/Clay	N/A	N/A	N/A	N/A
Shale (avg q_u = 319 ksf)	N/A	N/A	17.0	5.9 (ϕ=0.35)
Limestone (avg q_u = 517 ksf)	78.5	33.8 (ϕ=0.43)	21.6	9.9 (ϕ=0.46)

ksf = kips per square foot

Each shaft should be cast the same day it is completed and approved. The base of each shaft should be cleaned of loose rock or soil material using a cleanout bucket. The shaft should continually be pumped as necessary to prevent the accumulation of water. No more than one inch of water accumulation on the shaft base should be allowed at the time of concrete placement.

The design capacity of drilled shafts is intimately tied to installation procedures and observations during construction. Drilled shafts should be installed in accordance with the latest version of Section 701 of the Missouri Standard Specification for Highway Construction. TSi should be retained to review the plans and specifications related to drilled pier construction, especially the estimation of bearing elevations in bid-issue drawings. It is considered essential that a representative of TSi be on-site during all phases of drilled shaft construction. The drilled shaft construction should be performed by an experienced, knowledgeable contractor, familiar with the subsurface conditions in the area of the project site. Rock bits or core barrels will be required to continue the pier excavations into the harder shale and limestone units.

5.3 DEEP FOUNDATION LATERAL LOADS

The lateral load capacity of the drilled shafts and steel H piles will vary based on the dimensions, depth to bedrock, and condition of the bedrock. Foundations subjected to lateral loads should be designed and analyzed for lateral deflection using the LPILE Version 6 computer program by Ensoft, Inc., or an equivalent program. This program analyzes pile deflection as a function of the design loads, foundation properties and subsurface conditions.

Recommended parameters for use in the evaluation of lateral load capacity and deflection are presented in Table 6. Based on the commentary for EPG 751.37.5, TSi understands that probabilistic calibrations for laterally loaded foundations have not been completed at this time. As such, the values provided herein are based on our analysis of the existing subsurface conditions and were estimated, or calculated, based on generally accepted engineering correlations. The lateral design parameters below assume that no interaction of loading will occur between the drilled shafts or H-pile foundations. This condition can be achieved if the foundations are spaced at least 3 diameters apart (center-to-center spacing) in a direction perpendicular to the applied loading and at least 7 diameters apart (center-to-center spacing) in a direction parallel to the applied loading. If the foundations are more closely spaced than this, then a reduction in the lateral design parameters would apply.

TABLE 6
LPILE PARAMETERS

Material	L-PILE Material Type [Note 1]	Effective Unit Weight [Note 2] γ', pcf	Undrained Cohesion psf	Effective Angle of Internal Friction ϕ' degrees	Soil Modulus Parameter k, pci	E_{50} Value [Note 3]
Soft Clay / Existing Fill	1	120 (55)	250	N/A	N/A	0.02
Stiff Clay	3	125 (60)	700	N/A	500	0.007
Highly Weathered Shale (N≤50)	9	130 (65)	3,000	N/A	2,000	0.0005
Shale Bedrock	9	135 (70)	N/A	N/A	N/A	q_u = 500 psi RQD = 80% E_r = 25,000 psi K_rm = 0.0005
Limestone Bedrock	6	140 (75)	N/A	N/A	N/A	q_u = 1,500 psi

[1] Material Type: 1 = Soft Clay, 3 = Stiff Clay, 9 = Weak rock
[2] Use first value above water table and value in parentheses below water table.
[3] Version 6 of LPILE requires input of unconfined compressive strength (q_u), Young's Modulus (E_r), K_rm and RQD, for weak rock models.

5.4 Slope Stability

Global stability analysis was performed for the banks at the bridge abutments. The slope stability analysis was based on borings located near the east bank of the Blue River. The analysis was performed with SLOPE/W using an allowable stress design (ASD) method where a factor of safety (FS) greater than 1.3 is generally considered acceptable for long term, drained conditions, and a FS less than 1.0 is generally considered unstable. Analysis was performed on a 2.5 Horizontal to 1 Vertical (2.5H:1V) slope to evaluate what effect a 5-foot thick rip rap blanket would have on the stability of the slope. The results of the analysis indicated a FS of 1.302. Figure 2, located in Appendix A, illustrates the results of our global stability analysis.

5.5 Swelling Clay Considerations

High plasticity (fat) clay soils will likely be exposed during excavation at the site. The fat clay is of concern with regard to its potential for volume change. This concern applies to this material whether it is in its natural condition or used as fill material. This material tends to swell when it absorbs water and to shrink when it dries out. Some relatively simple design and construction considerations are recommended that will help to maintain the natural moisture content of the fat clays. Avoiding conditions that could result in excessive wetting or drying of the fat clay will reduce its potential for volume change. The following design and construction precautions are recommended:

1. Fat clay material should not be used as fill within 18 inches of the pavement section.
2. Fat clay used as fill should be placed and compacted wet of its optimum moisture content, as discussed in Section 6.4 of this report.
3. Positive surface drainage should be provided during and after construction to prevent ponding of water in and around any exposed subgrade and finished pavements.

5.6 Pavement Design

TSi recommends a well-graded aggregate base, such as MoDOT Type 5, directly underlying the pavements with a minimum thickness of 6 inches.

A California Bearing Ratio (CBR) test of the native soil was conducted on a combined sample of subgrade soil from 0 to 2 feet across the site. This test resulted in a CBR of 3.2. The CBR test results are included in Appendix C of this report. Based on the general character of the on-site subsurface conditions and assuming a properly prepared subgrade, a CBR value of 2.5 is considered appropriate for use in designing the flexible pavement sections for the site.

Rigid pavement design can be based on a modulus-of-subgrade reaction (k) of 75 pounds per cubic inch (pci) for the subgrade. These values for rigid and flexible pavement design are based on the requirement that the pavement subgrade is prepared in accordance with the recommendations provided in this report.

5.7 Seismic Site Classification

Based on MoDOT EPG Figure 751.9.1.3.3, the project site is located within Seismic Performance Category (SPC) “A”. As such, the soils at the site are not considered susceptible to liquefaction or substantial settlement or loss in strength when subject to the design earthquake loading. The seismic analysis and design procedures outlined in MoDOT EPG 751.9.1 are not required for this project.

6.0 Site Preparation and Excavation Considerations

6.1 Subgrade Preparation

Construction areas should be stripped of existing pavement, organic soil, and any deleterious materials prior to site excavation and grading. Care should be taken during stripping to prevent excessive disturbance of the underlying soil. After the removal of these materials, and where further excavation is not required, the exposed subgrade should be proofrolled. Proofrolling is accomplished by passing over the subgrade with proper equipment, such as a loaded tandem-axle dump truck or scraper, and observing the subgrade for pockets of excessively soft, wet, disturbed, or otherwise unsuitable soils. Any unacceptable materials thus found should be excavated and either recompacted or replaced with new structural fill.

Prior to placing fill in any area, the subgrade should be scarified to a depth of about 6 inches, the moisture content adjusted to near its optimum moisture content, and the subgrade recompacted in accordance with recommendations made in subsequent sections of this report. The recommended proofrolling and/or scarification and recompaction may be waived if, in the opinion of a geotechnical engineer, this procedure would be detrimental or unnecessary. Following satisfactory preparation of the subgrade, controlled fill material may be placed.

6.2 Subgrade Protection

Construction areas should be properly drained in order to reduce or prevent surface runoff from collecting on the exposed subgrade. Any ponded water on the exposed subgrade should be removed immediately. Temporary stormwater swales and collection areas may be required to control surface water flow into low areas of the site.

To prevent unnecessary disturbance of the subgrade soils, heavy construction vehicles should be restricted from traveling through the finished subgrade. If areas of disturbed subgrade develop, they should be properly repaired in accordance with the recommendations in this report.

The clay soils present at the site are highly susceptible to disturbance from construction traffic, especially during rainy weather. Consideration should be given to leaving cut areas 1 to 2 feet higher than planned subgrade until immediately before paving operations are planned. The extra material that is left in place would protect the final subgrade from disturbance.

Immediately prior to construction of the pavement, it is recommended that the exposed subgrade be evaluated to determine whether moisture contents are within the recommended range and to identify areas disturbed by construction operations. Moisture conditioning of wet or dry areas is recommended prior to construction of the pavement section. Areas disturbed by construction traffic should be reworked.

6.3 Fill and Backfill Materials

In general, fills should consist of low to moderate plasticity clay or well-graded granular materials with a maximum particle size of 1.5 inches. Some of the clays present on the site have moderate plasticity, but there is no practical method of classifying and separating this material during construction. However, the soils encountered in the borings are suitable for use in the deeper fill areas except within 18 inches of the pavement section. Fill materials from off-site sources should be approved prior to their use. Soil with decayable material such as wood, trash, metal, or vegetation is typically not acceptable.

