

**REFERENCE: B-3186/B-5898**

**PROJECT: 38332/48030**

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

**STRUCTURE**  
**SUBSURFACE INVESTIGATION**

COUNTY HAYWOOD  
 PROJECT DESCRIPTION US 23/US 74/US 19 (GREAT SMOKY MOUNTAIN HWY) FROM WEST OF NC 209 (CRABTREE RD.) TO EAST OF RUSS AVE.  
 SITE DESCRIPTION BRIDGE NO. 168 ON -YIRT- (US 19) OVER -L-, -L LT- AND -L RT- (US 74 /US 23) BETWEEN US 276 AND NC 209

**CONTENTS**

<u>SHEET NO.</u>	<u>DESCRIPTION</u>
1	TITLE SHEET
2	LEGEND
3	SITE PLAN
4-5	PROFILES
6-7	CROSS SECTIONS
8-16	BORE LOGS, CORE REPORTS, & CORE PHOTOGRAPHS
17	ROCK TEST RESULTS

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	B-3186/B-5898	1	17

**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.

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DATE NOVEMBER 2021



Kenneth R. Bussey, Jr.  
SIGNATURE

9/6/2023  
DATE

**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 208, 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, <i>VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6</i>												<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>HARD ROCK</b> 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:												<b>ALLUVIUM (ALLUV.)</b> - SOILS THAT HAVE BEEN TRANSPORTED BY WATER. <b>AQUIFER</b> - A WATER BEARING FORMATION OR STRATA. <b>ARENACEOUS</b> - APPLIED TO ROCKS THAT HAVE BEEN DERIVED FROM SAND OR THAT CONTAIN SAND. <b>ARGILLACEOUS</b> - 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. <b>ARTESIAN</b> - 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. <b>CALCAREOUS (CALC.)</b> - SOILS THAT CONTAIN APPRECIABLE AMOUNTS OF CALCIUM CARBONATE. <b>COLLUVIUM</b> - ROCK FRAGMENTS MIXED WITH SOIL DEPOSITED BY GRAVITY ON SLOPE OR AT BOTTOM OF SLOPE. <b>CORE RECOVERY (REC.)</b> - TOTAL LENGTH OF ALL MATERIAL RECOVERED IN THE CORE BARREL DIVIDED BY TOTAL LENGTH OF CORE RUN AND EXPRESSED AS A PERCENTAGE. <b>DIKE</b> - A TABULAR BODY OF IGNEOUS ROCK THAT CUTS ACROSS THE STRUCTURE OF ADJACENT ROCKS OR CUTS MASSIVE ROCK. <b>DIP</b> - THE ANGLE AT WHICH A STRATUM OR ANY PLANAR FEATURE IS INCLINED FROM THE HORIZONTAL. <b>DIP DIRECTION (DIP AZIMUTH)</b> - THE DIRECTION OR BEARING OF THE HORIZONTAL TRACE OF THE LINE OF DIP, MEASURED CLOCKWISE FROM NORTH. <b>FAULT</b> - A FRACTURE OR FRACTURE ZONE ALONG WHICH THERE HAS BEEN DISPLACEMENT OF THE SIDES RELATIVE TO ONE ANOTHER PARALLEL TO THE FRACTURE. <b>FISSILE</b> - A PROPERTY OF SPLITTING ALONG CLOSELY SPACED PARALLEL PLANES. <b>FLOAT</b> - ROCK FRAGMENTS ON SURFACE NEAR THEIR ORIGINAL POSITION AND DISLODGED FROM PARENT MATERIAL. <b>FLOOD PLAIN (FP)</b> - LAND BORDERING A STREAM, BUILT OF SEDIMENTS DEPOSITED BY THE STREAM. <b>FORMATION (FM)</b> - A MAPPABLE GEOLOGIC UNIT THAT CAN BE RECOGNIZED AND TRACED IN THE FIELD. <b>JOINT</b> - FRACTURE IN ROCK ALONG WHICH NO APPRECIABLE MOVEMENT HAS OCCURRED. <b>LEDGE</b> - A SHELF-LIKE RIDGE OR PROJECTION OF ROCK WHOSE THICKNESS IS SMALL COMPARED TO ITS LATERAL EXTENT. <b>LENS</b> - A BODY OF SOIL OR ROCK THAT THINS OUT IN ONE OR MORE DIRECTIONS. <b>MOTTLED (MT)</b> - IRREGULARLY MARKED WITH SPOTS OF DIFFERENT COLORS. MOTTLING IN SOILS USUALLY INDICATES POOR AERATION AND LACK OF GOOD DRAINAGE. <b>PERCHED WATER</b> - WATER MAINTAINED ABOVE THE NORMAL GROUND WATER LEVEL BY THE PRESENCE OF AN INTERVENING IMPERVIOUS STRATUM. <b>RESIDUAL (RES.) SOIL</b> - SOIL FORMED IN PLACE BY THE WEATHERING OF ROCK. <b>ROCK QUALITY DESIGNATION (ROD)</b> - 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. <b>SAPROLITE (SAP.)</b> - RESIDUAL SOIL THAT RETAINS THE RELIC STRUCTURE OR FABRIC OF THE PARENT ROCK. <b>SILL</b> - 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. <b>SLICKENSIDE</b> - POLISHED AND STRIATED SURFACE THAT RESULTS FROM FRICTION ALONG A FAULT OR SLIP PLANE. <b>STANDARD PENETRATION TEST (PENETRATION RESISTANCE) (SPT)</b> - NUMBER OF BLOWS (IN 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. <b>STRATA CORE RECOVERY (SREC.)</b> - TOTAL LENGTH OF STRATA MATERIAL RECOVERED DIVIDED BY TOTAL LENGTH OF STRATUM AND EXPRESSED AS A PERCENTAGE. <b>STRATA ROCK QUALITY DESIGNATION (SROD)</b> - 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. <b>TOPSOIL (TS.)</b> - SURFACE SOILS USUALLY CONTAINING ORGANIC MATTER.											
<b>SOIL LEGEND AND AASHTO CLASSIFICATION</b>												<b>ANGULARITY OF GRAINS</b> THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS: <b>ANGULAR</b> , <b>SUBANGULAR</b> , <b>SUBROUNDED</b> , OR <b>ROUNDED</b> .												<b>WEATHERED ROCK (WR)</b> NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.																							
