



September 18, 2017  
Kleinfelder Project No. 20174530.001A

Mr. Steven L. Scott, PE  
Senior Vice President  
SEPI Engineering & Construction  
1025 Wade Avenue  
Raleigh, North Carolina 27605

**Reference:   Structure Foundation Recommendations Report  
                  Culvert No. 75 - SR 1564 Holly Mount Church Road over Little Creek  
                  WBS No. 17BP.8.R.128  
                  TIP No. SF-610075  
                  Montgomery County, North Carolina**

Dear Mr. Scott:

Kleinfelder has completed the authorized subsurface investigation and structure foundation recommendation report for the referenced project. Included in the Appendix is the structure subsurface inventory

## **PROJECT INFORMATION**

Proposed for construction are two new cast-in-place box culverts for SR 1564 Holly Mount Church over Little Creek. The proposed culverts will be approximately 68 feet in length, 9 feet in height, and 7 feet in width. The skew angle is 43°36' to the tangent. The invert elevations at the inlet and outlet are expected to be near 274.35 feet and 273.84 feet, respectively. Based on information provided by SEPI, no local scour is anticipated. The maximum embankment height at the culvert is anticipated to be approximately 3.5 feet.

## **FOUNDATION RECOMMENDATIONS**

### **Culvert Foundations**

Based on the geologic conditions encountered and our foundation analyses, shallow spread footing foundations on weathered rock and crystalline rock are the most appropriate foundation system for the culvert bottom. The weathered rock and crystalline rock below the bottom slab are suitable for a net allowable contact pressure of up to 4,000 pounds per square foot in conjunction with a modulus of subgrade reaction equal to 150 pounds per cubic inch as referenced to a 30 inch diameter plate.

Foundation conditioning material will be required between the culvert floor slab bottom and the foundation soils. A minimum 12 inch blanket of Foundation Conditioning Material is required under the entire area of the floor slab, per the Structure Design Manual.

### **Culvert Settlements**

The proposed fill embankment was analyzed to estimate the anticipated consolidation of the foundation soils due to the weight of the new fill. The results of Kleinfelder's analysis indicate the total embankment settlement is expected to be on the order of 0.5 inch or less.

## CONSTRUCTION CONSIDERATIONS

Alluvial soils are present at the north end of the culvert, to an elevation of 272.2 feet MSL. Any alluvial soil present at or below the culvert foundation level should be removed and replaced with Foundation Conditioning Material prior to culvert construction.

Proper drainage and filtration of the wing wall backfill soils should be included as part of culvert design and construction. The engineering properties of the soils in the reinforced zone should be confirmed through laboratory testing as part of the submittals.

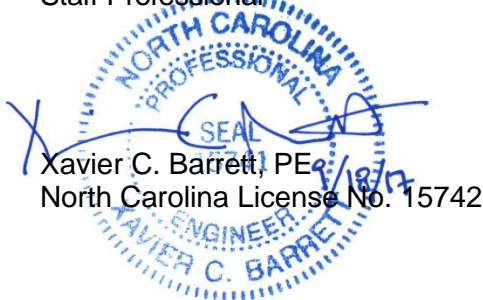
## CLOSURE

Kleinfelder appreciates the opportunity to be of service to you on this project. Should you have any questions or require additional information, please contact the undersigned.

Respectfully,  
**KLEINFELDER, INC.**  
Firm License No. F-1312

A handwritten signature in blue ink, appearing to read "Dan Kubinski".

Daniel H. Kubinski, EIT  
Staff Professional

A circular blue ink seal for a North Carolina Professional Engineer. The outer ring contains the text "NORTH CAROLINA" at the top and "PROFESSIONAL" at the bottom. The inner circle contains the word "SEAL" at the top, "ENGINEER" at the bottom, and the name "XAVIER C. BARRETT" in the center. A handwritten signature in blue ink is written across the seal, and the date "9/18/17" is written to the right of the seal.

Xavier C. Barrett, PE  
North Carolina License No. 15742

DHK/XCB:cas  
Attachments

- Notes and Comments
- Bearing Capacity Calculations
- Settlement Calculations
- Subsurface Inventory

## RCBC RECOMMENDATION NOTES AND COMMENTS

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**WBS NO.:** 17BP.8.R.128

**T.I.P. NO.:** SF-610075

**DESCRIPTION:** Culvert No. 75 - SR 1564 Holly Mount Church Road over Little Creek

**COUNTY:** Montgomery

**ALIGNMENT:** -L-

**FOUNDATION RECOMMENDATION NOTES ON PLANS:**

1. Construct the reinforced concrete box culverts at station 16+90 with 0" camber to account for anticipated settlement.
2. Backfill with select material, Class III meeting the requirements of Section 1016 of the Standard Specifications.
3. Use Class VI select material foundation conditioning material in accordance with Section 1016 of the Standard Specifications.

**FOUNDATION RECOMMENDATION COMMENTS:**

1. The Geotechnical Engineer of Record should field verify during construction that adequate foundation conditions are present at the culvert site and adjust foundation conditioning material thickness recommendations as needed.