Some of the fill material may require the addition of moisture prior to compaction. This should be performed in a controlled manner using a tank truck with a spray bar, and the moistened soil should be thoroughly blended with a disk or pulverizer to produce a uniform moisture content. Repeated passages of the equipment may be required to achieve a uniform moisture content. If fill is placed during the winter season, fill materials should be carefully observed to see that no ice or frozen soils are placed as fill or remain in the base materials upon which fill is placed.

Some of the fill material may require moisture reduction prior to compaction. During warm weather, moisture reduction can generally be accomplished by disking, or otherwise aerating the soil. When air-drying is not possible, a moisture-reducing chemical additive, such as lime or Class C fly ash, may be used as a drying agent.

6.4 Fill and Backfill Placement

Cohesive fill should be compacted to a dry density of at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the soil. Granular material, such as crushed limestone, placed for structure or pavement support, should be compacted to at least 100% of the standard Proctor maximum dry density. The moisture content of low plasticity clay or granular fill at the time of compaction should be within ±2% of the optimum moisture content of the material as determined by the standard Proctor compaction test. The moisture content of moderate to high plasticity clay fill materials should be from the optimum moisture content to 4% above optimum. Fill should be placed in loose lifts not in excess of 8 inches thick, and compacted to the aforementioned criterion. However, it may be necessary to place fill in thinner lifts to achieve the recommended compaction when using small hand-operated equipment.

7.0 Construction Observation and Testing

It is recommended that TSi be retained during construction to perform testing and observation services for the following items:

- observation and documentation of the exposed soil after stripping existing pavements and/or topsoil during scarification, compaction, and proofrolling;
- observation and documentation of the installation of foundation elements;
- testing of asphalt and concrete materials used for paving and structures; and
- placement and compaction of fill materials.

These Quality Assurance services should help verify the design assumptions and maintain construction procedures in accordance with the project plans, specifications, and good engineering practice.

8.0 Report Limitations

This geotechnical report has been prepared for the exclusive use of **Shafer, Kline & Warren, Inc.** for the specific application to the subject project. The information and recommendations contained in this report have been made in accordance with generally accepted geotechnical and foundation engineering practices; no other warranties are implied or expressed.

The assessments and recommendations submitted in this report are based in part upon the data obtained from the borings. The nature and extent of variations between the borings may not be evident at this time. If variations appear evident at a later date, it may be necessary to re-evaluate the recommendations of this report.

We emphasize that this report was prepared for design purposes only and may not be sufficient to prepare an accurate construction bid. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design purposes.

If conditions at the site have changed due to natural causes or other operations, this report should be reviewed by TSi to determine the applicability of the analyses and recommendations considering the changed conditions. The report should also be reviewed by TSi if changes occur in the structure location, size, and type, in the planned loads, elevations, grading and site development plans or the project concepts.

TSi requests the opportunity to review the final plans and specifications for the project prior to construction to verify that the recommendations in this report are properly interpreted and incorporated in the design and construction documents. If TSi is not accorded the opportunity to make this recommended review, we can assume no responsibility for the misinterpretation of our recommendations.

APPENDIX A

Site and Boring Location Plan

Legend

◉ Core Location

Figure 1, Site and Core Location Plan	Project No. 20152024
Kenneth Road Bridge Kansas City, Missouri	TSI
Approved by: JJ	

APPENDIX B

Boring Logs
General Notes
Unified Soil Classification System

LOG OF BORING NO. B-01

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **871.9**
Location: **Northing: 978906.34**
Easting: 2758122.67

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Asphaltic concrete (9.5")										
				Poorly graded gravel (GP)										
				Gray and brown, fat CLAY (CH)										
		ST-1			94			1.75	0.42	100	23	51	14	37
5														
		ST-2			67			0.75	0.74	103	24			
10														
		SS-3		- silty below 13.5 ft.	100		2 2 2	0.50			26			
15				Gray, shaley, lean CLAY (CL)										
				▽										
		SS-4		SHALE, gray, clayey	100		7 13 26	>4.5			22			
20														
				Boring terminated at 22.5 ft.										
25														

Completion Depth: 22.50
Date Boring Started: 12/15/15
Date Boring Completed: 12/15/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 17.5 ft. during drilling. Offset 7.5 ft. north from B-01 because of guardrail. Auger refusal at 22.5 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-02

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **870.9**
Location: **Northing: 978935.47**
Easting: 2758146.89

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Asphaltic concrete (8.0")										
				Brown and gray, lean CLAY (CL)										
5		SS-1			67		3 4 5	2.50			22			
10		ST-2			83			0.50	0.48	100	24			
15		ST-3			83			0.50	0.53	99	26	40	14	26
				▽										
				Gray, shaley, lean CLAY (CL)										
20		SS-4		SHALE, clayey, gray	100		7 16 24	>4.5			24			
		RUN1		SHALE, dark gray to gray, moderately hard, moderately to slightly weathered, thin to thick bedded - 0.5" shaley clay seam at 22.2 ft.	99	90								
25														

Completion Depth: 32.00
Date Boring Started: 12/15/15
Date Boring Completed: 12/15/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 16.5 ft. during drilling. Auger refusal at 22.0 ft.

KC LOG WITH LAB GINT KENNETH ROAD BRIDGE.GPJ 5/13/16

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

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LOG OF BORING NO. B-02

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **870.9**
Location: **Northing: 978935.47**
Easting: 2758146.89

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		RUN2		LIMESTONE, gray, moderately hard to hard, slightly weathered, fine crystalline, medium to thin bedded, with intermittent layers of shale, calcareous, medium to dark gray, moderately hard, slightly weathered, thin bedded to banded *(continued)*	99	99								
30														
				Boring terminated at 32.0 ft.										
35														
40														
45														
50														

Completion Depth:	32.00
Date Boring Started:	12/15/15
Date Boring Completed:	12/15/15
Engineer/Geologist:	FH
Project No.:	20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 16.5 ft. during drilling. Auger refusal at 22.0 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-03

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **871.4**
Location: **Northing: 978897.07**
Easting: 2758154.95

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Gravel with sand (FILL)										
5		SS-1			56		6 7 9				8			
10		SS-2		- trace clay below 8.5 ft.	44		2 5 5				9	30	14	16
15		SS-3		- trace sand below 13.5 ft.	17		16 8 4				2			
				∇ (17.5 ft.)										
20		SS-4		Dark brown and gray, silty, lean CLAY (CL)	67		WOH WOH WOH	0.50			26			
		SS-5		SHALE, gray, clayey	83		50/2"	>4.5			23			
25				Boring terminated at 24.0 ft.										

Completion Depth: 24.00
Date Boring Started: 12/15/15
Date Boring Completed: 12/15/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 17.5 ft. during drilling. Offset 9.0 ft. north-northwest from B-03 because of top of rock. Auger refusal at 24.0 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-04

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **869.9**
Location: **Northing: 978924.35**
Easting: 2758488.82

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Gravel with sand (FILL)										
5		SS-1			50		5 6 6				7			
10		SS-2			44		6 5 5				7			
15		SS-3			50		11 9 2				3			
17				▽ (groundwater)										
18.5		SS-4		Brown and gray, lean, silty CLAY (CL)	72		1 2 2	<0.25			30	38	13	25
22.8				- shaley below 22.8 ft.										
23.3		RUN1		LIMESTONE, gray, hard, slightly weathered, very fine crystalline, medium bedded	98	94								
25														

Completion Depth:	53.00
Date Boring Started:	12/16/15
Date Boring Completed:	12/16/15
Engineer/Geologist:	FH
Project No.:	20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 17.0 ft. during drilling. Offset 16.0 ft. south-southwest from B-04. Auger refusal 22.8 ft.

The stratification lines represent approximate strata boundaries. In situations, the transition may be gradual.

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LOG OF BORING NO. B-04

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **869.9**
Location: **Northing: 978924.35**
Easting: 2758488.82

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				SHALE, Dark gray, moderately hard, aphanite										
		RUN2		LIMESTONE, gray, hard, slightly weathered, very fine crystalline, medium to thin bedded - 1" shaley clay seam at 25.4 - with intermittent bands of calcareous shale below 27 ft.	100	86								
30														
		RUN3			100	100								
35				LIMESTONE, light gray, hard, slightly weathered, very fine crystalline, medium bedded - 2" gray shaley clay seam at 36.6 ft.										
		RUN4			100	94								
40				- 0.25" shale seam, dark gray at 39.6 ft.										
		RUN5		- 4.5" shale seam, dark gray, medium hard at 42.4 ft.	100	92								
45				- 6" clayey shale seam, dark gray, soft at 45.5 ft.										
		RUN6			98	97								
50														

Completion Depth: 53.00
Date Boring Started: 12/16/15
Date Boring Completed: 12/16/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 17.0 ft. during drilling. Offset 16.0 ft. south-southwest from B-04. Auger refusal 22.8 ft.

