

**This electronic collection of documents is provided  
for the convenience of the user  
and is Not a Certified Document –**

**The documents contained herein were originally issued  
and sealed by the individuals whose names and license  
numbers appear on each page, on the dates appearing  
with their signature on that page.**

**This file or an individual page  
shall not be considered a certified document.**



PAT McCRORY  
Governor

NICHOLAS J. TENNYSON  
Secretary

October 3, 2016

MEMORANDUM TO: Brice Bell, P.E.  
Division Bridge Program Manager - Division 6

FROM: K. J. Kim, Ph.D., P.E. DocuSigned by:  
*K.J. Kim* 10/3/2016  
Eastern Regional Geotechnical Manager C80085B481F44A7

PROJECT: 53088.1.FD1 (R-5752)  
COUNTY: Robeson

DESCRIPTION: Bridge on -Y- SR 2220 over -L- (US 74) at Sta. 30+39 -Y-

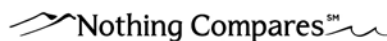
SUBJECT: Bridge Foundation Recommendations

The Geotechnical Engineering Unit has reviewed and presents the subsurface investigation and foundation recommendations prepared by Geosyntec Consultants of NC, for the above referenced structure and present the following project data:

- Bridge Inventory ( 8 ) pages
- Foundation Design Recommendations ( 3 ) pages
- Design Calculations ( ) pages
- Special Provisions ( 2 ) pages

Please call Majid Khazaei, P.E. or Jamie L. Pedro, L.G. at (919) 662-4710 if there are any questions concerning this memorandum.

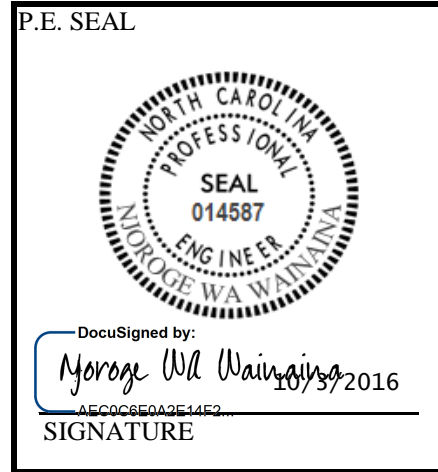
KJK/CAK/MK  
Attachment



# FOUNDATION RECOMMENDATIONS

WBS	53088.1.FD1	DESCRIPTION	Bridge On -Y- (SR 2220) Over -L-
TIP NO.	R-5752		(US 74)
COUNTY	Robeson		
STATION	30+39 -Y-		

	INITIALS	DATE
DESIGN	NWW	9/5/16
CHECK	WS	9/19/16

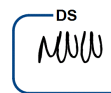


	BENT STATION	FOUNDATION TYPE	FACTORED RESISTANCE	ADDITIONAL INFORMATION
END BENT 1	29 + 46.23 -Y-	Cap on HP 12 x 53 Steel H-Piles	110 Tons/Pile	Bottom of Cap Elev. = 136.5 ft Average Estimated Pile Length = 55 ft Number of Piles/Cap = 8
BENT 1	30 + 39.23 -Y-	Footing on HP x 53 Steel H-Piles	100 Tons/Pile	Bottom of Footing Elev. = 117.9 ft Average Estimated Pile Length = 55 ft Number of Piles/Footing = 6
END BENT 2	31+32.23 -Y-	Cap on HP12 x 53 Steel H-Piles	110 Tons/pile	Bottom of Cap Elev. = 136.3 ft Average Estimated Pile Length = 55 ft. Number of Piles/Cap = 8

**(SEE NOTES ON PLANS AND COMMENTS ON FOLLOWING PAGES.)**

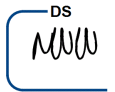
## **FOUNDATION RECOMMENDATIONS NOTES ON PLANS**

1. FOR PILES, SEE GEOTECHNICAL SPECIAL PROVISIONS AND SECTION 450 OF THE STANDARD SPECIFICATIONS.
2. PILES AT END BENT NO. 1 ARE DESIGNED FOR A FACTORED RESISTANCE OF 110 TONS PER PILE.
3. PILES AT END BENT NO. 2 ARE DESIGNED FOR A FACTORED RESISTANCE OF 110 TONS PER PILE.
4. PILES AT BENT NO. 1 ARE DESIGNED FOR A FACTORED RESISTANCE OF 100 TONS PER PILE.
5. DRIVE PILES AT END BENT NO. 1 TO A REQUIRED DRIVING RESISTANCE OF 183 TONS PER PILE.
6. DRIVE PILES AT END BENT NO. 2 TO A REQUIRED DRIVING RESISTANCE OF 183 TONS PER PILE.
7. DRIVE PILES AT BENT NO. 1 TO A REQUIRED DRIVING RESISTANCE OF 167 TONS PER PILE.
8. TESTING PILES WITH THE PDA DURING DRIVING, RESTRIKING OR REDRIVING MAY BE REQUIRED. THE ENGINEER WILL DETERMINE THE NEED FOR PDA TESTING. FOR PDA TESTING, SEE SECTION 450 OF THE STANDARD SPECIFICATIONS.



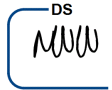
## **FOUNDATION RECOMMENDATIONS NOTES ON PLANS**

9. OBSERVE A 4 MONTH WAITING PERIOD AFTER CONSTRUCTING THE EMBANKMENT TO WITHIN 2 FT OF FINISHED GRADE BEFORE BEGINNING END BENT CONSTRUCTION AT END BENT NO 1. FOR BRIDGE WAITING PERIODS, SEE ROADWAY PLANS AND SPECIAL PROVISIONS
  
10. OBSERVE A 4 MONTH WAITING PERIOD AFTER CONSTRUCTING THE EMBANKMENT TO WITHIN 2 FT OF FINISHED GRADE BEFORE BEGINNING END BENT CONSTRUCTION AT END BENT NO 2. FOR BRIDGE WAITING PERIODS, SEE SEE ROADWAY PLANS AND SPECIAL PROVISIONS



## **FOUNDATION RECOMMENDATIONS COMMENTS**

1. Bridge end bent slopes of 1.5:1.0 (H:V) are ok with concrete slope protection.
2. Bridge approach fills for subregional tier bridges are required for both end bents.
3. The embankments to be constructed at both end bents will be instrumented to monitor settlement.  
See Roadway plans for detail.
4. The factored axial load for End Bent No. 1 is 110 tons per pile.
5. The factored axial load for End Bent No. 2 is 110 tons per pile.
6. The factored axial load for Bent No. 1 is 100 tons per pile.