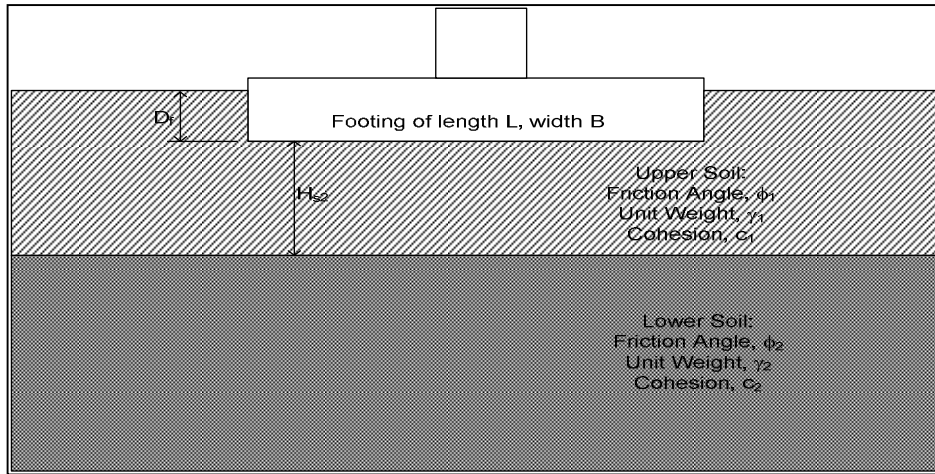
## BEARING CAPACITY CALCULATION

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Project Name: SEPI Culvert No 75  
 Project No.: 20174530  
 Subject: Spread Footing Bearing Capacity  
 Work: Culvert Foundation - No 75  
 Boring: B-2

Date: 09/06/17  
 Setup by: DHK  
 Computed By: DHK  
 Checked By: XCB

**OBJECTIVE:** Determine the LRFD factored bearing resistance of the culvert.



**Input:**

Upper Soil:		Lower Soil:		Footing Info:	
Cohesion, ksf	0	Cohesion, ksf	0	Width, B (ft)	25
Friction Angle, $\phi$	32	Friction Angle, $\phi$	45	Length, L (ft)	35
Unit Weight, kcf	0.105	Unit Weight, kcf	0.145	Df, ft	1
Is Upper Soil Drained?	yes	resistance factor	0.45	Hs2, (ft)	1.2

**May Consider Bearing Capacity of Upper Soil Layer Only**

**General Bearing Capacity Factors:**

Sc =	1.47	Nm =	0.2	Nc =	35.5
Sgamma =	0.71	Ncm =	0.0	Nq =	23.2
Sq =	1.45	Nqm =	1.0	Ngamma =	30.2
ic =	1	Ngammam =	21.6	Cwq =	1
iq =	1	Nc* =	6.17	Cwgamma =	1
igamma =	1			dq =	1

**Two-Layer Soil Parameters:**

q1 (ksf) =	31.84	Bm =	5.21
q2 (ksf) =	385.42	A =	48.45
Hcr (ft) =	-54.6	B =	4.21
$\kappa$ =	0	C =	74.41

**For the Drained Case:**

K =	0.56
qn (ksf) =	408.33

**Factored Bearing Resistance:**

qn, ksf =	31.84
qr, ksf =	14.30

## EMBANKMENT SETTLEMENT CALCULATION

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# EMBANKMENT FOUNDATION SOIL SETTLEMENT

Project Name: SEPI Culvert No. 75  
 KLF Project No.: 20174530  
 Subject: Subsurface Condition Modeling  
 Work: Culvert No. 75 Embankment Settlement Estimate

Date: 09/06/17  
 Setup by: DHK  
 Computed By: DHK  
 Checked By: XCB

## References:

- 1 Soils and Foundations Workshop Manual, USDOT, FHWA Publication No. HI-88-009
- 2 Boring B-2

## 1. MODEL SUBSURFACE CONDITIONS

$\gamma_m$  = 120 pcf, Unit Weight of New Embankment Fill  
 $h$  = 3.5 feet, Height of New Embankment  
 $b$  = 26.5 feet, distance from centerline of road to midpoint of side slope  
 $D$  = 6.5 feet, distance along centerline from midpoint of end slope to point below which calculation is to be made

Layer	From	To	SPT <sub>avg</sub>	Z <sub>avg</sub>	$\gamma_m$	$\gamma_m'$	From Figure 11, Ref. 1					
							Z/b	D/b	K	P <sub>o</sub>	$\Delta P$	P <sub>f</sub>
1	0.0	1.2	23	0.60	105.0	42.6	0.02	0.25	0.60	26	252	278
2	1.2	2.7	100	1.95	145.0	82.6	0.07	0.25	0.60	113	252	365
3	2.7	12.7	100	7.70	150.0	87.6	0.29	0.25	0.60	613	252	865

Note: Assume Soils With SPT>30 Are Incompressible

## 2. ESTIMATE SETTLEMENTS

$$\Delta H_i = H_i * (C_c / (1 + e_o)) \log(P_f / P_o) \quad (\text{Clays, Clayey Soils})$$

$$\Delta H_i = H_i * (1 / C') \log(P_f / P_o) \quad (\text{Sands, Sandy Silts})$$

C<sub>c</sub> From Consolidation Test Results

C' from Formula, Figure 13, Reference 1

$$C' = (1 + e_o) / C_c \quad (\text{SPT} > 10 \text{ bpf}) \quad \text{Calculate C' from Soil Type and SPT N-value}$$