The stratification lines represent approximate strata boundaries. In situations, the transition may be gradual.

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LOG OF BORING NO. B-04

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **869.9**
Location: **Northing: 978924.35**
Easting: 2758488.82

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				SHALE, medium to dark gray, moderately hard, slightly weathered, thin bedded to banded *(continued)*										
				Boring terminated at 53.0 ft.										
55														
60														
65														
70														
75														

Completion Depth: 53.00
Date Boring Started: 12/16/15
Date Boring Completed: 12/16/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 17.0 ft. during drilling. Offset 16.0 ft. south-southwest from B-04. Auger refusal 22.8 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-05

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **864.5**
Location: **Northing: 978870.13**
Easting: 2758286.54

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Brown, lean CLAY, with trace roots and organics										
				Dark brown, lean CLAY (CL), trace organics										
		ST-1			48			0.25	0.32	91	28			
5														
		ST-2			65			0.25	0.35	88	31			
10														
		ST-3			60				0.19	83	38	47	19	28
			∇											
				- with weathered limestone below 14.0 ft.										
15														
				LIMESTONE, gray, weathered										
				Boring terminated at 16.0 ft.										
20														
25														

Completion Depth:	16.00
Date Boring Started:	12/15/15
Date Boring Completed:	12/15/15
Engineer/Geologist:	FH
Project No.:	20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 12.5 ft. during drilling. Offset 8..0 ft. east-southeast from B-05 due to access. Auger refusal at 16.0 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-06

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **863.5**
Location: **Northing: 978902.55**
Easting: 2758315.60

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Brown, lean CLAY with roots and trace organics										
				Brown, lean CLAY (CL), trace organics										
4.5	SS	SS-1			44		4 4 4	3.00			15			
8	ST	ST-2		- dark brown below 8 ft.	83			0.75	0.37	85	34			
13	ST	ST-3		- gray below 13.0 ft.	42				0.14	84	33			
15.5				LIMESTONE, gray, medium hard, slightly weathered, fine crystalline, medium bedding										
				SHALE, calcareous, gray to dark gray, moderately hard, moderately weathered, thin to medium bedded										
	Core	RUN1			100	96								
				LIMESTONE, gray, hard, slightly weathered - 0.5" shale seam at 18.4 ft.										
				LIMESTONE, medium to dark gray, with intermittent seams of calcareous shale, slightly weathered, medium to thin bedded										
	Core	RUN2			100	93								
25														

Completion Depth: 45.50
Date Boring Started: 12/14/15
Date Boring Completed: 12/15/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater not observed during drilling. Offset 12.5 ft. northeast from B-06. Auger refusal at 15.5 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

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LOG OF BORING NO. B-06

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **863.5**
Location: **Northing: 978902.55**
Easting: 2758315.60

Depth, feet	Sample #	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
	RUN3	LIMESTONE, medium to dark gray, with intermittent seams of calcareous shale, slightly weathered, medium to thin bedded *(continued)*	100	88								
30												
	RUN4		98	98								
35		SHALE, dark gray										
	RUN5	LIMESTONE, gray, hard to moderately hard, slightly weathered, fine crystalline, thin to medium bedded, trace shale - shale seam at 38.3 ft.	100	85								
		SHALE, dark gray, moderately hard										
40		LIMESTONE, gray, weathered - shale seam, gray, hard at 39.7 ft.										
	RUN6	SHALE, dark gray, moderately hard - limestone seam at 42.1 ft.	98	92								
45		Boring terminated at 45.5 ft.										
50												

Completion Depth: 45.50
Date Boring Started: 12/14/15
Date Boring Completed: 12/15/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater not observed during drilling. Offset 12.5 ft. northeast from B-06. Auger refusal at 15.5 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-07

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **868.9**
Location: **Northing: 979946.46**
Easting: 2758377.01

Depth, feet	Sample #	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0		Asphatlic Concrete (7.5")										
		Brown, lean CLAY (CL)										
5	ST-1		92			1.50	0.45	99	25	46	19	27
10	ST-2		71			0.75	0.37	89	30			
15	SS-3	- sandy below 13.5 ft. - gray below 14.4 ft.	100		1 2 1				31			
		∇ (groundwater, 16.0 ft.)										
	SS-4	LIMESTONE, light gray, hard, slightly weathered, trace fossils and shale seams	83		50/1"				12			
20	RUN1		96	96								
		SHALE, gray, moderately hard, slightly weathered, sandy										
		LIMESTONE, gray, hard, slightly weathered - with shale seams below 21.8 ft. - 2" pitting at 22.0 ft.										
	RUN2	- 2" soft shale seam at 23.6 ft.	98	98								
25												

Completion Depth: 28.50
Date Boring Started: 12/11/15
Date Boring Completed: 12/11/15
Engineer/Geologist: JAK
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 16.0 ft. during drilling.

The stratification lines represent approximate strata boundaries. In situations, the transition may be gradual.

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LOG OF BORING NO. B-07

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **868.9**
Location: **Northing: 979946.46**
Easting: 2758377.01

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
		RUN3		LIMESTONE, gray, hard, slightly weathered*(continued)*	100	100								
				Boring terminated at 28.5 ft.										
30														
35														
40														
45														
50														

Completion Depth:	28.50
Date Boring Started:	12/11/15
Date Boring Completed:	12/11/15
Engineer/Geologist:	JAK
Project No.:	20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 16.0 ft. during drilling.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-08

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **865.5**
Location: **Northing: 978871.38**
Easting: 2758398.13

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
				Brown, lean CLAY with roots and trace organics										
				Brown, lean CLAY (CL)										
5		SS-1			78		2 2 3	0.75			30			
10		ST-2			79			<0.25	0.22	90	33	40	17	23
				▽										
		ST-3		Gray, lean CLAY (CL) with gravel	58						37			
15				Boring terminated at 15.0 ft.										
20														
25														

Completion Depth: 15.00
Date Boring Started: 12/15/15
Date Boring Completed: 12/15/15
Engineer/Geologist: FH
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 12.0 ft. during drilling. Auger refusal at 15.0 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-09

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX

Surface El.: **867.8**
Location: **Northing: 978821.10**
Easting: 2758481.48

Depth, feet	Samples	Sample #	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0–1.5			Brown, lean CLAY with roots and trace organics										
1.5–10			Brown, lean CLAY (CL)										
3.5–5	SS	SS-1		44		2 3 2				27			
8–10	ST	ST-2		79			0.50	0.41	96	28	42	17	25
10–15.5			Gray, sandy lean CLAY (CL), wih coarse gravel										
13.5			▽										
13.5–15	SS	SS-3		100		1 3 7				33			
15.5–16			LIMESTONE, gray, weathered										
16.0			Boring terminated at 16.0 ft.										

Completion Depth: 16.00
Date Boring Started: 12/11/15
Date Boring Completed: 12/11/15
Engineer/Geologist: JAK
Project No.: 20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 13.5 ft. during drilling. Auger refusal at 16.0 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

LOG OF BORING NO. B-10

Project Description: **Kenneth Road Bridge**
Kansas City, MO

TSi Geotechnical
8248 NW 101st Terrace, #5
Kansas City, MO 64153
(816) 599-7965 (816) 599-7967 FAX
TSi geotechnical, inc.

Surface El.: **868.8**
Location: **Northing: 978845.57**
Easting: 2758501.69

Depth, feet	Samples	Sample #	Graphic Log	MATERIAL DESCRIPTION	Recovery %	RQD	Penetration Blows Per 6 inches	Hand Penetrometer TSF	Undrained Shear Strength, TSF	Unit Dry Weight, lb/cu ft.	Water Content, %	Liquid Limit	Plastic Limit	Plasticity Index
0				Brown, lean CLAY (CL) with roots and trace organics										
				dark brown, lean CLAY (CL)										
5	SS	SS-1			56		1 2 3	0.50			24			
	ST	ST-2			79			0.75	0.41	96	26	46	18	28
10				Brown and gray, lean CLAY, trace sand, trace organics										
15	SS	SS-3		∇	100		1 1 1	0.25			30			
17				Boring terminated at 17.0 ft.										
20														
25														

Completion Depth:	17.00
Date Boring Started:	12/14/15
Date Boring Completed:	12/14/15
Engineer/Geologist:	FH
Project No.:	20152025

Remarks: Boring drilled with CME 550, using HSA and auto SPT. Groundwater observed at 14.0 ft. during drilling. Offset 4.0 ft. west-northwest from B-10 because of refusal. Auger refusal at 17.0 ft.