## PILE PAY ITEMS

(Revised 8/11/15)

WBS ELEMENT 53088.1.FD1

DATE 9/13/2017

TIP NO. R-5752

DESIGNED BY NWW

COUNTY Robeson

CHECKED BY WS

STATION 30+39 -Y-

DESCRIPTION Bridge On -Y- (SR 2220) Over -L- (US 74)

NUMBER OF BENTS WITH PILES _____	}	Only required for "Predrilling for Piles" & "Pile Excavation" pay items
NUMBER OF PILES PER BENT _____		
NUMBER OF END BENTS WITH PILES _____		
NUMBER OF PILES PER END BENT _____		

Bent # or End Bent #	PILE PAY ITEM QUANTITIES						PDA Testing (per each)
	Steel Pile Points (yes/no)	Pipe Pile Plates (yes/no/maybe)	Predrilling For Piles (per linear ft)	Pile Redrives (per each)	Pile Excavation (per linear ft)		
					In Soil	Not In Soil	
Bent # 1	No	No	No	9	No	No	X
End Bent # 1	No	No	No	4	No	No	
End Bent # 2	No	No	No	4	No	No	
TOTALS	X	X	0	17	0	0	

Notes:

Blanks or "no" represent quantity of zero.

If steel pile points are required, calculate quantity of "Steel Pile Points" as equal to the number of steel piles.

If pipe pile plates are or may be required, calculate the quantity of "Pipe Pile Plates" as equal to the number of pipe piles.

Show quantity of "PDA Testing" on the plans as total only.

**PILES****(10-20-15)**

Revise the *2012 Standard Specifications* as follows:

**Page 4-70, Article 450-2, Materials**, line 2, in the materials table, replace “Neat Cement Grout, Nonsrink” with “Neat Cement Grout, Type 1”.

**Page 4-70, Article 450-2, Materials**, line 8, in the last sentence of the second paragraph, replace “approved by the Materials and Tests Unit.” with “that are on the NCDOT Approved Products List.”

**Page 4-72, Subarticle 450-3(D)(3), Required Driving Resistance**, lines 26-30, replace first paragraph with the following:

The Engineer will determine if the proposed pile driving methods and equipment are acceptable and provide the blows/ft and equivalent set for the required driving resistance noted in the plans, i.e., “pile driving criteria” except for structures with pile driving analyzer (PDA) testing. For structures with PDA testing, provide pile driving criteria for any bents and end bents with piles in accordance with Subarticle 450-3(F)(4).

**Page 4-73, Subarticle 450-3(E)(1), Pile Excavation**, lines 19-20, in the third sentence of the second paragraph, replace “use smooth or corrugated clean watertight steel casings” with “use smooth non-corrugated clean watertight steel casings”.

**Page 4-73, Subarticle 450-3(F), Pile Driving Analyzer**, lines 45-48, replace third paragraph with the following:

The Engineer will complete the review of the proposed pile driving methods and equipment within 7 days of receiving PDA reports and pile driving criteria. Do not place concrete for caps or footings on piles until PDA reports and pile driving criteria have been accepted.

**Page 4-75, Subarticle 450-3(F), Pile Driving Analyzer**, line 21, add the following to the end of Article 450-3:

(4) Pile Driving Criteria

Analyze pile driving with the GRL Wave Equation Analysis Program (GRLWEAP) manufactured by Pile Dynamics, Inc. Use the same PDA Consultant that provides PDA reports to perform GRLWEAP analyses and develop pile driving criteria. Provide driving criteria sealed by an engineer approved as a Project Engineer (key person) for the same PDA Consultant.

Analyze pile driving so driving stresses, energy transfer, ram stroke and blows/ft from PDA testing and resistances from CAPWAP analyses correlate to GRLWEAP models. Provide pile driving criteria for each combination of required driving resistance and pile length installed for all pile types and sizes. Submit 2 copies of pile driving criteria with



PDA reports. Include the following for driving criteria:

- (a) Project information in accordance with Subarticle 450-3(F)(3)(a)
- (b) Table showing blows/ft and equivalent set vs. either stroke for multiple strokes in increments of 6" or bounce chamber pressure for multiple pressures in increments of 1 psi
- (c) Maximum stroke or blows/ft or pile cushion requirements to prevent overstressing piles as needed
- (d) GRLWEAP software version information
- (e) PDF copy of all pile driving criteria and executable GRLWEAP input and output files

**Page 4-76, Article 450-4, Measurement and Payment**, lines 27-29, replace third sentence of the sixth paragraph with the following:

The contract unit price for *PDA Testing* will be full compensation for performing PDA testing the first time a pile is tested, performing CAPWAP analysis on data collected during initial drive, restrikes and redrives, providing PDA reports, performing GRLWEAP analysis and developing and providing pile driving criteria.



DocuSigned by:  
George W. Wainaina  
AEC0C6E0A2E14F2...  
10/3/2016

REFERENCE: R-5752

PROJECT: 53088

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

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	R-5752	1	8

CONTENTS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	LEGEND (SOIL & ROCK)
3	SITE PLAN
4	PROFILE
5-7	BORE LOGS
8	SOIL TEST RESULTS

STRUCTURE  
SUBSURFACE INVESTIGATION

COUNTY ROBESON  
PROJECT DESCRIPTION PROPOSED BRIDGE ON  
-Y- (SR 2220) AT STA. 30+39.23 OVER  
-L- (US-74) AT STA. 55+06.59

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:
- 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.
  - 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.

PERSONNEL

GEOSYNTEC  
CAROLINA DRILLING  
-  
-  
-  
-  
-

INVESTIGATED BY ROHIT WARRIER  
DRAWN BY CHUCK TURLINGTON  
CHECKED BY NJOROGE WAINAINA  
SUBMITTED BY NJOROGE WAINAINA  
DATE SEPTEMBER 2016