Layer	Soil Type	Height (ft)	C <sub>c</sub> or C'	P <sub>o</sub>	e <sub>o</sub>	P <sub>f</sub>	$\Delta H_i$ (in)	Comments
1	SAND	1.2	-65	26	0.800	278	-0.2	
2	WR	1.5	-2000	113	0.500	365	0.0	
3	CR	10.0	-2000	613	0.500	865	0.0	
Total Calculated Settlement							-0.2	inches
Rheological Factor							2/3	for residual soils only
Total Settlement Potential							-0.2	inches

## 3. ESTIMATE TIME OF SETTLEMENT

From Reference 1, pgs 179 to 180

a. Time for Settlement, t, in days =  $T H_v^2 / C_v$ , where

T = Theoretical Time Factor for 90% Consol

H<sub>v</sub> = Maximum Drainage Path (feet)

C<sub>v</sub> = Coefficient of Consolidation (ft<sup>2</sup>/day)

$$T = 0.848$$

c. Estimate C<sub>v</sub>:

### c.1: From Lab Test:

T<sub>i</sub> = 0.848 Theoretical Time Factor For Period of Interest

H<sub>v</sub> = 0.953 Effective Test Specimen Drainage Path, cm

t<sub>i</sub> = 15 Consolidation Time For Period of Interest, min  
 (From Square Root of Time Plots)

$$C_v = 0.848 * 0.953^2 / 15$$

$$= 0.051 \text{ cm}^2/\text{min}$$

$$= 0.078 \text{ ft}^2/\text{day}$$

### c.3: From Experience, estimate

$$C_v = 1.00 \text{ ft}^2/\text{day}$$

b. Determine Drainage Path Length

Stratum Thickness = 1.2 feet (Layer 1)

Drainage = 1 (Single), 2 (Double) Drainage

Path Length = 1.2 feet

$$t = 0.848 * 1.2^2 / 1.00$$

$$= 1.2 \text{ days}$$

USCS	Percent Fines	C <sub>v</sub> (ft <sup>2</sup> /day)
GW	0 - 5	10
	5 - 10	4
	10 - 20	2
	>20	1
GM	0 - 5	5
	5 - 10	3
	10 - 20	2
	>20	1
SW	0 - 5	10
	5 - 10	5
	10 - 20	2
	>20	1
SM	0 - 5	4
	5 - 10	3
	10 - 20	2
	>20	1
ML	50 - 60	0.50
	60 - 70	0.30
	70 - 80	0.20
	>80	0.10
MH	50 - 60	0.30
	60 - 70	0.15
	70 - 80	0.10
	>80	0.05
CL	50 - 60	0.10
	60 - 70	0.05
	70 - 80	0.02
	>80	0.01



## STRUCTURE SUBSURFACE INVENTORY

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REFERENCE: SF-610075

PROJECT: 17BP.8.R.128

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	SF-610075	1	8

**STATE OF NORTH CAROLINA**  
**DEPARTMENT OF TRANSPORTATION**  
**DIVISION OF HIGHWAYS**  
**GEOTECHNICAL ENGINEERING UNIT**

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**STRUCTURE**  
**SUBSURFACE INVESTIGATION**

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COUNTY MONTGOMERY  
PROJECT DESCRIPTION CULVERT 75 ON SR 1564 (HOLLY MOUNTAIN CHURCH ROAD) OVER LITTLE CREEK

**CONTENTS**

<u>SHEET NO.</u>	<u>DESCRIPTION</u>
1	TITLE SHEET
2, 2A	LEGEND (SOIL & ROCK)
3	SITE PLAN
4	PROFILE
5-7	BORE LOGS

PERSONNEL  
C. DRISCOLL  
E. ESTEP  
T. PRESTON

INVESTIGATED BY C. DRISCOLL  
DRAWN BY B. JOHNSON  
CHECKED BY X. BARRETT  
SUBMITTED BY KLEINFELDER, INC.  
DATE SEPTEMBER 2017

**CAUTION NOTICE**

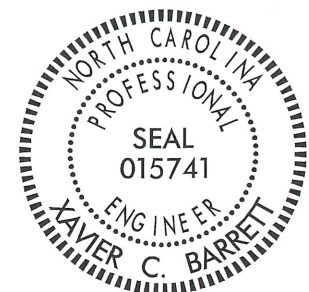
THE SUBSURFACE INFORMATION AND THE SUBSURFACE INVESTIGATION ON WHICH IT IS BASED WERE MADE FOR THE PURPOSE OF STUDY, PLANNING AND DESIGN, AND NOT FOR CONSTRUCTION OR PAY PURPOSES. THE VARIOUS FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA AVAILABLE MAY BE REVIEWED OR INSPECTED IN RALEIGH BY CONTACTING THE N.C. DEPARTMENT OF TRANSPORTATION, GEOTECHNICAL ENGINEERING UNIT AT (919) 707-6850. THE SUBSURFACE PLANS AND REPORTS, FIELD BORING LOGS, ROCK CORES AND SOIL TEST DATA ARE NOT PART OF THE CONTRACT.