The stratification lines represent approximate strata boundaries.
In situations, the transition may be gradual.

General Notes

The number of borings is based on: topographic and geologic factors; the magnitude of structure loading; the size, shape, and value of the structure; consequences of failure; and other factors. The type and sequence of sampling are selected to reduce the possibility of undiscovered anomalies and maintain drilling efficiency. Attempts are made to detect and/or identify occurrences during drilling and sampling such as the presence of water, boulders, gas, zones of lost circulation, relative ease or resistance to drilling progress, unusual sample recovery, variation in resistance to driving split-spoon samplers, unusual odors, etc. However, lack of notation regarding these occurrences does not preclude their presence.

Although attempts are made to obtain stabilized groundwater levels, the levels shown on the Logs of Boring may not have stabilized, particularly in more impermeable cohesive soils. Consequently, the indicated groundwater levels may not represent present or future levels. Groundwater levels may vary significantly over time due to the effects of precipitation, infiltration, or other factors not evident at the time indicated.

Unless otherwise noted, soil classifications indicated on the Logs of Boring are based on visual observations and are not the result of classification tests. Although visual classifications are performed by experienced technicians or engineers, classifications so made may not be conclusive.

Generally, variations in texture less than one foot in thickness are described as layers within a stratum, while thicker zones are logged as individual strata. However, minor anomalies and changes of questionable lateral extent may appear only in the verbal description. The lines indicating changes in strata on the Logs of Borings are approximate boundaries only, as the actual material change may be between samples or may be a gradual transition.

Samples chosen for laboratory testing are selected in such a manner as to measure selected physical characteristics of each material encountered. However, as samples are recovered only intermittently and not all samples undergo a complete series of tests, the results of such tests may not conclusively represent the characteristics of all subsurface materials present.

Notation Used on Boring Logs

Approximate Proportions

Trace	<15%
With	15-30%
Modifier	>30%

Clay or clayey may be used as major material or modifier, regardless of relative proportions, if the clay content is sufficient to dominate the soil properties.

Particle Size

Boulders		>12 Inches
Cobbles		12 Inches – 3 Inches
Gravel		
	Coarse	3 Inches – ¾ Inch
	Fine	¾ Inch – No. 4 Sieve (4.750 mm)
Sand		
	Coarse	No. 4 – No. 10 Sieve (2.000 mm)
	Medium	No. 10 – No. 40 Sieve (0.420 mm)
	Fine	No. 40 – No. 200 Sieve (0.074 mm)
Silt		No. 200 Sieve - 0.002 mm
Clay		< 0.002 mm

Penetration – Blows

Number of impacts of a 140-pound hammer falling a distance of 30 inches to cause a standard split-barrel sampler, 1 3/8 inches I.D., to penetrate a distance of 6 inches. The number of impacts for the first 6 inches of penetration is known as the seating drive. The sum of the impacts for the last 12 inches of penetration is the Standard Penetration Test Resistance or "N" value, blows per foot. For example, if blows = 6-8-9, "N" = 8+9 or 17.

Other Notations

Recovery % – length of recovered soil divided by length of sample attempted.

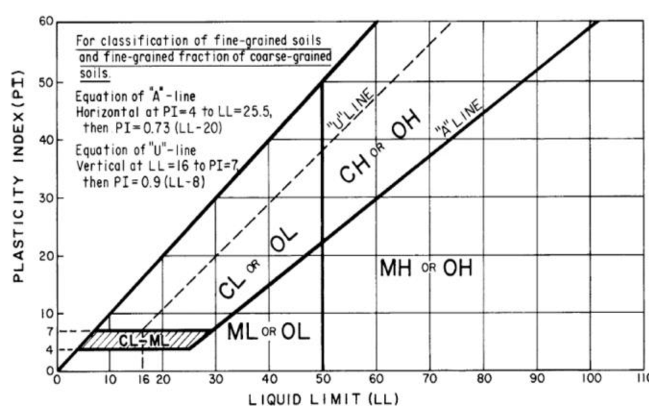
50/2"	Impacts of hammer to cause sampler to penetrate the indicated number of inches
WR	Sampler penetrated under the static loading of the weight of the drill rods
WH	Sampler penetrated under the static loading the weight of the hammer and drill rods
HSA	Hollow stem auger drilling method
FA	Flight auger drilling method
RW	Rotary wash drilling methods with drilling mud
AH	Automatic hammer used for Standard Penetration Test sample
SH	Safety hammer with rope and cathead used for Standard Penetration Test sample

Graphic Symbols

∇	Depth at which groundwater was encountered during drilling
▼	Depth at which groundwater was measured after drilling
⧗	Standard Penetration Test Sample, ASTM D1586
▮	3-inch diameter Shelby Tube Sample, ASTM D1587
G	Sample grabbed from auger
∥	NX Size rock core sample

TSi geotechnical

UNIFIED SOIL CLASSIFICATION SYSTEM, (ASTM D-2487)

Major Divisions			*Group Symbols*		*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (More than half of materials is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-Grained soils are classified as follows: Less than 5 per cent: GW, GP, SW, SP; More than 12 per cent: GM, GC, SM, SC; 5 to 12 per cent: Borderline cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.1. less than 4	Above "A" line with P.1. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line with P.1. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-mix mixtures		Atterberg limits about "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits about "A" line with P.I. greater than 7	
Fine-grained soils (More than half of materials is smaller than No. 200 sieve size)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of medium to high plasticity, organic silts			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			

[a]Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when L.L. is 26 or less and the P.1. is 6 or less; the suffix u used when L.L. is greater than 28.

[b]Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC, well-graded gravel-sand mixture with clay binder.

APPENDIX C

Laboratory Test Results

8248 NW 101st Terrace, #5
Kansas City, MO 64153
816-599-7965 816-599-7967 Fax

Compressive Strength Test of Rock Core

Date: 1/18/2016
Project Name: Kenneth Road Bridge
TSi Project No.: 20152024

COMPRESSIVE STRENGTH DATA

Boring No.	Sample Name	Sample Depth (ft)	Date Tested	Sample Diameter (in)	Sample Length (in)	Moisture, %	Wet Unit Weight (lbs/ft^3)	Sample Area (sq in)	Load (lbs)	Compressive Strength (psi)	Compressive Strength (ksf)
B-2	C-01	22.5	1/11/16	1.85	4.03	4.6	158.08	2.69	2,175	808	116
B-2	C-02	26.3	1/11/16	1.85	3.81	7.0	145.90	2.69	8,005	2,981	429
B-4	C-01	24.0	1/11/16	1.85	3.95	3.1	157.19	2.68	4,495	1,679	242
B-4	C-02	29.0	1/11/16	1.85	4.06	1.9	159.41	2.67	6,510	2,434	351
B-4	C-03	31.0	1/11/16	1.85	3.85	2.5	150.63	2.68	11,745	4,388	632
B-4	C-04	35.0	1/11/16	1.86	4.08	5.4	151.16	2.71	4,560	1,680	242
B-4	C-05	41.5	1/11/16	1.85	4.08	1.6	155.43	2.69	7,310	2,721	392
B-4	C-06	52.0	1/11/16	1.85	3.83	6.1	118.65	2.69	12,450	4,630	667
B-6	C-01	16.8	1/11/16	1.85	4.12	3.4	158.20	2.70	10,130	3,754	541
B-6	C-02	22.3	1/11/16	1.85	3.74	11.6	133.80	2.70	9,860	3,653	526
B-6	C-03	26.5	1/11/16	1.85	4.01	2.5	153.89	2.70	20,780	7,695	1,108
B-6	C-04	32.5	1/11/16	1.86	4.32	0.7	163.18	2.72	11,970	4,402	634
B-6	C-05	36.0	1/11/16	1.86	4.53	0.3	164.99	2.71	11,655	4,301	619
B-6	C-06	46.6	1/11/16	1.85	3.65	7.1	125.37	2.70	4,465	1,655	238
B-7	C-01	19.9	1/11/16	1.85	4.16	3.8	159.06	2.68	6,990	2,612	376
B-7	C-02	21.0	1/11/16	1.86	3.64	0.9	162.30	2.70	12,135	4,490	647
B-7	C-03	25.9	1/11/16	1.86	4.20	11.8	132.75	2.71	7,375	2,718	391

Note:* Compressive strength of rock cores were determined by trimming samples to 90 degree planes at each end and breaking in concrete strength machine per ASTM C39

Braun Intertec Corporation
11529 West 79th Street
Lenexa Kansas 66214
Phone: 913-962-0909

Proctor Report

Report No: PTR:W16-000069-S1
Issue No: 1

Client: Alan Rau
TSi Geotechnical
8248 NW 101st Terrace #5
Kansas City, MO, 64153
Project: B1506400
TSI On-Call 2015
Local on-call laboratory testing
Shawnee Mission, KS, 66214
TR: Elaine Dubray, edubray@braunintertec.com