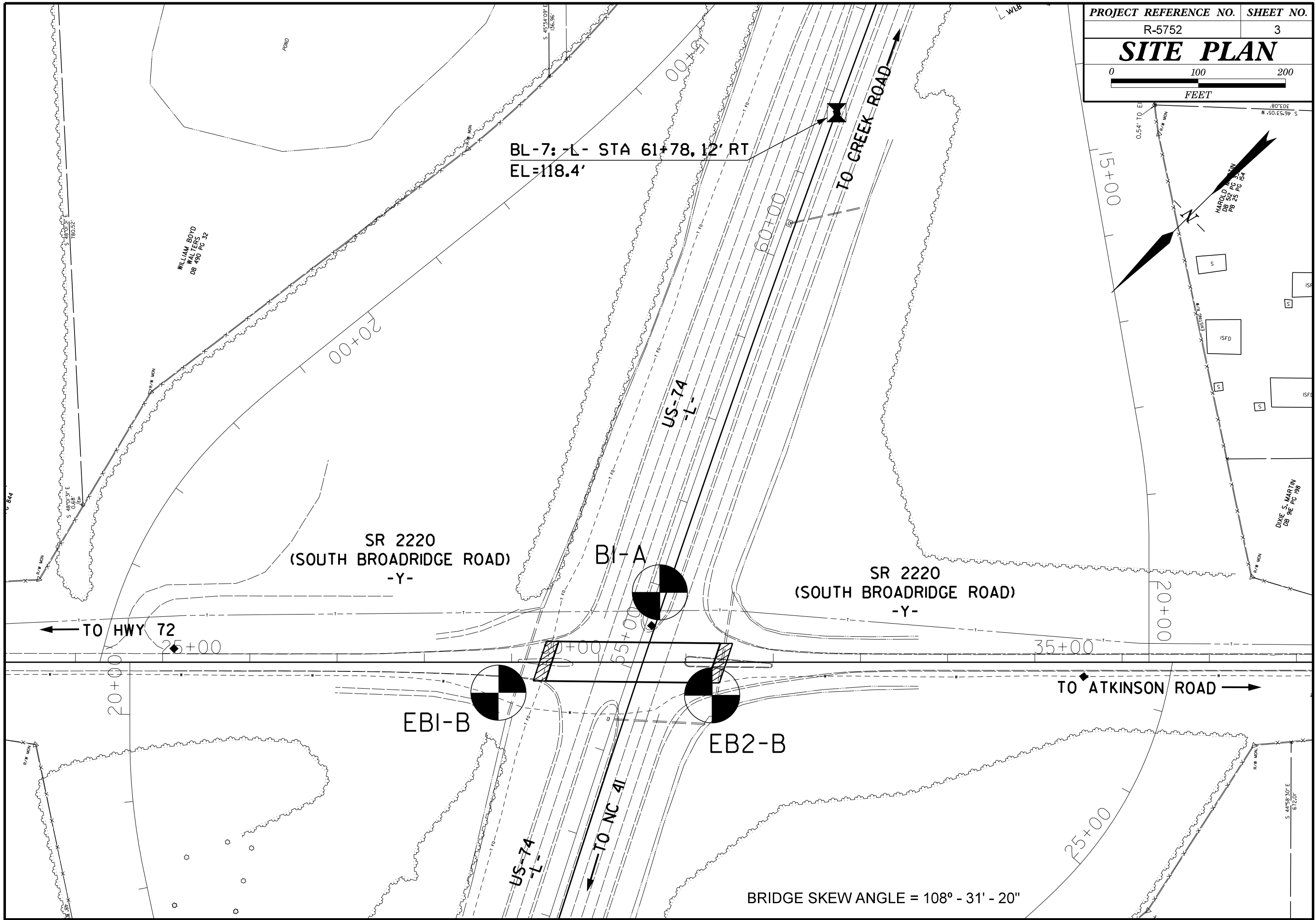


DocuSigned by:  
Njoroge Wl Wainaina 10/3/2016  
AEC0C6E0A2E14F2...  
SIGNATURE DATE