GENERAL SOIL AND ROCK STRATA DESCRIPTIONS AND INDICATED BOUNDARIES ARE BASED ON A GEOTECHNICAL INTERPRETATION OF ALL AVAILABLE SUBSURFACE DATA AND MAY NOT NECESSARILY REFLECT THE ACTUAL SUBSURFACE CONDITIONS BETWEEN BORINGS OR BETWEEN SAMPLED STRATA WITHIN THE BOREHOLE. THE LABORATORY SAMPLE DATA AND THE IN SITU (IN-PLACE) TEST DATA CAN BE RELIED ON ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE STANDARD TEST METHOD. THE OBSERVED WATER LEVELS OR SOIL MOISTURE CONDITIONS INDICATED IN THE SUBSURFACE INVESTIGATIONS ARE AS RECORDED AT THE TIME OF THE INVESTIGATION; THESE WATER LEVELS OR SOIL MOISTURE CONDITIONS MAY VARY CONSIDERABLY WITH TIME ACCORDING TO CLIMATIC CONDITIONS INCLUDING TEMPERATURES, PRECIPITATION AND WIND, AS WELL AS OTHER NON-CLIMATIC FACTORS.

THE BIDDER OR CONTRACTOR IS CAUTIONED THAT DETAILS SHOWN ON THE SUBSURFACE PLANS ARE PRELIMINARY ONLY AND IN MANY CASES THE FINAL DESIGN DETAILS ARE DIFFERENT. FOR BIDDING AND CONSTRUCTION PURPOSES, REFER TO THE CONSTRUCTION PLANS AND DOCUMENTS FOR FINAL DESIGN INFORMATION ON THIS PROJECT. THE DEPARTMENT DOES NOT WARRANT OR GUARANTEE THE SUFFICIENCY OR ACCURACY OF THE INVESTIGATION MADE, NOR THE INTERPRETATIONS MADE, OR OPINION OF THE DEPARTMENT AS TO THE TYPE OF MATERIALS AND CONDITIONS TO BE ENCOUNTERED. THE BIDDER OR CONTRACTOR IS CAUTIONED TO MAKE SUCH INDEPENDENT SUBSURFACE INVESTIGATIONS AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO CONDITIONS TO BE ENCOUNTERED ON THE PROJECT. THE CONTRACTOR SHALL HAVE NO CLAIM FOR ADDITIONAL COMPENSATION OR FOR AN EXTENSION OF TIME FOR ANY REASON RESULTING FROM THE ACTUAL CONDITIONS ENCOUNTERED AT THE SITE DIFFERING FROM THOSE INDICATED IN THE SUBSURFACE INFORMATION.

- NOTES:
1. THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N.C. DEPARTMENT OF TRANSPORTATION AS ACCURATE NOR IS IT CONSIDERED PART OF THE PLANS, SPECIFICATIONS OR CONTRACT FOR THE PROJECT.
  2. BY HAVING REQUESTED THIS INFORMATION, THE CONTRACTOR SPECIFICALLY WAIVES ANY CLAIMS FOR INCREASED COMPENSATION OR EXTENSION OF TIME BASED ON DIFFERENCES BETWEEN THE CONDITIONS INDICATED HEREIN AND THE ACTUAL CONDITIONS AT THE PROJECT SITE.

Prepared in the Office of:



*[Signature]* 9/18/17  
SIGNATURE DATE

**DOCUMENT NOT CONSIDERED FINAL  
UNLESS ALL SIGNATURES COMPLETED**

SF-610075

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**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
GEOTECHNICAL ENGINEERING UNIT**