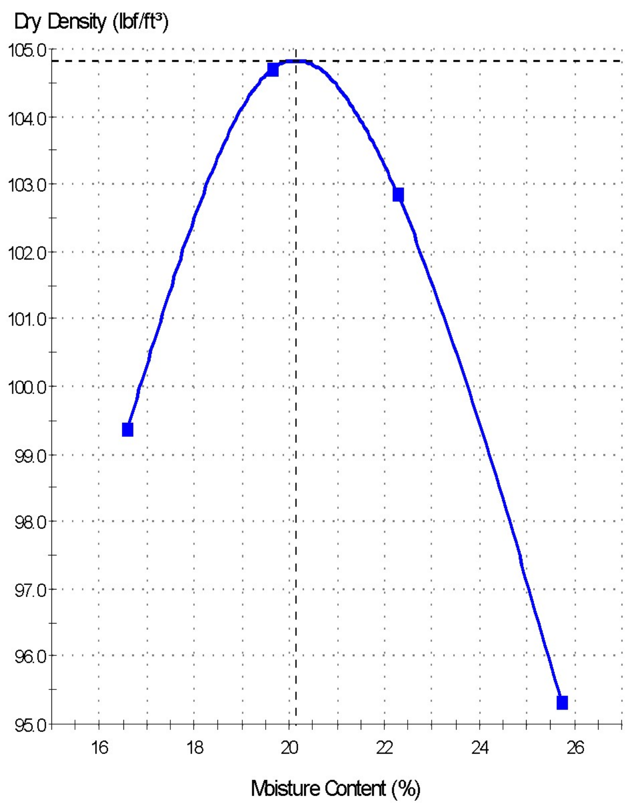
Laboratory Results Reviewed by:

Steve Tanquary
Senior Technician
Date of Issue: 1/19/2016

Sample Details

Sample ID:	W16-000069-S1	**Alternate Sample ID:**	15-1369
Date Sampled:	12/23/2015	**Date Submitted:**	12/23/2015
Sampled By:	Contractor	**Sampling Method:**	Grab
Source:	Kenneth Road Bridge		
Material:	Lean Clay		
Specification:			
Location:	Kenneth Road Bridge: Bulk Sample		
Date Tested:	1/11/2016		

Dry Density - Moisture Content Relationship



Test Results

ASTM D 698 - 07^

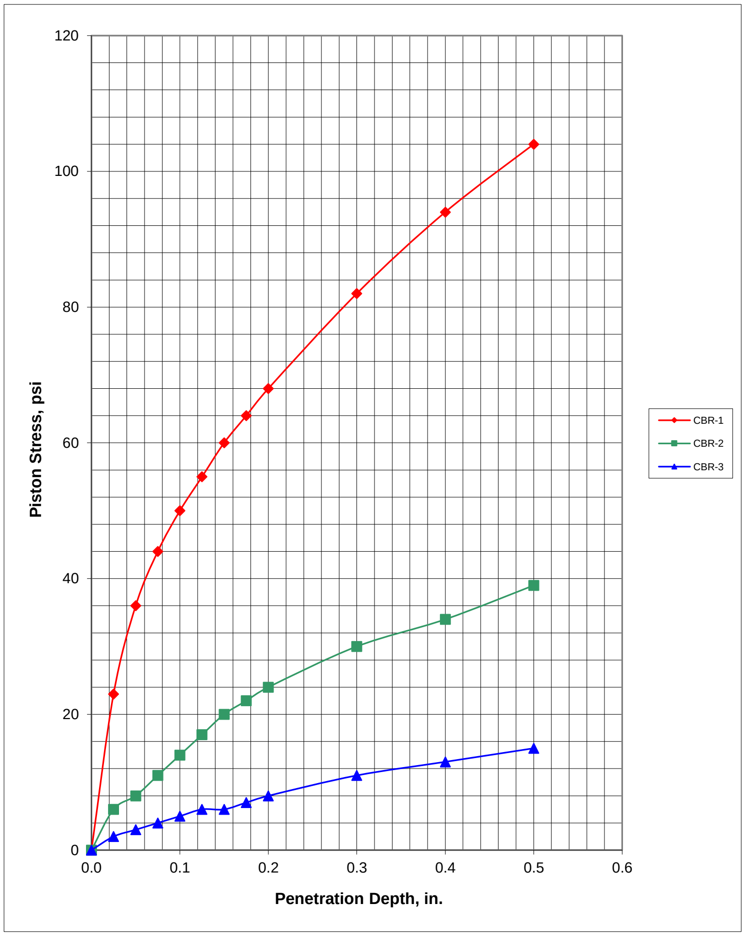
Maximum Dry Density (lbf/ft³):	**104.8**
Corrected Maximum Dry Density (lbf/ft³):	**104.8**
Optimum Moisture Content (%):	**20.1**
Corrected Optimum Moisture Content (%):	**20.1**
Method:	A
Preparation Method:	Moist
Retained Sieve No 4 (4.75mm) (%):	0
Passing Sieve No 4 (4.75mm) (%):	100
Visual Description:	Lean Clay, dark gray brown

Comments

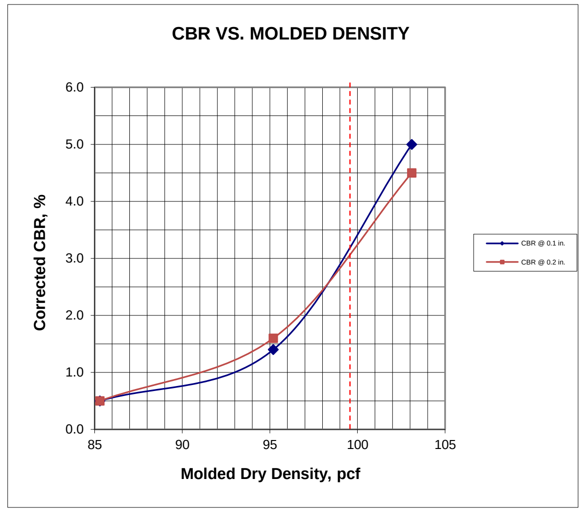
^ Only ASTM and AASHTO equivalent test methods are covered by our current AAP accreditation.
Atterberg Limits; ASTM D4318: LL=48, PL=19, PI=29

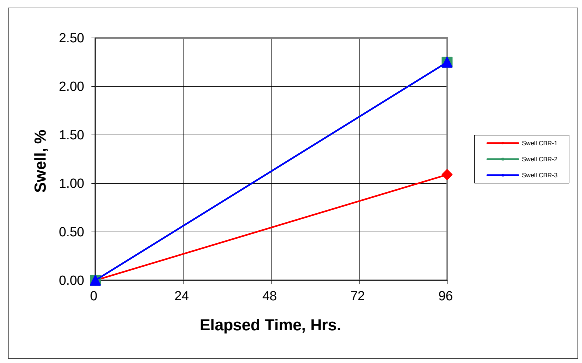
BEARING RATIO TEST REPORT

ASTM D 1883-07



% CBR Value @ 95% Compaction = 3.2 @ 0.1 in. penetration
% CBR Value @ 95% Compaction = 3.0 @ 0.2 in. penetration





	Molded			Soaked			CBR, %		Moisture of Top	Surcharge,	Max.
	Density, pcf	Percent of Max. Dens.	Moisture, %	Density, pcf	Percent of Max. Dens.	Moisture, %	0.10 in.	0.20 in.	1" Layer, %	lbs.	Swell, %
CBR-1	103.1	98.4	20.5	102.2	97.5	21.5	5.0	4.5	24.4	10	1.09
CBR-2	95.2	90.8	20.2	94.1	89.8	24.2	1.4	1.6	29.7	10	2.25
CBR-3	85.3	81.4	20.2	84.5	80.6	27.4	0.5	0.5	28.9	10	2.25

MATERIAL DESCRIPTION	USCS	MAX. DENSITY, pcf	OPTIMUM MOISTURE, %	LL	PI
Lean Clay, dark gray brown	CL	104.8	20.1	48	29

Remarks:

