CITY OF FOUNTAINS
HEART OF THE NATION

KANSAS CITY
MISSOURI

ADDENDUM NUMBER 1

Project Number **89008207**

Project Title **North Green Hills Road, Complete Streets Reconstruction Federal No. STP-3451 (404)**

ISSUE DATE: **3/10/2020**

Bidders are hereby notified that the Bidding and Contract Documents for the above project, for which Bids are to be received on **April 7, 2020**, 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 geotechnical reports for design purposes only. The geotechnical reports do not constitute the contractor's investigation of site conditions and was not included with the contract documents. The geotechnical reports have been requested by bidders and are included with this addenda. The geotechnical 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. Acknowledgement of this addenda shows acceptance of all risks associated with any use.

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.

NORTH GREEN HILLS ROAD WATER TRANSMISSION MAIN
KANSAS CITY, MISSOURI
WSD PROJECT NUMBER 89008207
TSI PROJECT NUMBER 20172033

HDR ENGINEERING, INC.
4435 Main Street, Suite 1000
Kansas City, Missouri 64111

TSi geotechnical, inc.

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

January 7, 2020

TSi
geotechnical, inc.

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

January 7, 2020

Mr. Scott Heavin, PE
HDR ENGINEERING, INC.
4435 Main Street, Suite 1000
Kansas City, Missouri 64111

Re: Report of Subsurface Exploration and
Geotechnical Engineering Evaluation
North Green Hills Road Water Transmission Main
Kansas City, Missouri
TSi Project No. 20172033

Dear Mr. Heavin:

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 HDR Engineering, Inc. (HDR). The purpose of our work was to determine subsurface conditions at specific exploration locations and to gather data on which to prepare geotechnical recommendations for the Water Transmission Main in Kansas City, Missouri. 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.

Benjamin Wilmes, PE
Staff Engineer

Brian Robben, PE, PG
Geotechnical Department Manager

STATE OF MISSOURI
BRIAN WILLIAM ROBBEN
NUMBER PE-2004017235
1/7/2020
PROFESSIONAL ENGINEER

for: Denise B. Hervey, PE
Principal

PROFESSIONAL SERVICE SINCE 1989

CONTENTS

SUBSURFACE EXPLORATION AND
GEOTECHNICAL ENGINEERING EVALUATION
NORTH GREEN HILLS ROAD WATER TRANSMISSION MAIN
KANSAS CITY, MISSOURI