# SUBSURFACE INVESTIGATION





## SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS (PAGE 1 OF 2)

SOIL DESCRIPTION										GRADATION																													
SOIL IS CONSIDERED UNCONSOLIDATED, SEMI-CONSOLIDATED, OR WEATHERED EARTH MATERIALS THAT CAN BE PENETRATED WITH A CONTINUOUS FLIGHT POWER AUGER AND YIELD LESS THAN 100 BLOWS PER FOOT ACCORDING TO THE STANDARD PENETRATION TEST (AASHTO T 206, ASTM D1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY INCLUDE THE FOLLOWING: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. FOR EXAMPLE, VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6										<b>WELL GRADED</b> - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE. <b>UNIFORMLY GRADED</b> - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. <b>GAP-GRADED</b> - INDICATES A MIXTURE OF UNIFORM PARTICLE SIZES OF TWO OR MORE SIZES.																													
<b>SOIL LEGEND AND AASHTO CLASSIFICATION</b>										<b>ANGULARITY OF GRAINS</b>																													
THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS: ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.										<b>MINERALOGICAL COMPOSITION</b>																													
MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.										<b>COMPRESSIBILITY</b>																													
SLIGHTLY COMPRESSIBLE MODERATELY COMPRESSIBLE HIGHLY COMPRESSIBLE										LL < 31 LL = 31 - 50 LL > 50																													
<b>PERCENTAGE OF MATERIAL</b>										<b>GROUND WATER</b>																													
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>ORGANIC MATERIAL</th> <th>GRANULAR SOILS</th> <th>SILT - CLAY SOILS</th> <th>OTHER MATERIAL</th> </tr> </thead> <tbody> <tr> <td>TRACE OF ORGANIC MATTER</td> <td>2 - 3%</td> <td>3 - 5%</td> <td>TRACE</td> </tr> <tr> <td>LITTLE ORGANIC MATTER</td> <td>3 - 5%</td> <td>5 - 12%</td> <td>LITTLE</td> </tr> <tr> <td>MODERATELY ORGANIC</td> <td>5 - 10%</td> <td>12 - 20%</td> <td>SOME</td> </tr> <tr> <td>HIGHLY ORGANIC</td> <td>&gt; 10%</td> <td>&gt; 20%</td> <td>HIGHLY</td> </tr> </tbody> </table>										ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL	TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE	LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE	MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME	HIGHLY ORGANIC	> 10%	> 20%	HIGHLY	WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING STATIC WATER LEVEL AFTER 24 HOURS PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA SPRING OR SEEP									
ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL																																				
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE																																				
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HIGHLY ORGANIC	> 10%	> 20%	HIGHLY																																				
<b>MISCELLANEOUS SYMBOLS</b>										<b>RECOMMENDATION SYMBOLS</b>																													
ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION SOIL SYMBOL ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT INFERRED SOIL BOUNDARY INFERRED ROCK LINE ALLUVIAL SOIL BOUNDARY										DIP & DIP DIRECTION OF ROCK STRUCTURES TEST BORING AUGER BORING CORE BORING MONITORING WELL PIEZOMETER INSTALLATION SLOPE INDICATOR INSTALLATION CONE PENETROMETER TEST SOUNDING ROD TEST BORING WITH CORE SPT N-VALUE																													
<b>TEXTURE OR GRAIN SIZE</b>										<b>ABBREVIATIONS</b>																													
U.S. STD. SIEVE SIZE OPENING (MM) 4 10 40 60 200 270 4.76 2.00 0.42 0.25 0.075 0.053										UNDERCUT UNCLASSIFIED EXCAVATION - UNSUITABLE WASTE UNCLASSIFIED EXCAVATION - ACCEPTABLE DEGRADABLE ROCK UNCLASSIFIED EXCAVATION - ACCEPTABLE, BUT NOT TO BE USED IN THE TOP 3 FEET OF EMBANKMENT OR BACKFILL																													
BOULDER (BLDR.) COBBLE (COB.) GRAVEL (GR.) COARSE SAND (CSE, SD.) FINE SAND (F SD.) SILT (SL.) CLAY (CL.)										<b>SOIL MOISTURE - CORRELATION OF TERMS</b>																													
GRAIN SIZE MM 305 75 2.0 0.25 0.05 0.005 IN. 12 3										AR - AUGER REFUSAL BT - BORING TERMINATED CL - CLAY CPT - CONE PENETRATION TEST CSE - COARSE DMT - DILATOMETER TEST DPT - DYNAMIC PENETRATION TEST e - VOID RATIO F - FINE FOSS. - FOSSILIFEROUS FRAC. - FRACTURED, FRACTURES FRAGS. - FRAGMENTS HI. - HIGHLY																													
<b>PLASTICITY</b>										<b>EQUIPMENT USED ON SUBJECT PROJECT</b>																													
SOIL MOISTURE SCALE (ATTERBERG LIMITS) FIELD MOISTURE DESCRIPTION GUIDE FOR FIELD MOISTURE DESCRIPTION										MED. - MEDIUM MICA - MICACEOUS MOD. - MODERATELY NP - NON PLASTIC ORG. - ORGANIC PMT - PRESSUREMETER TEST SAP. - SAPROLITIC SD. - SAND, SANDY SL. - SILT, SILTY SLI. - SLIGHTLY TCR - TRICONE REFUSAL w - MOISTURE CONTENT V - VERY																													
LL - LIQUID LIMIT PL - PLASTIC LIMIT OM - OPTIMUM MOISTURE SHRINKAGE LIMIT										VST - VANE SHEAR TEST WEA. - WEATHERED ? - UNIT WEIGHT ?g - DRY UNIT WEIGHT SAMPLE ABBREVIATIONS S - BULK SS - SPLIT SPOON ST - SHELBY TUBE RS - ROCK RT - RECOMPACTED TRIAXIAL CBR - CALIFORNIA BEARING RATIO																													
<b>DRILL UNITS:</b>										<b>ADVANCING TOOLS:</b>																													
<input type="checkbox"/> CME-45C <input type="checkbox"/> CME-55 <input type="checkbox"/> CME-550 <input type="checkbox"/> VANE SHEAR TEST <input type="checkbox"/> PORTABLE HOIST <input checked="" type="checkbox"/> MOBILE B-57										<input type="checkbox"/> CLAY BITS <input type="checkbox"/> 6" CONTINUOUS FLIGHT AUGER <input checked="" type="checkbox"/> 8" HOLLOW AUGERS <input type="checkbox"/> HARD FACED FINGER BITS <input type="checkbox"/> TUNG-CARBIDE INSERTS <input type="checkbox"/> CASING <input type="checkbox"/> W/ ADVANCER <input type="checkbox"/> TRICONE * STEEL TEETH <input type="checkbox"/> TRICONE * TUNG.-CARB. <input type="checkbox"/> CORE BIT																													
<b>PLASTICITY INDEX (PI)</b>										<b>HAMMER TYPE:</b>																													
NON PLASTIC 0-5 SLIGHTLY PLASTIC 6-15 MODERATELY PLASTIC 16-25 HIGHLY PLASTIC 26 OR MORE										<input checked="" type="checkbox"/> AUTOMATIC <input type="checkbox"/> MANUAL CORE SIZE: <input type="checkbox"/> -B <input type="checkbox"/> -H <input type="checkbox"/> -N																													
<b>COLOR</b>										<b>HAND TOOLS:</b>																													
DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-GRAY). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.										<input type="checkbox"/> POST HOLE DIGGER <input type="checkbox"/> HAND AUGER <input type="checkbox"/> SOUNDING ROD <input type="checkbox"/> VANE SHEAR TEST																													

**NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
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GEOTECHNICAL ENGINEERING UNIT**

# SUBSURFACE INVESTIGATION

## SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS (PAGE 2 OF 2)

ROCK DESCRIPTION		TERMS AND DEFINITIONS	
<p>HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS IN NON-COASTAL PLAIN MATERIAL. THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK. ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:</p>			
WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.	
CRYSTALLINE ROCK (CR)		FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.	
NON-CRYSTALLINE ROCK (NCR)		FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.	
COASTAL PLAIN SEDIMENTARY ROCK (CP)		COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.	
WEATHERING			
FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.		
VERY SLIGHT (V SL.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN. CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.		
SLIGHT (SL.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.		
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.		
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. <u>IF TESTED, WOULD YIELD SPT REFUSAL</u>		
SEVERE (SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES &gt; 100 BPF</u>		
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. <u>IF TESTED, WOULD YIELD SPT N VALUES &lt; 100 BPF</u>		
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.		
ROCK HARDNESS			
VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.		
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.		
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.		
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.		
SOFT	CAN BE GROVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.		
VERY SOFT	CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.		
FRACTURE SPACING		BEDDING	
TERM	SPACING	TERM	THICKNESS
VERY WIDE	MORE THAN 10 FEET	VERY THICKLY BEDDED	4 FEET
WIDE	3 TO 10 FEET	THICKLY BEDDED	1.5 - 4 FEET
MODERATELY CLOSE	1 TO 3 FEET	THINLY BEDDED	0.16 - 1.5 FEET
CLOSE	0.16 TO 1 FOOT	VERY THINLY BEDDED	0.03 - 0.16 FEET
VERY CLOSE	LESS THAN 0.16 FEET	THICKLY LAMINATED	0.008 - 0.03 FEET
		THINLY LAMINATED	< 0.008 FEET
INDURATION			
FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.			
FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.		
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.		
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.		
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.		
		BENCH MARK: RR SPIKE IN 17" HICKORY TREE STA. 13+05 -BL- (543,16 FT. N, 1,734,432 FT. E)	
		ELEVATION: 290.13 FEET	
NOTES:			
FIAD - FILLED IMMEDIATELY AFTER DRILLING			