DOCUMENT NOT CONSIDERED FINAL  
UNLESS ALL SIGNATURES COMPLETED

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION  
 DIVISION OF HIGHWAYS  
 GEOTECHNICAL ENGINEERING UNIT  
**SUBSURFACE INVESTIGATION**  
 SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION										GRADATION										ROCK DESCRIPTION										TERMS AND DEFINITIONS																																																																																																																																																																																																																													
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										WELL GRADED - INDICATES A GOOD REPRESENTATION OF PARTICLE SIZES FROM FINE TO COARSE. UNIFORMLY GRADED - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLE SIZES OF TWO OR MORE SIZES.										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:										ALLUVIUM (ALLUV.) - SOILS THAT HAVE BEEN TRANSPORTED BY WATER. AQUIFER - A WATER BEARING FORMATION OR STRATA. ARENACEOUS - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND. ARGILLACEOUS - APPLIED TO ALL ROCKS OR SUBSTANCES COMPOSED OF CLAY MINERALS, OR HAVING A NOTABLE PROPORTION OF CLAY IN THEIR COMPOSITION, SUCH AS SHALE, SLATE, ETC. ARTESIAN - GROUND WATER THAT IS UNDER SUFFICIENT PRESSURE TO RISE ABOVE THE LEVEL AT WHICH IT IS ENCOUNTERED, BUT WHICH DOES NOT NECESSARILY RISE TO OR ABOVE THE GROUND SURFACE. CALCAREOUS (CALC.) - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE. COLLUVIUM - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE. CORE RECOVERY (REC.) - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE. DIKE - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK. DIP - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL. DIP DIRECTION (DIP AZIMUTH) - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH. FAULT - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE. FISSILE - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES. FLOAT - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL. FLOOD PLAIN (FP) - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM. FORMATION (FM) - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD. JOINT - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED. LEDGE - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT. LENS - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS. MOTTLED (MOT.) - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE. PERCHED WATER - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM. RESIDUAL (RES.) SOIL - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK. ROCK QUALITY DESIGNATION (ROD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE. SAPROLITE (SAP.) - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK. SILL - AN INTRUSIVE BODY OF IGNEOUS ROCK OF APPROXIMATELY UNIFORM THICKNESS AND RELATIVELY THIN COMPARED WITH ITS LATERAL EXTENT, THAT HAS BEEN EMPLACED PARALLEL TO THE BEDDING OR SCHISTOSITY OF THE INTRUDED ROCKS. SLICKENSIDE - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE. STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT) - NUMBER OF BLOWS (N OR BPF) OF A 140 LB. HAMMER FALLING 30 INCHES REQUIRED TO PRODUCE A PENETRATION OF 1 FOOT INTO SOIL WITH A 2 INCH OUTSIDE DIAMETER SPLIT SPOON SAMPLER. SPT REFUSAL IS PENETRATION EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS. STRATA CORE RECOVERY (SREC.) - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE. STRATA ROCK QUALITY DESIGNATION (SROD) - A MEASURE OF ROCK QUALITY DESCRIBED BY TOTAL LENGTH OF ROCK SEGMENTS WITHIN A STRATUM EQUAL TO OR GREATER THAN 4 INCHES DIVIDED BY THE TOTAL LENGTH OF STRATA AND EXPRESSED AS A PERCENTAGE. TOPSOIL (TS.) - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.																																																																																																																																																																																																																													
<b>SOIL LEGEND AND AASHTO CLASSIFICATION</b> <table border="1"> <tr> <th>GENERAL CLASS.</th> <th colspan="6">GRANULAR MATERIALS (&lt;= 35% PASSING #200)</th> <th colspan="6">SILT-CLAY MATERIALS (&gt; 35% PASSING #200)</th> <th colspan="6">ORGANIC MATERIALS</th> </tr> <tr> <th>GROUP CLASS.</th> <th colspan="2">A-1</th> <th colspan="2">A-3</th> <th colspan="2">A-2</th> <th colspan="2">A-4</th> <th colspan="2">A-5</th> <th colspan="2">A-6</th> <th colspan="2">A-7</th> <th colspan="2">A-1, A-2</th> <th colspan="2">A-3</th> <th colspan="2">A-4, A-5</th> <th colspan="2">A-6, A-7</th> </tr> <tr> <th>SYMBOL</th> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> <td colspan="2">[Symbol]</td> </tr> <tr> <th>% PASSING #10 #40 #200</th> <td colspan="2">50 MX 30 MX 15 MX</td> <td colspan="2">50 MX 25 MX</td> <td colspan="2">51 MN 10 MX</td> <td colspan="2">35 MX 35 MX</td> <td colspan="2">35 MX 35 MX</td> <td colspan="2">35 MX 35 MX</td> <td colspan="2">36 MN 36 MN</td> <td colspan="2">36 MN 36 MN</td> <td colspan="2">GRANULAR SOILS</td> <td colspan="2">SILT-CLAY SOILS</td> <td colspan="2">MUCK, PEAT</td> </tr> <tr> <th>MATERIAL PASSING #40 LL PI</th> <td colspan="2">-</td> <td colspan="2">-</td> <td colspan="2">40 MX 41 MN</td> <td colspan="2">40 MX 41 MN</td> <td colspan="2">40 MX 41 MN</td> <td colspan="2">40 MX 41 MN</td> <td colspan="2">40 MX 41 MN</td> <td colspan="2">40 MX 41 MN</td> <td colspan="2">SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER</td> <td colspan="2">HIGHLY ORGANIC SOILS</td> <td colspan="2"></td> </tr> <tr> <th>GROUP INDEX</th> <td colspan="2">0</td> <td colspan="2">0</td> <td colspan="2">0</td> <td colspan="2">4 MX</td> <td colspan="2">8 MX</td> <td colspan="2">12 MX</td> <td colspan="2">16 MX</td> <td colspan="2">NO MX</td> <td colspan="2"></td> <td colspan="2"></td> <td colspan="2"></td> </tr> <tr> <th>USUAL TYPES OF MAJOR MATERIALS</th> <td colspan="2">STONE FRAGS. GRAVEL, AND SAND</td> <td colspan="2">FINE SAND</td> <td colspan="2">SILTY OR CLAYEY GRAVEL AND SAND</td> <td colspan="2">SILTY SOILS</td> <td colspan="2">CLAYEY SOILS</td> <td colspan="2"></td> <td colspan="2"></td> <td colspan="2"></td> <td colspan="2"></td> <td colspan="2"></td> <td colspan="2"></td> </tr> <tr> <th>GEN. RATING AS SUBGRADE</th> <td colspan="6">EXCELLENT TO GOOD</td> <td colspan="6">FAIR TO POOR</td> <td colspan="2">FAIR TO POOR</td> <td colspan="2">POOR</td> <td colspan="2">UNSATURABLE</td> <td colspan="2"></td> <td colspan="2"></td> </tr> <tr> <th colspan="22">PI OF A-7-5 SUBGROUP IS &lt;= LL - 30 ; PI OF A-7-6 SUBGROUP IS &gt; LL - 30</th> </tr> </table>										GENERAL CLASS.	GRANULAR MATERIALS (<= 35% PASSING #200)						SILT-CLAY MATERIALS (> 35% PASSING #200)						ORGANIC MATERIALS						GROUP CLASS.	A-1		A-3		A-2		A-4		A-5		A-6		A-7		A-1, A-2		A-3		A-4, A-5		A-6, A-7		SYMBOL	[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		% PASSING #10 #40 #200	50 MX 30 MX 15 MX		50 MX 25 MX		51 MN 10 MX		35 MX 35 MX		35 MX 35 MX		35 MX 35 MX		36 MN 36 MN		36 MN 36 MN		GRANULAR SOILS		SILT-CLAY SOILS		MUCK, PEAT		MATERIAL PASSING #40 LL PI	-		-		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS				GROUP INDEX	0		0		0		4 MX		8 MX		12 MX		16 MX		NO MX								USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND		SILTY OR CLAYEY GRAVEL AND SAND		SILTY SOILS		CLAYEY SOILS														GEN. RATING AS SUBGRADE	EXCELLENT TO GOOD						FAIR TO POOR						FAIR TO POOR		POOR		UNSATURABLE						PI OF A-7-5 SUBGROUP IS <= LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30																						<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 LL < 31 MODERATELY COMPRESSIBLE LL = 31 - 50 HIGHLY COMPRESSIBLE LL > 50 <b>PERCENTAGE OF MATERIAL</b> <table border="1"> <tr> <th>ORGANIC MATERIAL</th> <th>GRANULAR SOILS</th> <th>SILT - CLAY SOILS</th> <th>OTHER MATERIAL</th> </tr> <tr> <td>TRACE OF ORGANIC MATTER</td> <td>2 - 3%</td> <td>3 - 5%</td> <td>TRACE 1 - 10%</td> </tr> <tr> <td>LITTLE ORGANIC MATTER</td> <td>3 - 5%</td> <td>5 - 12%</td> <td>LITTLE 10 - 20%</td> </tr> <tr> <td>MODERATELY ORGANIC</td> <td>5 - 10%</td> <td>12 - 20%</td> <td>SOME 20 - 35%</td> </tr> <tr> <td>HIGHLY ORGANIC</td> <td>&gt; 10%</td> <td>&gt; 20%</td> <td>HIGHLY 35% AND ABOVE</td> </tr> </table>										ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL	TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE 1 - 10%	LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE 10 - 20%	MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME 20 - 35%	HIGHLY ORGANIC	> 10%	> 20%	HIGHLY 35% AND ABOVE	<b>WEATHERING</b> FRESH ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE. VERY SLIGHT (IV SLI.) 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 (SLI.) 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. IF TESTED, WOULD YIELD SPT REFUSAL. 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. IF TESTED, WOULD YIELD SPT N VALUES > 100 BPF. VERY SEVERE (IV 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. IF TESTED, WOULD YIELD SPT N VALUES < 100 BPF. 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.									
GENERAL CLASS.	GRANULAR MATERIALS (<= 35% PASSING #200)						SILT-CLAY MATERIALS (> 35% PASSING #200)						ORGANIC MATERIALS																																																																																																																																																																																																																																														
GROUP CLASS.	A-1		A-3		A-2		A-4		A-5		A-6		A-7		A-1, A-2		A-3		A-4, A-5		A-6, A-7																																																																																																																																																																																																																																						
SYMBOL	[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]		[Symbol]																																																																																																																																																																																																																																						
% PASSING #10 #40 #200	50 MX 30 MX 15 MX		50 MX 25 MX		51 MN 10 MX		35 MX 35 MX		35 MX 35 MX		35 MX 35 MX		36 MN 36 MN		36 MN 36 MN		GRANULAR SOILS		SILT-CLAY SOILS		MUCK, PEAT																																																																																																																																																																																																																																						
MATERIAL PASSING #40 LL PI	-		-		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		40 MX 41 MN		SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS																																																																																																																																																																																																																																								
GROUP INDEX	0		0		0		4 MX		8 MX		12 MX		16 MX		NO MX																																																																																																																																																																																																																																												
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND		SILTY OR CLAYEY GRAVEL AND SAND		SILTY SOILS		CLAYEY SOILS																																																																																																																																																																																																																																																		
GEN. RATING AS SUBGRADE	EXCELLENT TO GOOD						FAIR TO POOR						FAIR TO POOR		POOR		UNSATURABLE																																																																																																																																																																																																																																										
PI OF A-7-5 SUBGROUP IS <= LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30																																																																																																																																																																																																																																																											
ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL																																																																																																																																																																																																																																																								