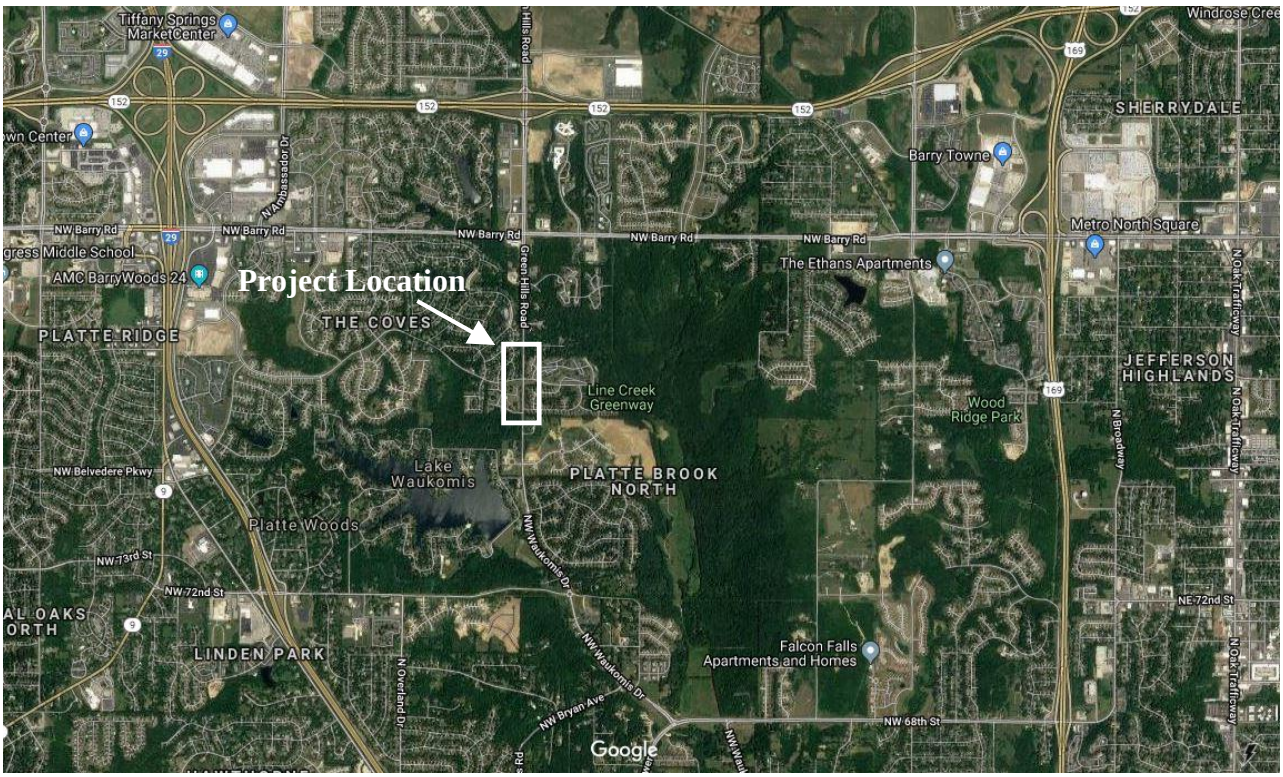
1.0 SCOPE OF SERVICES

This report summarizes the results of a geotechnical study performed for the proposed North Green Hills Road Water Transmission Main, extending from 78th Street to approximately 500 feet south of the intersection of North Green Hills Road and Platte Brooke Drive in Kansas City, Missouri. The study was performed in general accordance with TSi's proposal to HDR Engineering, Inc., dated July 27, 2017. Based on TSi's understanding of the project, the following items have been identified for inclusion in this study report:

- Subsurface conditions at the boring locations;
- Laboratory test results;
- Influence of groundwater;
- Lateral earth pressures;
- Bedrock depths and elevations;
- Pipe bedding recommendations;
- Excavation considerations;
- General construction considerations; and
- Recommendations for fill and backfill materials, placement, and compaction;

2.0 SITE AND PROJECT DESCRIPTIONS

The following project understanding is based on discussions with HDR, and a site reconnaissance by a geotechnical engineer from TSi. The project will consist of the design and construction of a new 30 to 36-inch diameter water transmission main spanning approximately 2,700 feet in Kansas City, Missouri. The general location of the project site is shown below. The Site and Boring Location Plan, Figure 1 in Appendix A, provides a more detailed plan of the project area.



3.0 FIELD EXPLORATION AND LABORATORY TESTING

3.1 FIELD EXPLORATION

TSi conducted an exploration program at the project site on October 24, October 25, and December 12th, 2019 consisting of 10 soil borings, designated as Borings B-01 to B-10. The logs from this exploration are attached to this report. The boring locations were selected by HDR, and located in the field by TSi. Elevations on the logs were estimated from Google Earth and should be considered approximate.

The borings were drilled using a CME 550 ATV-mounted drill rig to advance flight auger drilling tools. Split-spoon and Shelby tube samples were recovered from the borings. Split-spoon samples were recovered using a 2-inch outside-diameter, split-barrel sampler, driven by an automatic hammer, in accordance with ASTM D 1586. 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. The split-spoon samples were placed in plastic bags for later testing in the laboratory.

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 specialist'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.

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 date shown; the reported conditions may be different at other locations or at other times.

4.1 GENERALIZED SUBSURFACE PROFILE

In general, the surficial materials consisted of approximately 5 inches of lean clay with roots and organics. Boring B-05 encountered 4 inches of gravel at the surface. The surficial materials at Boring B-02 were underlain by existing fill to a depth of 3 feet. Standard penetration test (N-value) and the moisture content in the fill were 7 blows per foot (bpf) and 23%, respectively. The existing fill at Boring B-02 and surficial materials at the remaining borings were generally underlain by native lean clay (CL in accordance with the Unified Soil Classification System). N-values and the moisture contents in the native clays ranged from 9 to 32 bpf and 12% to 27%, respectively. In Borings B-02 to B-10, sandstone was encountered below the native clay. The sandstone continued to auger refusal in Borings B-05 to B-10. In Borings B-02 and B-04 the sandstone was underlain by shale which continued to auger refusal. N-values and the moisture contents in the sandstone and shale ranged from 2 bpf to 50 blows for 3 inches of penetration and 6% to 34%, respectively. In Boring B-03, the sandstone was underlain by highly weathered limestone. Boring B-01 and B-02 were continued below auger refusal into the underlying limestone bedrock.