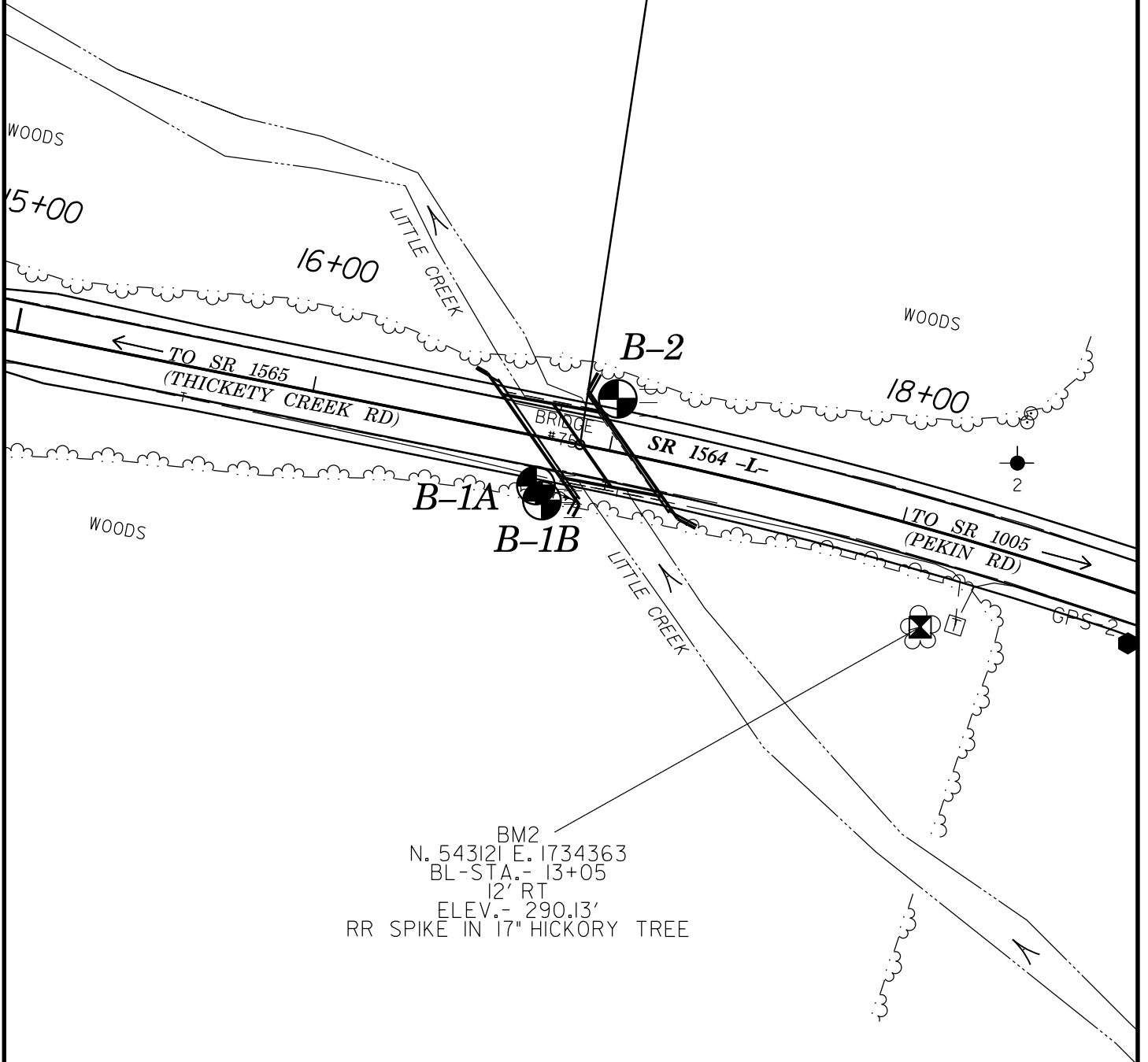
DATE: 8-15-14

PROJECT REFERENCE NO.	SHEET NO.
SF-610075	3
SITE PLAN	
0 50 100 FEET	



-L- PC Sta. 16+90.04

-L- PT Sta. 1

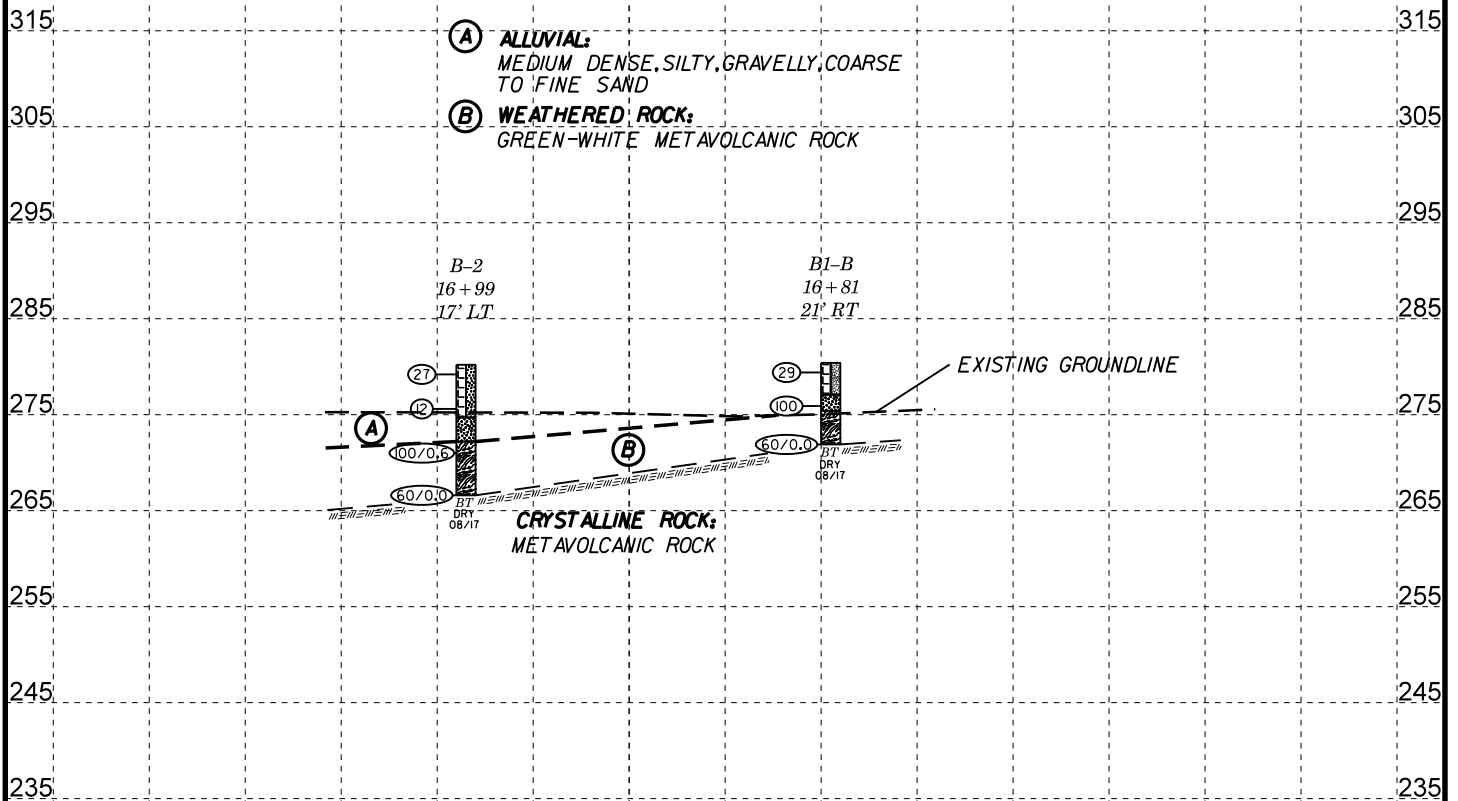


**SKEW ANGLE: 43° 36' 15"**

NOTES:  
 GROUNDLINE TAKEN FROM ROADWAY DESIGN  
 TIN FILE 620212\_LS\_TIN.TIN RECEIVED ON  
 8/25/2017

INFERRED STRATIGRAPHY IS DRAWN THROUGH  
 THE BORINGS WITH BOTH PROJECTED ONTO  
 THE PROFILE

SKEW: 43°36'15"



HORIZ. SCALE 0 20 40  
 (FEET)

VE = 1:1

PROFILE ALONG CULVERT  
 NO. 75 CENTERLINE



# GEOTECHNICAL BORING REPORT

## BORE LOG

SHEET 6

<b>WBS</b> 17BP.8.R.128			<b>TIP</b> SF-610075			<b>COUNTY</b> MONTGOMERY			<b>GEOLOGIST</b> Driscoll, C.		
<b>SITE DESCRIPTION</b> Culvert No. 75 - SR 1564 Holly Mount Church Road over Little Creek									<b>GROUND WTR (ft)</b>		
<b>BORING NO.</b> B-1B			<b>STATION</b> 16+81			<b>OFFSET</b> 21 ft RT			<b>ALIGNMENT</b> -L-		
<b>COLLAR ELEV.</b> 280.4 ft			<b>TOTAL DEPTH</b> 8.5 ft			<b>NORTHING</b> 543,163			<b>EASTING</b> 1,734,238		
<b>DRILL RIG/HAMMER EFF./DATE</b> TRI8016 MOBILE B-57 97% 02/24/2017						<b>DRILL METHOD</b> H.S. Augers			<b>HAMMER TYPE</b> Automatic		
<b>DRILLER</b> Estep, E.			<b>START DATE</b> 08/01/17			<b>COMP. DATE</b> 08/01/17			<b>SURFACE WATER DEPTH</b> N/A		

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100							
285																	
280	280.4	0.0	9	14	15										280.4	GROUND SURFACE	0.0
	276.9	3.5	24	19	81										277.1	<b>ROADWAY EMBANKMENT</b> Very Stiff, Non Plastic, Light Brown, Coarse to Fine Sandy SILT	3.3
275	271.9	8.5													275.4	<b>ALLUVIAL</b> Very Dense, Non Plastic, Gray-Light Brown, Silty, Gravelly, Coarse to Fine SAND	5.0