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE 1 - 10%																																																																																																																																																																																																																																																								
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE 10 - 20%																																																																																																																																																																																																																																																								
MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME 20 - 35%																																																																																																																																																																																																																																																								
HIGHLY ORGANIC	> 10%	> 20%	HIGHLY 35% AND ABOVE																																																																																																																																																																																																																																																								
<b>GROUND WATER</b> 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										<b>MISCELLANEOUS 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>CONSISTENCY OR DENSENESS</b> <table border="1"> <tr> <th>PRIMARY SOIL TYPE</th> <th>COMPACTNESS OR CONSISTENCY</th> <th>RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE)</th> <th>RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT<sup>2</sup>)</th> </tr> <tr> <td>GENERALLY GRANULAR MATERIAL (NON-COHESSIVE)</td> <td>VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE</td> <td>&lt; 4 4 TO 10 10 TO 30 30 TO 50 &gt; 50</td> <td>N/A</td> </tr> <tr> <td>GENERALLY SILT-CLAY MATERIAL (COHESIVE)</td> <td>VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD</td> <td>&lt; 2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 &gt; 30</td> <td>&lt; 0.25 0.25 TO 0.5 0.5 TO 1.0 1 TO 2 2 TO 4 &gt; 4</td> </tr> </table>										PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT <sup>2</sup> )	GENERALLY GRANULAR MATERIAL (NON-COHESSIVE)	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 4 4 TO 10 10 TO 30 30 TO 50 > 50	N/A	GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	< 2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 > 30	< 0.25 0.25 TO 0.5 0.5 TO 1.0 1 TO 2 2 TO 4 > 4	<b>RECOMMENDATION SYMBOLS</b> UNDERCUT SHALLOW 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																																																																																																																																																																																																																																					
PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT <sup>2</sup> )																																																																																																																																																																																																																																																								
GENERALLY GRANULAR MATERIAL (NON-COHESSIVE)	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 4 4 TO 10 10 TO 30 30 TO 50 > 50	N/A																																																																																																																																																																																																																																																								
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	< 2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 > 30	< 0.25 0.25 TO 0.5 0.5 TO 1.0 1 TO 2 2 TO 4 > 4																																																																																																																																																																																																																																																								
<b>TEXTURE OR GRAIN SIZE</b> <table border="1"> <tr> <th>U.S. STD. SIEVE SIZE OPENING (MM)</th> <th>4</th> <th>10</th> <th>40</th> <th>60</th> <th>200</th> <th>270</th> </tr> <tr> <td></td> <td>4.75</td> <td>2.00</td> <td>0.42</td> <td>0.25</td> <td>0.075</td> <td>0.053</td> </tr> <tr> <th>BOULDER (BLDR.)</th> <th>COBBLE (COB.)</th> <th>GRAVEL (GR.)</th> <th>COARSE SAND (CSE. SD.)</th> <th>FINE SAND (F SD.)</th> <th>SILT (SL.)</th> <th>CLAY (CL.)</th> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <th>GRAIN SIZE</th> <th>MM</th> <th>305</th> <th>75</th> <th>2.0</th> <th>0.25</th> <th>0.05</th> <th>0.005</th> </tr> <tr> <td></td> <td>IN.</td> <td>12</td> <td>3</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>										U.S. STD. SIEVE SIZE OPENING (MM)	4	10	40	60	200	270		4.75	2.00	0.42	0.25	0.075	0.053	BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)								GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005		IN.	12	3					<b>ABBREVIATIONS</b> 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 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 - TRIAXIAL REFUSAL w - MOISTURE CONTENT V - VERY VST - VANE SHEAR TEST WE. - WEATHERED UG - UNIT WEIGHT DUG - DRY UNIT WEIGHT <b>SAMPLE ABBREVIATIONS</b> S - BULK SS - SPLIT SPOON ST - SHELBY TUBE RS - ROCK RT - RECOMPACTED TRIAXIAL CBR - CALIFORNIA BEARING RATIO																																																																																																																																																																																																					
U.S. STD. SIEVE SIZE OPENING (MM)	4	10	40	60	200	270																																																																																																																																																																																																																																																					
	4.75	2.00	0.42	0.25	0.075	0.053																																																																																																																																																																																																																																																					
BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)																																																																																																																																																																																																																																																					
GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005																																																																																																																																																																																																																																																				
	IN.	12	3																																																																																																																																																																																																																																																								
<b>SOIL MOISTURE - CORRELATION OF TERMS</b> <table border="1"> <tr> <th>SOIL MOISTURE SCALE (ATTERBERG LIMITS)</th> <th>FIELD MOISTURE DESCRIPTION</th> <th>GUIDE FOR FIELD MOISTURE DESCRIPTION</th> </tr> <tr> <td>LL</td> <td>LIQUID LIMIT</td> <td></td> </tr> <tr> <td>PL</td> <td>PLASTIC LIMIT</td> <td></td> </tr> <tr> <td>OM</td> <td>OPTIMUM MOISTURE SHRINKAGE LIMIT</td> <td></td> </tr> <tr> <td></td> <td>- SATURATED - (SAT.)</td> <td>USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE</td> </tr> <tr> <td></td> <td>- WET - (W)</td> <td>SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE</td> </tr> <tr> <td></td> <td>- MOIST - (M)</td> <td>SOLID; AT OR NEAR OPTIMUM MOISTURE</td> </tr> <tr> <td></td> <td>- DRY - (D)</td> <td>REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE</td> </tr> </table>										SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION	LL	LIQUID LIMIT		PL	PLASTIC LIMIT		OM	OPTIMUM MOISTURE SHRINKAGE LIMIT			- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE		- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE		- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE		- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE	<b>EQUIPMENT USED ON SUBJECT PROJECT</b> <table border="1"> <tr> <th>DRILL UNITS:</th> <th>ADVANCING TOOLS:</th> <th>HAMMER TYPE:</th> </tr> <tr> <td><input checked="" type="checkbox"/> CME-45C</td> <td><input type="checkbox"/> CLAY BITS</td> <td><input checked="" type="checkbox"/> AUTOMATIC <input type="checkbox"/> MANUAL</td> </tr> <tr> <td><input type="checkbox"/> CME-55</td> <td><input type="checkbox"/> 6" CONTINUOUS FLIGHT AUGER</td> <td></td> </tr> <tr> <td><input type="checkbox"/> CME-550</td> <td><input checked="" type="checkbox"/> 8" HOLLOW AUGERS</td> <td></td> </tr> <tr> <td><input type="checkbox"/> VANE SHEAR TEST</td> <td><input type="checkbox"/> HARD FACED FINGER BITS</td> <td></td> </tr> <tr> <td><input type="checkbox"/> PORTABLE HOIST</td> <td><input type="checkbox"/> TUNG-CARBIDE INSERTS</td> <td></td> </tr> <tr> <td></td> <td><input checked="" type="checkbox"/> CASING <input type="checkbox"/> W/ ADVANCER</td> <td></td> </tr> <tr> <td></td> <td><input type="checkbox"/> TRICONE <input type="checkbox"/> STEEL TEETH</td> <td></td> </tr> <tr> <td></td> <td><input type="checkbox"/> TRICONE <input type="checkbox"/> TUNG-CARB.</td> <td></td> </tr> <tr> <td></td> <td><input type="checkbox"/> CORE BIT</td> <td></td> </tr> <tr> <td></td> <td><input checked="" type="checkbox"/> 2 3/8 AND 3 3/8 DRAG BIT</td> <td></td> </tr> </table>										DRILL UNITS:	ADVANCING TOOLS:	HAMMER TYPE:	<input checked="" type="checkbox"/> CME-45C	<input type="checkbox"/> CLAY BITS	<input checked="" type="checkbox"/> AUTOMATIC <input type="checkbox"/> MANUAL	<input type="checkbox"/> CME-55	<input type="checkbox"/> 6" CONTINUOUS FLIGHT AUGER		<input type="checkbox"/> CME-550	<input checked="" type="checkbox"/> 8" HOLLOW AUGERS		<input type="checkbox"/> VANE SHEAR TEST	<input type="checkbox"/> HARD FACED FINGER BITS		<input type="checkbox"/> PORTABLE HOIST	<input type="checkbox"/> TUNG-CARBIDE INSERTS			<input checked="" type="checkbox"/> CASING <input type="checkbox"/> W/ ADVANCER			<input type="checkbox"/> TRICONE <input type="checkbox"/> STEEL TEETH			<input type="checkbox"/> TRICONE <input type="checkbox"/> TUNG-CARB.			<input type="checkbox"/> CORE BIT			<input checked="" type="checkbox"/> 2 3/8 AND 3 3/8 DRAG BIT																																																																																																																																																																																
SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION																																																																																																																																																																																																																																																									
LL	LIQUID LIMIT																																																																																																																																																																																																																																																										
PL	PLASTIC LIMIT																																																																																																																																																																																																																																																										
OM	OPTIMUM MOISTURE SHRINKAGE LIMIT																																																																																																																																																																																																																																																										
	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE																																																																																																																																																																																																																																																									
	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE																																																																																																																																																																																																																																																									