Compaction Method: ASTM D698

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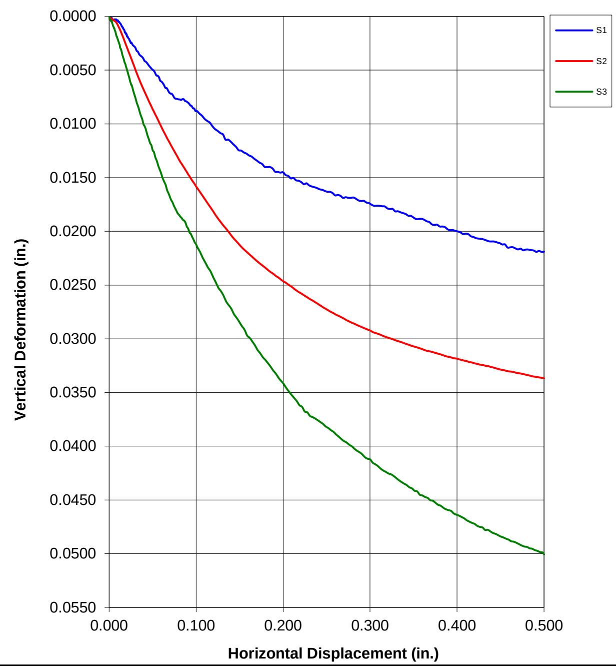
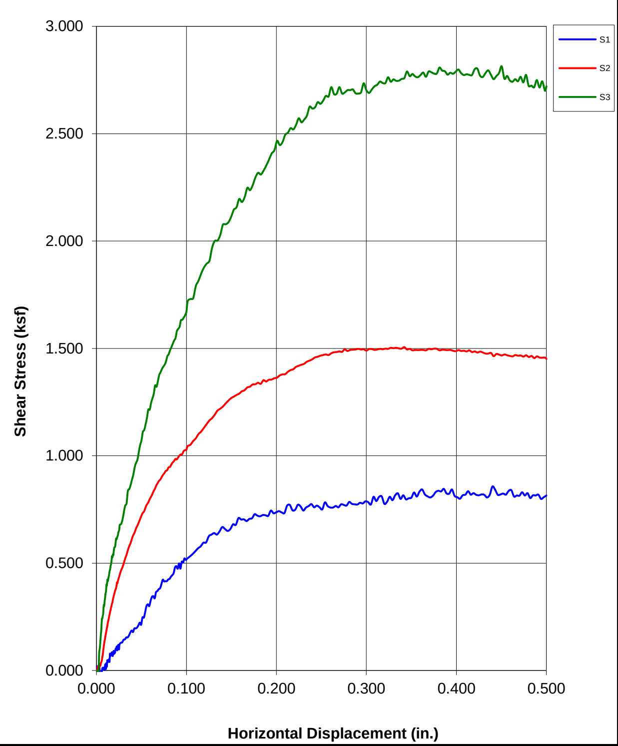
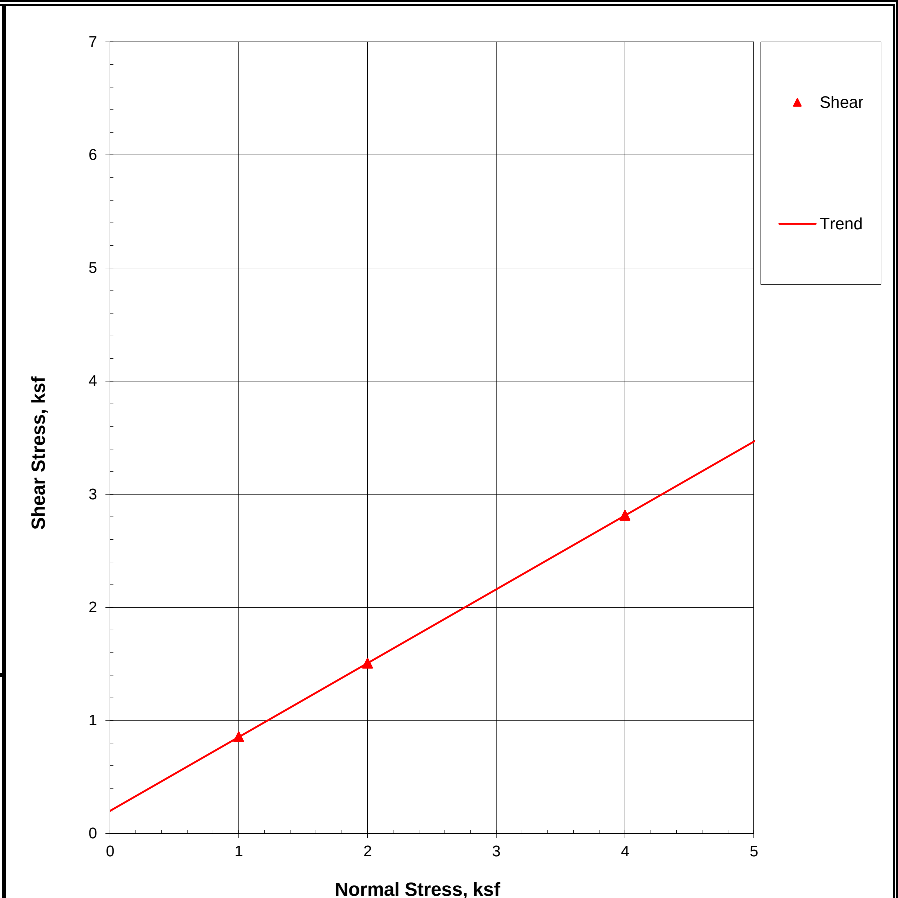
Project:	Kenneth Road Bridge
Location:	Kansas City, Missouri
Client:	TSI Geotechnical Inc.
Sample No.:	15-1369
Boring:	Bulk
Project No.:	B1506400
Depth:	0-2 feet
Date:	1/15/16

Direct Shear Test Report







Specimen Number			1	2	3	4
Initial	Water Content,	%	34.4	32.8	32.0	
	Dry Density,	pcf	84.9	86.8	87.8	
	Void Ratio		0.985	0.941	0.920	
	Saturation,	%	94.2	94.1	93.8	
	Area,	in^2	4.90	4.90	4.90	
	Height,	in	0.99	0.99	0.99	
At Test	Water Content,	%	31.5	28.3	25.9	
	Dry Density,	pcf	87.2	90.6	93.9	
	Void Ratio		0.931	0.860	0.794	
	Saturation,	%	91.2	88.7	88.0	
	Area,	in^2	4.90	4.90	4.90	
	Height,	in	0.96	0.95	0.93	
Maximum Shear Stress,		ksf	0.857	1.506	2.814	
Horizontal Displacment,		in	0.440	0.339	0.450	
Normal Stress,		ksf	1.000	2.000	4.000	
Strain Rate,		in/min	0.0020	0.0020	0.0020	

Test Standard: ASTM D3080

Test Date: 1/11/2016

Results	C, ksf	ϕ, deg.	Tan ϕ
Failure	0.200	33.14	0.65

LL: PL: PI: G_S: 2.7 Assumed

Description of Specimen 1: Lean Clay, dark gray brown
Description of Specimen 2: Lean Clay, dark gray brown
Description of Specimen 3: Lean Clay, dark gray brown

Test Conditions: Undisturbed / Inundated
Remarks:

Project: Kenneth Road Bridge
Location: Kansas City, Missouri
Client: TSI Geotechnical, Inc.
Checked By: JGH