															271.9	<b>WEATHERED ROCK</b> Green-White METAVOLCANIC ROCK Boring Terminated with Standard Penetration Test Refusal at Elevation 271.9 ft on CRYSTALLINE ROCK (METAVOLCANIC ROCK)	8.5



# GEOTECHNICAL BORING REPORT

## BORE LOG

SHEET 7

<b>WBS</b> 17BP.8.R.128			<b>TIP</b> SF-610075			<b>COUNTY</b> MONTGOMERY			<b>GEOLOGIST</b> Driscoll, C.		
<b>SITE DESCRIPTION</b> Culvert No. 75 - SR 1564 Holly Mount Church Road over Little Creek									<b>GROUND WTR (ft)</b>		
<b>BORING NO.</b> B-2			<b>STATION</b> 16+99			<b>OFFSET</b> 17 ft LT			<b>ALIGNMENT</b> -L-		
<b>COLLAR ELEV.</b> 280.2 ft			<b>TOTAL DEPTH</b> 13.6 ft			<b>NORTHING</b> 543,197			<b>EASTING</b> 1,734,263		
<b>DRILL RIG/HAMMER EFF./DATE</b> TRI8016 MOBILE B-57 97% 02/24/2017						<b>DRILL METHOD</b> H.S. Augers			<b>HAMMER TYPE</b> Automatic		
<b>DRILLER</b> Estep, E.			<b>START DATE</b> 08/01/17			<b>COMP. DATE</b> 08/01/17			<b>SURFACE WATER DEPTH</b> N/A		

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)		
			0.5ft	0.5ft	0.5ft	0	25	50	75	100							
285																	
280	280.2	0.0	9	8	19										280.2	GROUND SURFACE	0.0
275	276.6	3.6	17	8	4										274.7	ROADWAY EMBANKMENT Medium Dense, Non Plastic, Silty, Gravelly, Coarse to Fine SAND	5.5
270	271.6	8.6	75	25/0.1											272.2	ALLUVIAL Medium Dense, Non Plastic, Silty, Gravelly, Coarse to Fine SAND	8.0
	266.6	13.6	60/0.0												266.6	WEATHERED ROCK Green-White METAVOLCANIC ROCK	13.6
																Boring Terminated with Standard Penetration Test Refusal at Elevation 266.6 ft on CRYSTALLINE ROCK (METAVOLCANIC ROCK)	