TABLE 1
BEDROCK DEPTHS AND ELEVATIONS

Boring Location	Auger Refusal Depth (ft.)	Auger Refusal Elevation** (ft.)
B-01	2.5	951.5
B-02	11.0	943.0
B-03	10.0	953.0
B-04	NE	NE
B-05	NE	NE
B-06*	3.1	995.9
B-07	NE	NE
B-08*	5.3	1000.7
B-09*	8.2	1000.8
B-10*	8.2	982.8

NE = Not Encountered
* hand auger boring
** Elevation should be considered approximate

4.2 GROUNDWATER

Groundwater was observed in 3 of the 10 borings during drilling. Table 2 below lists the groundwater depths and elevations encountered 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 level in the nearby lake, and other unknown considerations could cause fluctuations in water levels and the presence of water in the soils.

TABLE 2
GROUNDWATER DEPTHS AND ELEVATIONS

Boring Location	Groundwater Depth (ft.)	Groundwater Elevation (ft.)
B-01	NE	NE
B-02	8.5	945.5
B-03	NE	NE
B-04	NE	NE
B-05	14.5	986.5
B-06	NE	NE
B-07	14.0	986
B-08	NE	NE
B-09	NE	NE
B-10	NE	NE

NE = Not Encountered

5.0 Engineering Assessments and Recommendations

5.1 Existing Fill

Undocumented existing fill material was encountered at Boring B-02. The character of the existing fill is discussed in Section 4.1 of this report. It is not known how this fill was placed and how much deleterious material may be in the fill between the locations sampled during this investigation. Given the uncertain nature of the existing fill, there is potential for significant differential settlements across the building. In order to eliminate the risk of significant differential settlements, TSi recommends that the new transmission line does not bear on existing fill material. If fill is encountered at the pipe bearing elevation it should be removed to a depth of 2 feet and replaced with properly compacted new fill.

5.2 Lateral Earth Pressures

Lateral earth pressure parameters are provided for the design of the buried structures such as manholes that may be included in the project. It is assumed that the walls of these structures will be restricted from movement at the top and therefore should be designed to resist at-rest earth pressures. Earth pressures are a function of the excavation configuration and the backfill materials. Lateral earth pressure parameters are provided in Table 3 for the design of these subsurface structures. Hydrostatic forces should be added to the analyses below the design groundwater level unless the structure is designed with a permanent underdrain and pump system to prevent buildup of hydrostatic forces on the structure.

Below-grade structures that are restricted from movement at the top, such as footings or foundation walls, should be designed to resist at-rest pressures. Walls that are free to move and deflect at the top should be designed to resist active earth pressures. A horizontal deflection at the top of the wall of approximately 1% of the freestanding wall height is typically required to permit active pressure to develop. Earth pressures are a function of the excavation configuration and the backfill materials.

TABLE 3
LATERAL EARTH PRESSURE PARAMETERS FOR SUBSURFACE STRUCTURES*

Parameter		Backfilled with Crushed Limestone	Backfilled with Cohesive Soil	Backfill with Cohesionless Soil
At-Rest Equivalent Fluid Pressure	Drained	55 pcf	72 pcf	63 pcf
	Undrained	91 pcf	99 pcf	94 pcf
Active Equivalent Fluid Pressure	Drained	35 pcf	51 pcf	42 pcf
	Undrained	81 pcf	88 pcf	83 pcf
Passive Equivalent Fluid Pressure	Drained	480 pcf	308 pcf	375 pcf
	Undrained	310 pcf	217 pcf	250 pcf
Soil Unit Weight		130 pcf	125 pcf	125 pcf
Angle of Internal Friction for Backfill		35°	25°	30°
Assumed Surcharge Condition		None	None	None
Slope Profile Behind Structure		Horizontal	Horizontal	Horizontal

* No factor of safety has been applied to the above values

Significant wall movements would generally be necessary to develop the full values of passive pressures given; typically, the passive values stated are reduced by up to one-half for design.

To prevent the accumulation of water behind new subsurface walls and resulting hydrostatic pressure, a free-draining granular backfill material is recommended for the walls. The drainage backfill material should be encased in a nonwoven geotextile having a minimum weight of 8 ounces per square yard. A perforated pipe should be placed at the base of the wall to collect the water and carry it to daylight, to a storm sewer, or to a sump.