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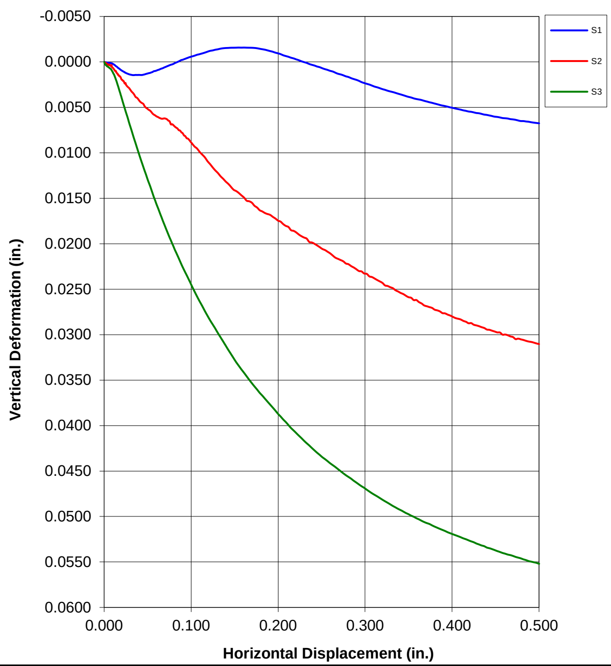
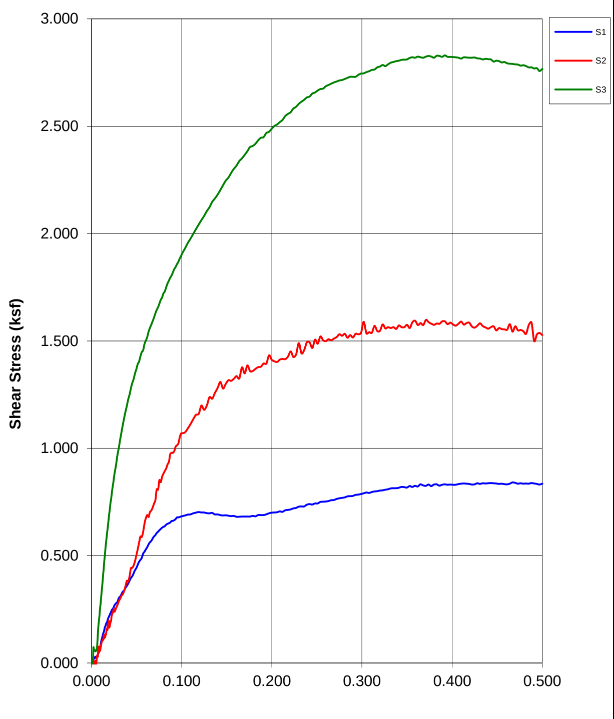
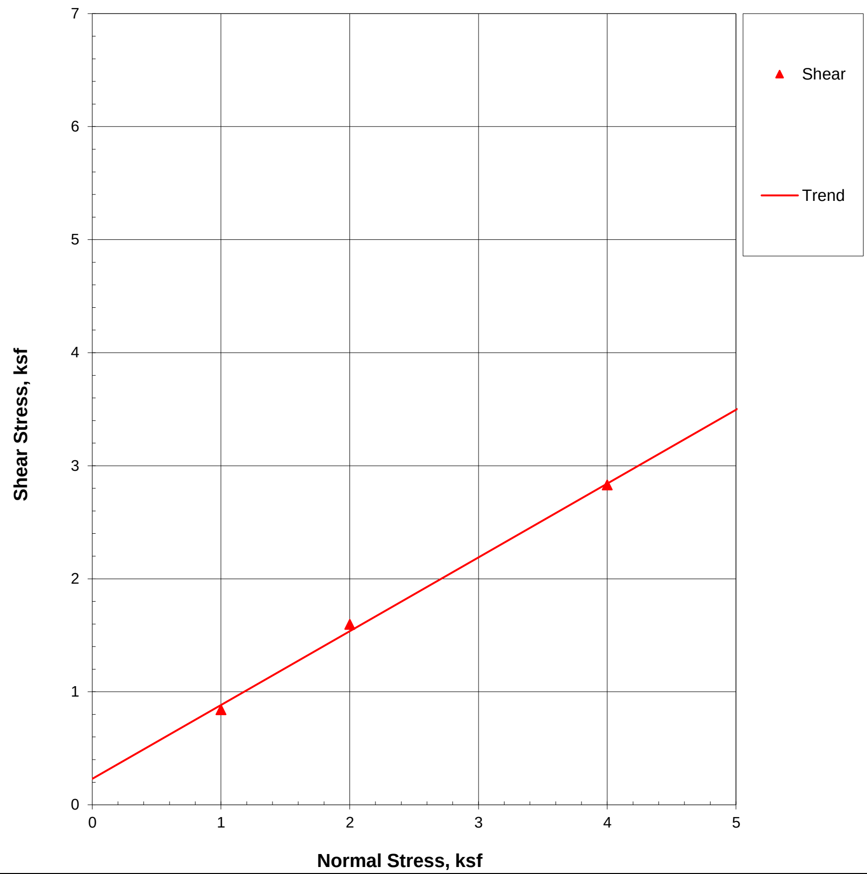
Project No.: B1506400
Boring No.: B-5
Depth: 8-10 feet

PLATE

Direct Shear Test Report







Specimen Number			1	2	3	4
Initial	Water Content,	%	32.3	32.7	31.8	
	Dry Density,	pcf	85.3	84.6	84.9	
	Void Ratio		0.976	0.993	0.983	
	Saturation,	%	89.4	89.0	87.4	
	Area,	in^2	4.90	4.90	4.90	
	Height,	in	0.99	0.99	0.99	
At Test	Water Content,	%	32.7	31.3	28.8	
	Dry Density,	pcf	86.6	86.8	89.8	
	Void Ratio		0.946	0.941	0.876	
	Saturation,	%	93.4	89.7	88.7	
	Area,	in^2	4.90	4.90	4.90	
	Height,	in	0.97	0.96	0.94	
Maximum Shear Stress,		ksf	0.841	1.598	2.830	
Horizontal Displacment,		in	0.467	0.368	0.392	
Normal Stress,		ksf	1.000	2.000	4.000	
Strain Rate,		in/min	0.0020	0.0020	0.0020	

Test Standard: ASTM D3080

Test Date: 1/12/2016

LL: PL: PI: G_S: 2.7 Assumed

Results	C, ksf	ϕ, deg.	Tan ϕ
Failure	0.230	33.14	0.65

Description of Specimen 1: Lean Clay, blocky structure, very dark brown

Description of Specimen 2: Lean Clay, blocky structure, very dark brown

Description of Specimen 3: Lean Clay, blocky structure, very dark brown

Test Conditions: Undisturbed / Inundated

Remarks:

Project: Kenneth Road Bridge

Location: Kansas City, Missouri

Client: TSI Geotechnical, Inc.

Checked By: JGH

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Project No.: B1506400

Boring No.: B-6

Depth: 8-10 feet

PLATE

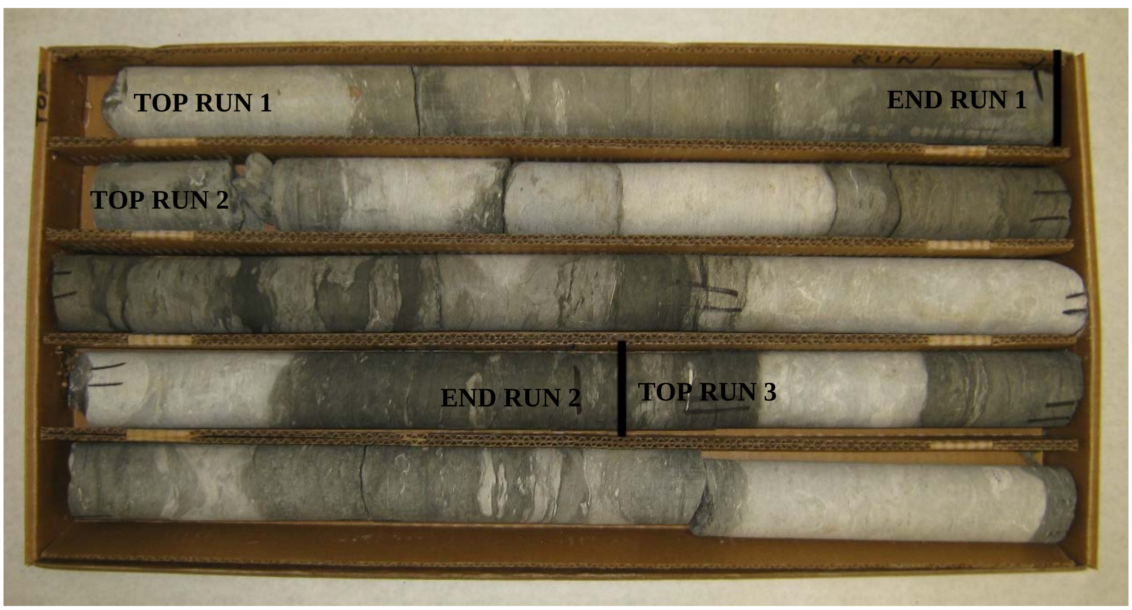
APPENDIX D

Rock Core Photographs

B-02 Kenneth Road Bridge 20152024

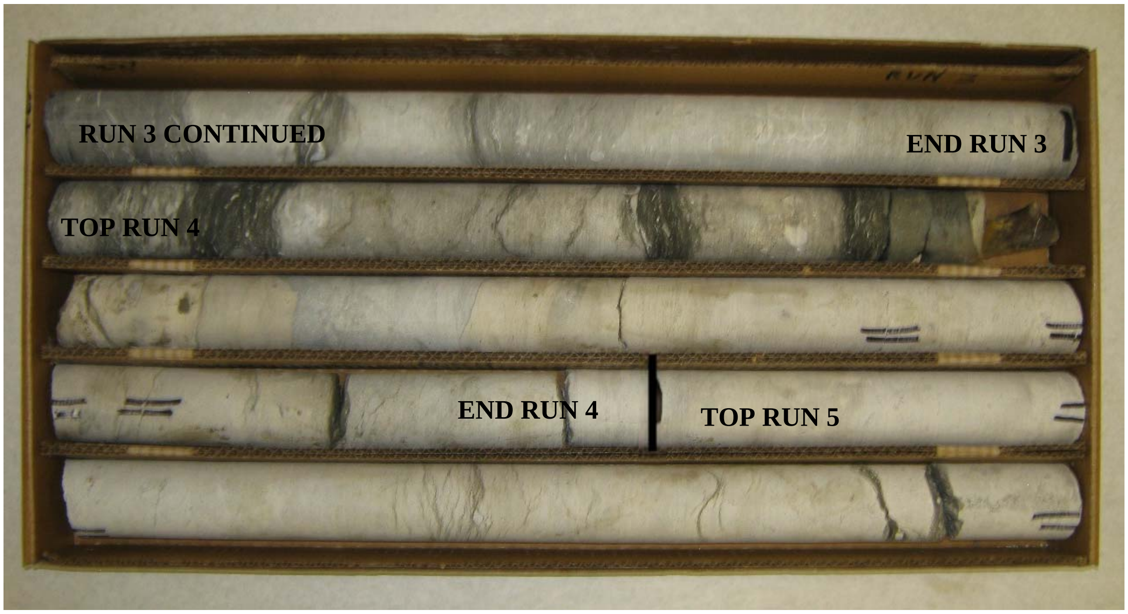
Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	22.0 to 25.0	99	90
2	25.0 to 32.0	99	99