	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE																																																																																																																																																																																																																																																									
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE																																																																																																																																																																																																																																																									
DRILL UNITS:	ADVANCING TOOLS:	HAMMER TYPE:																																																																																																																																																																																																																																																									
<input checked="" type="checkbox"/> CME-45C	<input type="checkbox"/> CLAY BITS	<input checked="" type="checkbox"/> AUTOMATIC <input type="checkbox"/> MANUAL																																																																																																																																																																																																																																																									
<input type="checkbox"/> CME-55	<input type="checkbox"/> 6" CONTINUOUS FLIGHT AUGER																																																																																																																																																																																																																																																										
<input type="checkbox"/> CME-550	<input checked="" type="checkbox"/> 8" HOLLOW AUGERS																																																																																																																																																																																																																																																										
<input type="checkbox"/> VANE SHEAR TEST	<input type="checkbox"/> HARD FACED FINGER BITS																																																																																																																																																																																																																																																										
<input type="checkbox"/> PORTABLE HOIST	<input type="checkbox"/> TUNG-CARBIDE INSERTS																																																																																																																																																																																																																																																										
	<input checked="" type="checkbox"/> CASING <input type="checkbox"/> W/ ADVANCER																																																																																																																																																																																																																																																										
	<input type="checkbox"/> TRICONE <input type="checkbox"/> STEEL TEETH																																																																																																																																																																																																																																																										
	<input type="checkbox"/> TRICONE <input type="checkbox"/> TUNG-CARB.																																																																																																																																																																																																																																																										
	<input type="checkbox"/> CORE BIT																																																																																																																																																																																																																																																										
	<input checked="" type="checkbox"/> 2 3/8 AND 3 3/8 DRAG BIT																																																																																																																																																																																																																																																										
<b>PLASTICITY</b> <table border="1"> <tr> <th>NON PLASTIC</th> <th>SLIGHTLY PLASTIC</th> <th>MODERATELY PLASTIC</th> <th>HIGHLY PLASTIC</th> </tr> <tr> <td></td> <td>0-5</td> <td>6-15</td> <td>16-25</td> </tr> <tr> <td></td> <td></td> <td>26 OR MORE</td> <td></td> </tr> <tr> <th colspan="2">PLASTICITY INDEX (PI)</th> <th colspan="2">DRY STRENGTH</th> </tr> <tr> <td colspan="2"></td> <td>VERY LOW</td> <td>SLIGHT</td> </tr> <tr> <td colspan="2"></td> <td>MEDIUM</td> <td>HIGH</td> </tr> </table>										NON PLASTIC	SLIGHTLY PLASTIC	MODERATELY PLASTIC	HIGHLY PLASTIC		0-5	6-15	16-25			26 OR MORE		PLASTICITY INDEX (PI)		DRY STRENGTH				VERY LOW	SLIGHT			MEDIUM	HIGH	<b>FRACTURE SPACING</b> <table border="1"> <tr> <th>TERM</th> <th>SPACING</th> </tr> <tr> <td>VERY WIDE</td> <td>MORE THAN 10 FEET</td> </tr> <tr> <td>WIDE</td> <td>3 TO 10 FEET</td> </tr> <tr> <td>MODERATELY CLOSE</td> <td>1 TO 3 FEET</td> </tr> <tr> <td>CLOSE</td> <td>0.16 TO 1 FOOT</td> </tr> <tr> <td>VERY CLOSE</td> <td>LESS THAN 0.16 FEET</td> </tr> </table>										TERM	SPACING	VERY WIDE	MORE THAN 10 FEET	WIDE	3 TO 10 FEET	MODERATELY CLOSE	1 TO 3 FEET	CLOSE	0.16 TO 1 FOOT	VERY CLOSE	LESS THAN 0.16 FEET	<b>BEDDING</b> <table border="1"> <tr> <th>TERM</th> <th>THICKNESS</th> </tr> <tr> <td>VERY THICKLY BEDDED</td> <td>4 FEET</td> </tr> <tr> <td>THICKLY BEDDED</td> <td>1.5 - 4 FEET</td> </tr> <tr> <td>THINLY BEDDED</td> <td>0.16 - 1.5 FEET</td> </tr> <tr> <td>VERY THINLY BEDDED</td> <td>0.03 - 0.16 FEET</td> </tr> <tr> <td>THICKLY LAMINATED</td> <td>0.008 - 0.03 FEET</td> </tr> <tr> <td>THINLY LAMINATED</td> <td>&lt; 0.008 FEET</td> </tr> </table>										TERM	THICKNESS	VERY THICKLY BEDDED	4 FEET	THICKLY BEDDED	1.5 - 4 FEET	THINLY BEDDED	0.16 - 1.5 FEET	VERY THINLY BEDDED	0.03 - 0.16 FEET	THICKLY LAMINATED	0.008 - 0.03 FEET	THINLY LAMINATED	< 0.008 FEET																																																																																																																																																																												
NON PLASTIC	SLIGHTLY PLASTIC	MODERATELY PLASTIC	HIGHLY PLASTIC																																																																																																																																																																																																																																																								
	0-5	6-15	16-25																																																																																																																																																																																																																																																								
		26 OR MORE																																																																																																																																																																																																																																																									
PLASTICITY INDEX (PI)		DRY STRENGTH																																																																																																																																																																																																																																																									
		VERY LOW	SLIGHT																																																																																																																																																																																																																																																								
		MEDIUM	HIGH																																																																																																																																																																																																																																																								
TERM	SPACING																																																																																																																																																																																																																																																										
VERY WIDE	MORE THAN 10 FEET																																																																																																																																																																																																																																																										
WIDE	3 TO 10 FEET																																																																																																																																																																																																																																																										
MODERATELY CLOSE	1 TO 3 FEET																																																																																																																																																																																																																																																										
CLOSE	0.16 TO 1 FOOT																																																																																																																																																																																																																																																										
VERY CLOSE	LESS THAN 0.16 FEET																																																																																																																																																																																																																																																										
TERM	THICKNESS																																																																																																																																																																																																																																																										
VERY THICKLY BEDDED	4 FEET																																																																																																																																																																																																																																																										
THICKLY BEDDED	1.5 - 4 FEET																																																																																																																																																																																																																																																										
THINLY BEDDED	0.16 - 1.5 FEET																																																																																																																																																																																																																																																										
VERY THINLY BEDDED	0.03 - 0.16 FEET																																																																																																																																																																																																																																																										
THICKLY LAMINATED	0.008 - 0.03 FEET																																																																																																																																																																																																																																																										
THINLY LAMINATED	< 0.008 FEET																																																																																																																																																																																																																																																										
<b>COLOR</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.										<b>INDURATION</b> 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.																																																																																																																																																																																																																																																	
<b>FRAC. MARK: BL-7; -L- STA: 61+78, OFFSET: 12' RT</b> <b>NORTHING: 273,021</b> <b>EASTING: 2,000,517</b> <b>ELEVATION: 118.4 FEET</b>										<b>NOTES:</b> TIN FILE NAME "r5752_is.tbl.tin" WITH FILE DATE 2/23/2016, WAS USED TO GENERATE BORING PROFILE GROUND LINE.																																																																																																																																																																																																																																																	