The effects of vertical surcharge loads or sloping ground behind the wall are not included for the stated fluid pressures. The effect of surface loading may be included as a uniform horizontal load against the wall equal to one-half the vertical load intensity.

5.3 BEDROCK EXCAVATION CONSIDERATIONS

Most of the borings at this site encountered shale, sandstone, or limestone bedrock. Construction budgets and schedules should anticipate significant rock excavation. The weathered upper portion of the bedrock can probably be excavated using conventional excavators, but use of hydraulic breakers, or the equivalent, could be required as the bedrock gets harder with depth.

Auger refusal on apparent limestone bedrock was encountered in 7 of the 10 borings. Although in Borings B-6, B-8. B-9, and B-10, the refusal was with hand auger equipment and the actual depth to limestone bedrock may vary slightly at this location. The limestone bedrock may not be able to be excavated using conventional excavation machinery equipped with rock bucket teeth. The limestone excavations will likely require the utilization of jackhammers or hoe-rams. If the

limestone encountered is too hard for these machines, other methods including blasting may have to be employed, where allowable. The most suitable means to excavate the bedrock materials should be determined by the contractor in the field.

5.4 Swelling Shale Considerations

Shale bedrock was encountered at Borings B-02 and B-04 and may be exposed during trench excavation in some areas. The shale bedrock is of concern with regard to its potential for volume change. This concern applies to these materials whether they are in their natural condition or used as fill material. This material tends to swell when it absorbs water and 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 shale. Avoiding conditions that could result in excessive wetting or drying of the shale will reduce its potential for volume change. The following design and construction precautions are recommended:

1. Shale material should not be used as backfill material within 2.0 feet of the pipe perimeter or in the upper 2.0 feet.

2. Shale used as fill should be placed and compacted wet of its optimum moisture content, as discussed in Section 6.4 of this report.

3. The shale maximum particle size should not exceed 2 inches in any dimension.

4. Positive surface drainage should be provided during and after construction to prevent ponding of water in and around the trench.

5.5 Pipe Support

TSi recommends that the transmission main be supported by 6 inches of crushed aggregate base placed over a properly prepared soil subgrade. Crushed stone used to support pipe should fall within the APWA Division II Specification of not less than 95% of the aggregate passing a ½-inch sieve and not less than 95% of the aggregate retained on a No 4 sieve. The aggregate will provide a uniform base for support of the pipe and a stable working surface during construction. The aggregate base should be compacted according to Section 6.4 of this report.

Excavations for the pipe subgrades should be done carefully to not excessively disturb the soil base. If soft subgrade soils are encountered in the bottom of the trench, the soft soils should be overexcavated, up to 2 feet below the pipe, and replaced with crushed aggregate base.

Where the transmission main trench is to be excavated into bedrock, an additional 6 inches of bedrock should be excavated to allow for the placement of 6 inches of crushed stone below the pipe. This base will prevent the pipe from bearing on a non-yielding hard surface.

The City of Kansas City Missouri and APWA Division II Specification requirements should be followed in the selection of pipe bedding materials and embedment depths.

To prevent the pipe bedding and backfill from acting as a conduit for the flow of groundwater along the pipe, clay or flowable fill plugs could be installed at 100-foot intervals along the alignment. The clay plugs should be compacted in accordance with the cohesive fill specification in Section 6.4.

5.6 Pipe Settlement and Loading

TSi understands a portion of the proposed water transmission main elevations will be in bedrock. If bedrock is directly supporting the crushed granular bedding material, settlement of the pipe should be insignificant. Pipe that is supported by stiff in-situ soils should experience less than 1-inch of settlement.

Pipe loading at the site will vary with the embedment depth of the pipe. In general, the depth of pipe embedment in feet should be multiplied by 125 pcf (moist unit weight in pounds per cubic foot) to calculate the total overburden pressure on the pipe in pounds per square foot.

6.0 Site Preparation and Excavation Considerations

6.1 Excavations

Construction areas should be stripped of organic soil and any deleterious materials along the trench alignment prior to trench excavation. Tree stumps and root balls should also be removed.