B-04 Kenneth Road Bridge 20152024



Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	23.0 to 25.0	98	94
2	25.0 to 30.0	100	86
3	30.0 to 33.0	100	100

B-04 **Kenneth Road Bridge** **20152024**



Run No.	Depth (ft)	Recovery (%)	RQD (%)
3	33.0 to 35.0	100	100
4	35.0 to 40.0	100	94
5	40.0 to 43.0	100	92

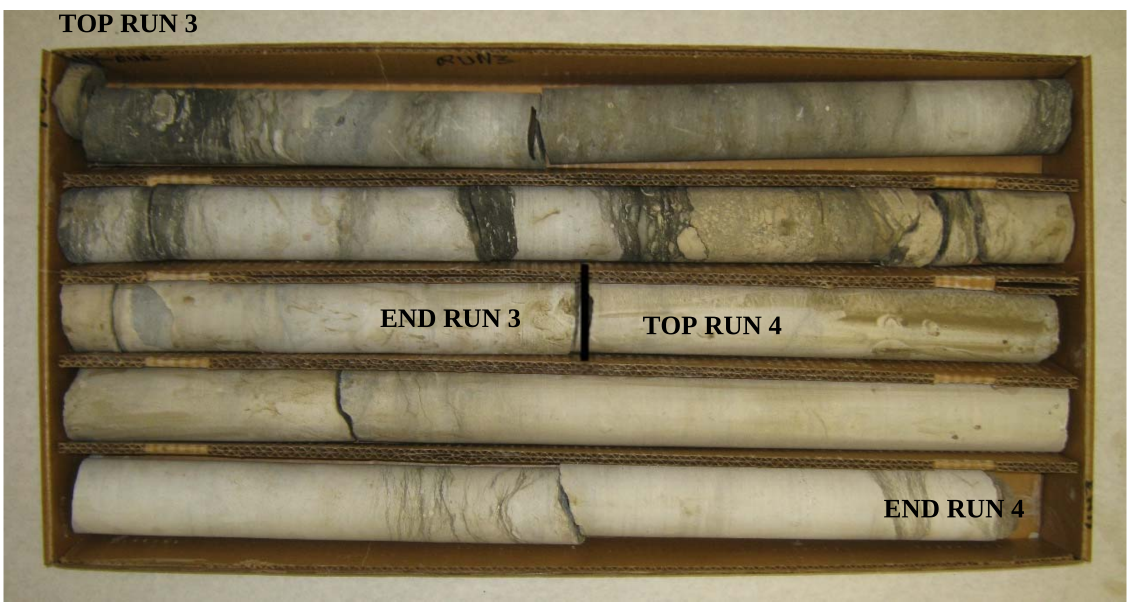
B-04 **Kenneth Road Bridge** **20152024**

Run No.	Depth (ft)	Recovery (%)	RQD (%)
5	43.0 to 45.0	100	92
6	45.0 to 53.0	98	97

B-06 | Kenneth Road Bridge | 20152024

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	15.5 to 20.5	100	96
2	20.5 to 25.5	100	93

B-06 | Kenneth Road Bridge | 20152024



Run No.	Depth (ft)	Recovery (%)	RQD (%)
3	25.5 to 30.5	100	88
4	30.5 to 35.5	98	98

B-06 **Kenneth Road Bridge** **20152024**

Run No.	Depth (ft)	Recovery (%)	RQD (%)
5	35.5 to 40.5	100	85
6	40.5 to 45.5	98	92

B-07 **Kenneth Road Bridge** **20152024**

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	18.5 to 20.5	96	96
2	20.5 to 25.5	98	98
3	25.5 to 28.5	100	100

APPENDIX E

Pavement Core Photographs

B-1 **Kenneth Rd. Bridge** **20152024**

Material	Thickness (in)	Notes
Asphalt	9.5	
Total	9.5	

B-2 **Kenneth Rd. Bridge** **20152024**

Material	Thickness (in)	Notes
Asphalt	8.0	
Total	8.0	

APPENDIX F

Global Stability Analysis Results

File Name: Kenneth Road Bank 2.5:1V Embankment
Date: 5/12/2016
Name: Rip Rap Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion: 0 psf Phi: 36 °
Name: Lean CLAY (CL) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 28 °
Name: Limestone Model: Mohr-Coulomb Unit Weight: 140 pcf Cohesion: 10000 psf Phi: 35 °

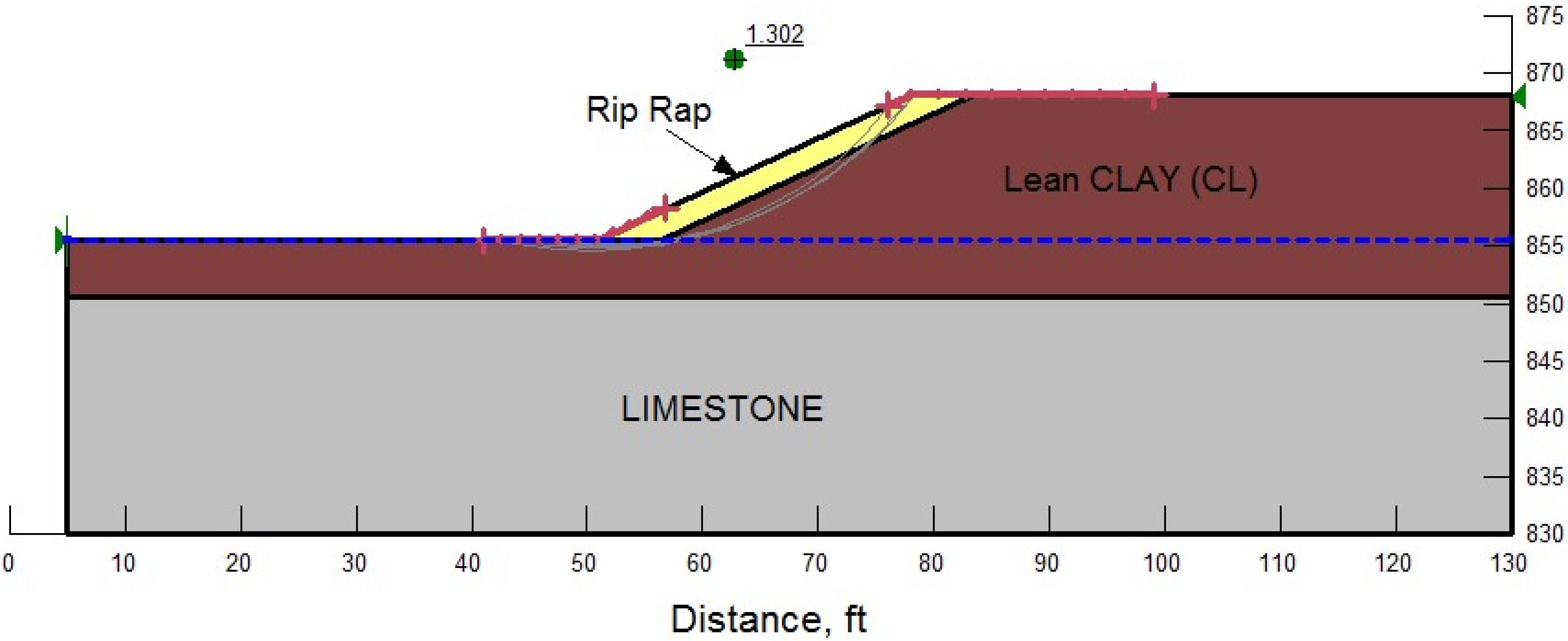


Figure 2, Global Stability Analysis	Project No. 20152024
Kenneth Road Bridge Kansas City, Missouri	
Approved by: WAS	