BL-7: -L- STA 61+78.12' RT  
EL=118.4'

SR 2220  
(SOUTH BROADRIDGE ROAD)  
-Y-

SR 2220  
(SOUTH BROADRIDGE ROAD)  
-Y-

TO HWY 72

TO ATKINSON ROAD

BRIDGE SKEW ANGLE = 108° - 31' - 20"

BI-A

EBI-B

EB2-B

US-74  
-L-

US-74  
-L-

TO NC 41

TO CREEK ROAD

WILLIAM BOYD  
WALTERS  
DB 490 PC 32

HAROLD  
DB 512 PC 35  
PB 25 PC 64

DIXIE S. MARTIN  
DB 91E PC 98

15+00

20+00

50+00

20+00

20+00

25+00

30+00

35+00

35+00

25+00

WLB

S 44°59'30" E  
672.01'

S 46°53'05" W  
303.08'

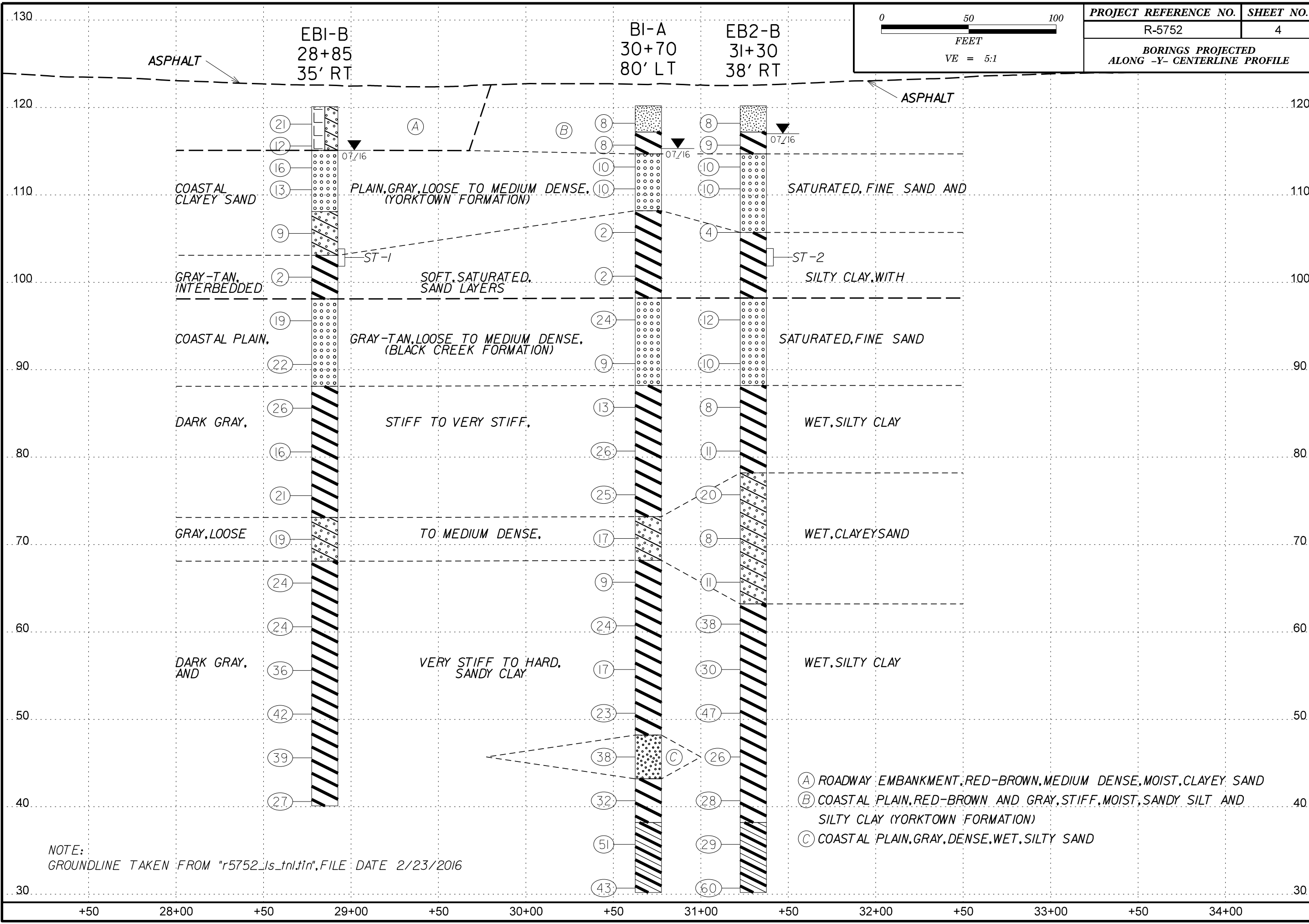
844

S 48°03'31" E  
180.52'

S 48°03'31" E  
0.68'

S 46°24'05" E  
136.96'

0.54' TO E



# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 53088.1.FD1		TIP R-5752		COUNTY ROBESON		GEOLOGIST Rohit Warriar									
SITE DESCRIPTION PROPOSED BRIDGE ON -Y- (SR 2220) AT STA. 30+39.23 OVER -L- (US 74) AT STA. 55+06.59							GROUND WTR (ft)								
BORING NO. EB1-B		STATION 28+85		OFFSET 35 ft RT		ALIGNMENT -Y-									
COLLAR ELEV. 120.1 ft		TOTAL DEPTH 80.0 ft		NORTHING 273,765		EASTING 2,000,319									
DRILL RIG/HAMMER EFF./DATE BR18284 CME-45C 89% 02/26/2016			DRILL METHOD Mud Rotary			HAMMER TYPE Automatic									
DRILLER Anderson, J.		START DATE 07/20/16		COMP. DATE 07/20/16		SURFACE WATER DEPTH N/A									
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
125															
120	119.1	1.0	6	10	11									120.1	GROUND SURFACE
	116.6	3.5	2	5	7									115.1	ROADWAY EMBANKMENT RED-BROWN, CLAYEY SAND
115	114.1	6.0	3	7	9										COASTAL PLAIN GRAY, FINE SAND (YORKTOWN FORMATION)
	111.6	8.5	2	6	7										
110	106.6	13.5	5	5	4									108.1	GRAY-YELLOW, CLAYEY SAND
105	101.6	18.5	2	1	1									103.1	BROWN-GRAY, SILTY CLAY WITH INTERBEDDED SAND LAYERS
100	96.6	23.5	7	10	9									98.1	COASTAL PLAIN GRAY, FINE SAND (BLACK CREEK FORMATION)
95	91.6	28.5	5	9	13										
90	86.6	33.5	10	12	14									88.1	DARK GRAY, SILTY CLAY
85	81.6	38.5	5	8	8										
80	76.6	43.5	8	9	12										
75	71.6	48.5	5	7	12									73.1	GRAY, CLAYEY SAND
70	66.6	53.5	7	11	13									68.1	DARK GRAY, SILTY CLAY
65	61.6	58.5	7	10	14										
60	56.6	63.5	10	16	20										
55	51.6	68.5	11	17	25										
50	46.6	73.5	11	17	22										
45															