Trenching, excavating, and bracing should be performed by the contractor in accordance with OSHA (Occupational Safety and Health Administration) regulations and other applicable regulatory agencies. In accordance with the OSHA excavation standards, the soil at the site is considered Type C, which requires a side slope for excavations of not steeper than 1.5 horizontal to 1.0 vertical (1.5H:1V). Worker safety and classification of the excavation soil is the responsibility of the contractor. Also according to OSHA requirements, any excavation extending to a depth of more than 20 feet requires sheeting, shoring, and bracing, or other means of extra support designed by a registered professional engineer. An excavation retention system, such as soldier piles and lagging or sheet piling, may be used as an alternate to sloping back the sides of trench excavations.

6.2 Subgrade Protection

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

To prevent unnecessary disturbance of the subgrade soils in the bottom of the trench, foot traffic should be minimized to prevent disturbance of the subgrade. If areas of disturbed subgrade develop, they should be properly repaired by removing and replacing the disturbed subgrade with properly compacted fill. Another option for improving a weak subgrade is overexcavation of the soft material to a depth of not more than 2 feet then use of a geogrid or geotextile placed at the bottom of the excavation, and backfilling with a properly compacted crushed limestone.

6.3 Fill and Backfill Materials

According to the preliminary plans, a minimum of 5 feet of fill is required to be placed over the water main. In general, trench backfill or engineered fill placed over the pipe should consist of clay or well-graded granular soils with a maximum particle size of 3 inches. The clay soils encountered in the borings are suitable for use as fill. 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 not acceptable.

Rock fragments, such as limestone and shale, can be used in the trench backfill and engineered fills that are more than 2 feet below final grade and not within 2 feet of the water pipe. Rock fragments should be less than 6 inches in maximum overall dimension, assuming a minimum trench width of 7 feet. The rock fill should contain a sufficient amount of clay and smaller rock

fragment sizes to fill voids between fragments. The fill should be placed in a manner that will achieve compaction of the clay around and between the limestone fragments. Placement and compaction of rock fill should be closely observed on a full-time basis by an experienced engineering technician, since testing the density of the rock fill may not be possible or may not provide meaningful results.

Some of the soil on the site will require the addition of moisture prior to compaction. This should be performed in a controlled manner, and the moistened soil should be thoroughly blended to produce a uniform moisture content. Fat clays and shale should be compacted wet of their optimum 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 on-site soil 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, could 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 stone, used should be compacted to at least 100% of the standard Proctor maximum dry density. The moisture content of lean clay at the time of compaction should generally be within ±2% of the optimum moisture content of the material as determined by the standard Proctor compaction test. Fat clay or shale material should be placed and maintained at a moisture content ranging from 0 to 4% wet of the 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 of the trench bottom prior to backfilling and installation of the pipe; and
- Placement and compaction of trench backfill materials.

These Quality Assurance services should help to 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 **HDR ENGINEERING, 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 location, size, and type, in the planned loads, elevations, grading and site development plans or the project concepts.

TSi recommends we be afforded 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

Boring Location

N
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Figure 1, Boring Location Plan	Project No. 20172033
North Green Hills Road Water Transmission Main Kansas City, MO	
Not to Scale	Approved by: TBS

TSi geotechnical, inc.

APPENDIX B

Boring Logs
General Notes
Unified Soil Classification System

LOG OF BORING NO. B-01

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **954.0**
Location: **See Site and Boring Location Plan**

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 organics										
				Brown and orange brown, lean CLAY (CL), trace organics and fine-grained sand										
		SS-1			44		13 50/5"				22			
		RUN1		LIMESTONE, gray, hard, weathered	76	0								
				Boring terminated at 3.6 ft.										
5														
10														
15														
20														
25														

Completion Depth: 3.60
Date Boring Started: 12/12/19
Date Boring Completed: 12/12/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling. Auger refusal was encountered at 2.5 ft. Boring offset 26.0 ft. west and 13.0 ft. south.