NCDOT BORE DOUBLE R5752\_GEO\_BRDG\_BH.GPJ\_NC\_DOT.GDT 9/30/16

WBS 53088.1.FD1		TIP R-5752		COUNTY ROBESON		GEOLOGIST Rohit Warriar									
SITE DESCRIPTION PROPOSED BRIDGE ON -Y- (SR 2220) AT STA. 30+39.23 OVER -L- (US 74) AT STA. 55+06.59							GROUND WTR (ft)								
BORING NO. EB1-B		STATION 28+85		OFFSET 35 ft RT		ALIGNMENT -Y-									
COLLAR ELEV. 120.1 ft		TOTAL DEPTH 80.0 ft		NORTHING 273,765		EASTING 2,000,319									
DRILL RIG/HAMMER EFF./DATE BR18284 CME-45C 89% 02/26/2016			DRILL METHOD Mud Rotary			HAMMER TYPE Automatic									
DRILLER Anderson, J.		START DATE 07/20/16		COMP. DATE 07/20/16		SURFACE WATER DEPTH N/A									
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
45															
	41.6	78.5	7	12	15									40.1	Match Line
															DARK GRAY, SILTY CLAY (continued)
															Boring Terminated at Elevation 40.1 ft COASTAL PLAIN, SILTY CLAY
															Other Samples: ST-1 (17.0 - 19.0)



# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 53088.1.FD1		TIP R-5752		COUNTY ROBESON		GEOLOGIST Rohit Warriar	
SITE DESCRIPTION PROPOSED BRIDGE ON -Y- (SR 2220) AT STA. 30+39.23 OVER -L- (US 74) AT STA. 55+06.59							GROUND WTR (ft)
BORING NO. EB2-B		STATION 31+30		OFFSET 38 ft RT		ALIGNMENT -Y-	
COLLAR ELEV. 120.2 ft		TOTAL DEPTH 90.0 ft		NORTHING 273,593		EASTING 2,000,144	
DRILL RIG/HAMMER EFF./DATE BR18284 CME-45C 89% 02/26/2016			DRILL METHOD Mud Rotary		HAMMER TYPE Automatic		
DRILLER Anderson, J.		START DATE 07/23/16		COMP. DATE 07/23/16		SURFACE WATER DEPTH 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						
125																
120	119.2	1.0	3	4	4									GROUND SURFACE	0.0	
	116.7	3.5	2	3	6									COASTAL PLAIN RED-BROWN, SANDY SILT (YORKTOWN FORMATION)	3.0	
115	114.2	6.0	1	5	5									GRAY-RED, SILTY CLAY	5.5	
	111.7	8.5	1	5	5									GRAY, FINE SAND		
110	106.7	13.5	4	2	2											
105	96.7	23.5	4	4	8									COASTAL PLAIN DARK GRAY, FINE SAND (BLACK CREEK FORMATION)	22.0	
100	91.7	28.5	6	7	3											
95	86.7	33.5	1	4	4									DARK GRAY, SILTY CLAY	32.0	
90	81.7	38.5	4	5	6											
85	76.7	43.5	4	10	10									GRAY-TAN, CLAYEY SAND	42.0	
80	71.7	48.5	2	2	6											
75	66.7	53.5	3	4	7											
70	61.9	58.3	9	16	22									DARK GRAY, SILTY CLAY	57.0	
65	56.7	63.5	10	13	17											
60	51.7	68.5	15	22	25											
55	46.7	73.5	10	10	16											

WBS 53088.1.FD1		TIP R-5752		COUNTY ROBESON		GEOLOGIST Rohit Warriar	
SITE DESCRIPTION PROPOSED BRIDGE ON -Y- (SR 2220) AT STA. 30+39.23 OVER -L- (US 74) AT STA. 55+06.59							GROUND WTR (ft)
BORING NO. EB2-B		STATION 31+30		OFFSET 38 ft RT		ALIGNMENT -Y-	
COLLAR ELEV. 120.2 ft		TOTAL DEPTH 90.0 ft		NORTHING 273,593		EASTING 2,000,144	
DRILL RIG/HAMMER EFF./DATE BR18284 CME-45C 89% 02/26/2016			DRILL METHOD Mud Rotary		HAMMER TYPE Automatic		
DRILLER Anderson, J.		START DATE 07/23/16		COMP. DATE 07/23/16		SURFACE WATER DEPTH 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					
45															
40	41.7	78.5	10	14	14									Match Line	
	36.7	83.5	6	8	21										
35	31.7	88.5	17	30	30										

	38.2	DARK GRAY, SILTY CLAY (continued)			82.0
		DARK GRAY, SANDY CLAY			
	30.2	Boring Terminated at Elevation 30.2 ft COASTAL PLAIN, SANDY CLAY			90.0
		Other Samples: ST-2 (18.0 - 20.0)			

NCDOT BORE DOUBLE R5752\_GEO\_BRDG\_BH.GPJ\_NC\_DOT.GDT 9/30/16



# SOIL TEST RESULTS

## EB1-B

SOIL TEST RESULTS															
SAMPLE NO.	OFFSET	STATION	DEPTH INTERVAL	AASHTO CLASS.	L.L.	P.I.	% BY WEIGHT				% PASSING (SIEVES)			% MOISTURE	% ORGANIC
							C.SAND	F.SAND	SILT	CLAY	10	40	200		
ST-1	35' RT	28+85	17.0-19.0	A-2-4(0)	23	NP	28	44	7	21	100	76	28	23.0	-

## EB2-B

SOIL TEST RESULTS															
SAMPLE NO.	OFFSET	STATION	DEPTH INTERVAL	AASHTO CLASS.	L.L.	P.I.	% BY WEIGHT				% PASSING (SIEVES)			% MOISTURE	% ORGANIC
							C.SAND	F.SAND	SILT	CLAY	10	40	200		
SS-19	38' RT	31+30	3.5-5.0	A-7-6(53)	84	62	1	20	13	66	100	99	80	37.8	-
ST-2	38' RT	31+30	18.0-20.0	A-2-4(0)	21	NP	25	63	5	7	100	78	13	71.4	-