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

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

LOG OF BORING NO. B-02

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **954.0**
Location: **See Site and Boring Location Plan**

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
		SS-1		Brown, dark gray, light brown, lean CLAY (FILL), with organics	83		3 3 4				23	38	21	17
		ST-2		Dark brown, lean CLAY (CL)	79				0.43	99	21			
5		SS-3		SANDSTONE, brown, soft, weathered	100		7 15				19			
		SS-4		SHALE, dark gray, soft, weathered ▽	120		30 23 33 50/3"				16			
10		RUN1		LIMESTONE, gray, hard, weathered - 12" soft, dark gray, shale seam at 14.0 ft.	92	81								
15				Boring terminated at 15.0 ft.										
20														
25														

Completion Depth: 15.00
Date Boring Started: 10/24/19
Date Boring Completed: 10/24/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was encountered at 8.5 feet during drilling. Auger refusal was encountered at 11.0 ft. Boring offset 30.0 ft. west.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

LOG OF BORING NO. B-03

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **963.0**
Location: **See Site and Boring Location Plan**

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 and gray, lean CLAY, with organics										
		SS-1		Brown and gray, lean CLAY (CL)	94		4 10 12				20			
5		SS-2		SANDSTONE, brown, soft, weathered	83		4 4 4				21	41	19	22
		SS-3		- trace limestone below 6.0 ft.	100		3 8 8				28			
		SS-4		LIMESTONE, gray, soft, weathered	104		50/2"				2			
10				Boring terminated at 10.0 ft.										
15														
20														
25														

Completion Depth: 10.00
Date Boring Started: 10/25/19
Date Boring Completed: 10/25/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling. Auger refusal was encountered at 10.0 ft.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

LOG OF BORING NO. B-04

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **985.0**
Location: **See Site and Boring Location Plan**

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, trace organics										
		ST-1		Brown, lean CLAY (CL), trace organics	108				0.82	107	18			
5		SS-2		- brown and gray, no organics below 3.5 ft.	100		5 7 11				27			
		SS-3		SANDSTONE, brown, soft, weathered - trace shale below 7.0 ft.	100		19 43 50/4.5"				15			
10		SS-4		- trace limestone below 11.0 ft.	100		18 28 44				16			
		SS-5		SHALE, gray, soft, weathered	113		30 50/3.5"				9			
15				Boring terminated at 15.0 ft.										
20														
25														

Completion Depth: 15.00
Date Boring Started: 10/24/19
Date Boring Completed: 10/24/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was not encountered during drilling.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

LOG OF BORING NO. B-05

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **1001.0**
Location: **See Site and Boring Location Plan**

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
				GRAVEL (FILL)										
		SS-1		Brown, lean CLAY (CL), with fine-grained sand	100		8 8 24				12			
		SS-2		SANDSTONE, brown, soft, weathered	100		18 45 50/5"				8			
5		SS-3			102		50/5.5"				6			
		SS-4			101		50/3.5"				8			
10														
		SS-5		▽	67		2 1 1				34			
15				Boring terminated at 15.0 ft.										
20														
25														

Completion Depth: 15.00
Date Boring Started: 10/24/19
Date Boring Completed: 10/24/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was encountered at 14.5 feet during drilling.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

LOG OF BORING NO. B-06

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **999.0**
Location: **See Site and Boring Location Plan**

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
		BAG1		Brown, lean CLAY, with organics							18			
		BAG2		SANDSTONE. brown, soft, weathered							17			
		BAG3		Boring terminated at 3.1 ft.										
5														
10														
15														
20														
25														

Completion Depth: 3.10
Date Boring Started: 10/25/19
Date Boring Completed: 10/25/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using hand auger. Groundwater was not encountered during drilling. Hand auger refusal was encountered at 3.1 ft.

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

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

LOG OF BORING NO. B-07

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **1000.0**
Location: **See Site and Boring Location Plan**

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 organics										
		SS-1		Brown, lean CLAY (CL), trace fine-grained sand	83		4 4 5				18			
		SS-2		SANDSTONE, brown, soft, weathered	92		30 50/5"				6			
5		SS-3			48		50/5.5"				8			
		SS-4			37		50/3.5"				7			
10														
		SS-5		▽	100		5 2 1				17			
15				Boring terminated at 15.0 ft.										
20														
25														

Completion Depth: 15.00
Date Boring Started: 10/25/19
Date Boring Completed: 10/25/19
Engineer/Geologist: AB
Project No.: 20172033

Remarks: Boring drilled using CME-550 drill rig with auto SPT. Groundwater was encountered at 14.0 feet during drilling.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

LOG OF BORING NO. B-08

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **1006.0**

Location: **See Site and Boring Location Plan**

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
		BAG1		Brown, silty lean CLAY (CL), trace organics										
		BAG2		- light brown and brown from 1.0 to 2.0 ft.							23			
		BAG3		- light brown and gray, no organics below 2.0 ft.										
		BAG4									21			
		BAG5		- with fine-grained sand below 4.0 ft.							19			
5	B	BAG6		SANDSTONE, light brown, soft, weathered							6			
				Boring terminated at 5.3 ft.										
10														
15														
20														
25														

Completion Depth: 5.30
Date Boring Started: 12/13/19
Date Boring Completed: 12/13/19
Engineer/Geologist: BH
Project No.: 20172033

Remarks: Boring drilled using hand auger. Groundwater was not encountered during drilling. Hand auger refusal was encountered at 5.3 ft.

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

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

LOG OF BORING NO. B-09

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **1009.0**
Location: **See Site and Boring Location Plan**

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
		BAG1		Brown, silty lean CLAY (CL), trace organics										
		BAG2		SANDSTONE, light brown, soft, weathered							12			
		BAG3												
		BAG4									13			
		BAG5												
5		BAG6		- trace limestone from 5.0 to 6.0 ft.							21	49	24	25
		BAG7									14			
		BAG8												
	B	BAG9									6			
				Boring terminated at 8.2 ft.										
10														
15														
20														
25														

Completion Depth: 8.20
Date Boring Started: 12/13/19
Date Boring Completed: 12/13/19
Engineer/Geologist: BH
Project No.: 20172033

Remarks: Boring drilled using hand auger. Groundwater was not encountered during drilling. Hand auger refusal was encountered at 8.2 ft.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

LOG OF BORING NO. B-10

Project Description: **North Green Hills Rd. Water Transmission Main**
Kansas City , MO

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

Surface El.: **991.0**
Location: **See Site and Boring Location Plan**

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
		BAG1		Brown, silty lean CLAY (CL), trace organics and sandstone fragments							22			
		BAG2												
		BAG3									11			
		BAG4		SANDSTONE, light brown, soft, weathered, trace organics							12			
		BAG5												
5		BAG6		- no organics below 5.0 ft. - trace limestone from 5.1 to 6.0 ft.							10			
		BAG7									22			
		BAG8												
	B	BAG9									20			
				Boring terminated at 8.2 ft.										
10														
15														
20														
25														

Completion Depth: 8.20
Date Boring Started: 12/13/19
Date Boring Completed: 12/13/19
Engineer/Geologist: BH
Project No.: 20172033

Remarks: Boring drilled using hand auger. Groundwater was not encountered during drilling. Hand auger refusal was encountered at 8.2 ft.

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

KC LOG WITH LAB BORING LOGS.GPJ 12/31/19

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

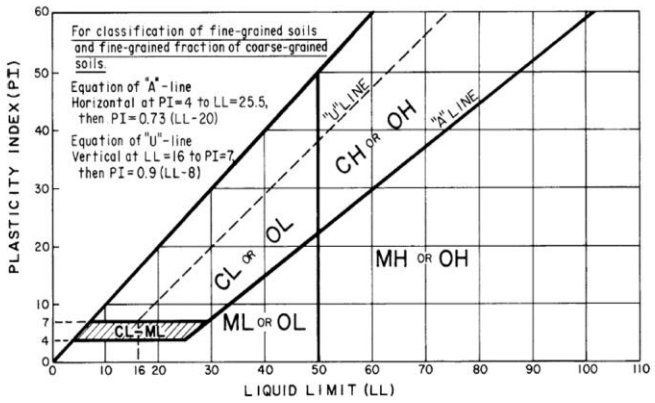
G Sample grabbed from auger

▮▮ 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 Terr. #5
Kansas City, MO 64153
816-599-7965 816-599-7967 Fax

Compressive Strength Test of Rock Core

Date: 12/24/2019
Project Name: North Green Hills Road Water Transmissior
TSi Project No.: 20172033

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	11.0	12/23/19	1.86	4.50	0.14	164.36	2.71	40,860	15,098	2,174
B-2	C-02	12.5	12/23/19	1.85	4.60	0.32	162.22	2.68	30,880	11,523	1,659

Note:* Compressive strength of rock cores were determined by trimming samples to 90 degree planes at each end (differs slightly from method described in D4543) and breaking in concrete strength machine per ASTM C39.

APPENDIX D

Rock Core Photographs

B-01 **North Green Hills Road Water Transmission Main** **20172033**

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	2.5 to 3.6	76	0

B-02 **North Green Hills Road Water Transmission Main** **20172033**

Run No.	Depth (ft)	Recovery (%)	RQD (%)
1	11.0 to 15.0	92	81