<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>CRYSTALLINE ROCK (CR)</b> FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.																																			
<b>COMPRESSION</b> SLIGHTLY COMPRESSIBLE LL < 31 MODERATELY COMPRESSIBLE LL = 31 - 50 HIGHLY COMPRESSIBLE LL > 50												<b>NON-CRYSTALLINE ROCK (NCR)</b> 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.																																			
<b>PERCENTAGE OF MATERIAL</b>												<b>COASTAL PLAIN SEDIMENTARY ROCK (CP)</b> COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.																																			
<b>ORGANIC MATERIAL</b> TRACE OF ORGANIC MATTER 2 - 3% LITTLE ORGANIC MATTER 3 - 5% MODERATELY ORGANIC 5 - 10% HIGHLY ORGANIC > 10%												<b>GRANDULAR SOILS</b> 2 - 3% <b>SILT - CLAY SOILS</b> 3 - 5% <b>OTHER MATERIAL</b> TRACE 1 - 10%, LITTLE 10 - 20%, SOME 20 - 35%, HIGHLY 35% AND ABOVE												<b>WEATHERING</b> <b>FRESH</b> ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE. <b>VERY SLIGHT (V SL.)</b> 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. <b>SLIGHT (SL)</b> 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. <b>MODERATE (MOD.)</b> 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. <b>MODERATELY SEVERE (MOD. SEV.)</b> 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> <b>SEVERE (SEV.)</b> 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> <b>VERY SEVERE (V SEV.)</b> 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> <b>COMPLETE</b> 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.																							
<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>CONSISTENCY OR DENSENESS</b>												<b>MISCELLANEOUS SYMBOLS</b>																																			
PRIMARY SOIL TYPE: COMPACTNESS OR CONSISTENCY, RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE), RANGE OF UNCONFINED COMPRESSIVE STRENGTH (TONS/FT <sup>2</sup> )												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>RECOMMENDATION SYMBOLS</b>																																			
U.S. STD. SIEVE SIZE OPENING (MM): 4, 10, 40, 60, 200, 270 COEFFICIENTS: 4.76, 2.00, 0.42, 0.25, 0.075, 0.053												UNDERCUT EXCAVATION, 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																																			
<b>SOIL MOISTURE - CORRELATION OF TERMS</b>												<b>ABBREVIATIONS</b>																																			
SOIL MOISTURE SCALE (ATTERBERG LIMITS), FIELD MOISTURE DESCRIPTION, GUIDE FOR FIELD MOISTURE DESCRIPTION												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 - TRICONE REFUSAL, w - MOISTURE CONTENT, V - VERY, VST - VANE SHEAR TEST, WE. - WEATHERED, UNIT WEIGHT, DRY UNIT WEIGHT, SAMPLE ABBREVIATIONS: S - BULK, SS - SPLIT SPOON, ST - SHELBY TUBE, RS - ROCK, RT - RECOMPACTED TRIAXIAL, CBR - CALIFORNIA BEARING RATIO																																			
<b>PLASTICITY</b>												<b>EQUIPMENT USED ON SUBJECT PROJECT</b>																																			
NON PLASTIC, SLIGHTLY PLASTIC, MODERATELY PLASTIC, HIGHLY PLASTIC												DRILL UNITS: CME-45C, CME-55, CME-550X, VANE SHEAR TEST, PORTABLE HOIST, CME-75, MUD ROTARY																																			
<b>COLOR</b> DESCRIPTIONS MAY INCLUDE COLOR OR COLOR COMBINATIONS (TAN, RED, YELLOW-BROWN, BLUE-BROWN). MODIFIERS SUCH AS LIGHT, DARK, STREAKED, ETC. ARE USED TO DESCRIBE APPEARANCE.																																															
												<b>FRACATURE SPACING</b> TERM: VERY WIDE, WIDE, MODERATELY CLOSE, CLOSE, VERY CLOSE SPACING: MORE THAN 10 FEET, 3 TO 10 FEET, 1 TO 3 FEET, 0.16 TO 1 FOOT, LESS THAN 0.16 FEET												<b>BEDDING</b> TERM: VERY THICKLY BEDDED, THICKLY BEDDED, THINLY BEDDED, VERY THINLY BEDDED, THICKLY LAMINATED, THINLY LAMINATED THICKNESS: 4 FEET, 1.5 - 4 FEET, 0.16 - 1.5 FEET, 0.03 - 0.16 FEET, 0.008 - 0.03 FEET, < 0.008 FEET																							
												<b>INDURATION</b> FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC. <b>FRIABLE</b> RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE. <b>MODERATELY INDURATED</b> GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER. <b>INDURATED</b> GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER. <b>EXTREMELY INDURATED</b> SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.												<b>NOTES:</b> BORING ELEVATIONS OBTAINED FROM GPS UNIT FIAD - FILLED IMMEDIATELY AFTER DRILLING																							
																								<b>BENCH MARK:</b> N/A																							
																								<b>ELEVATION:</b> FEET																							

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# **SUBSURFACE INVESTIGATION**

**SUPPLEMENTAL LEGEND, GEOLOGICAL STRENGTH INDEX (GSI) TABLES  
FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS**

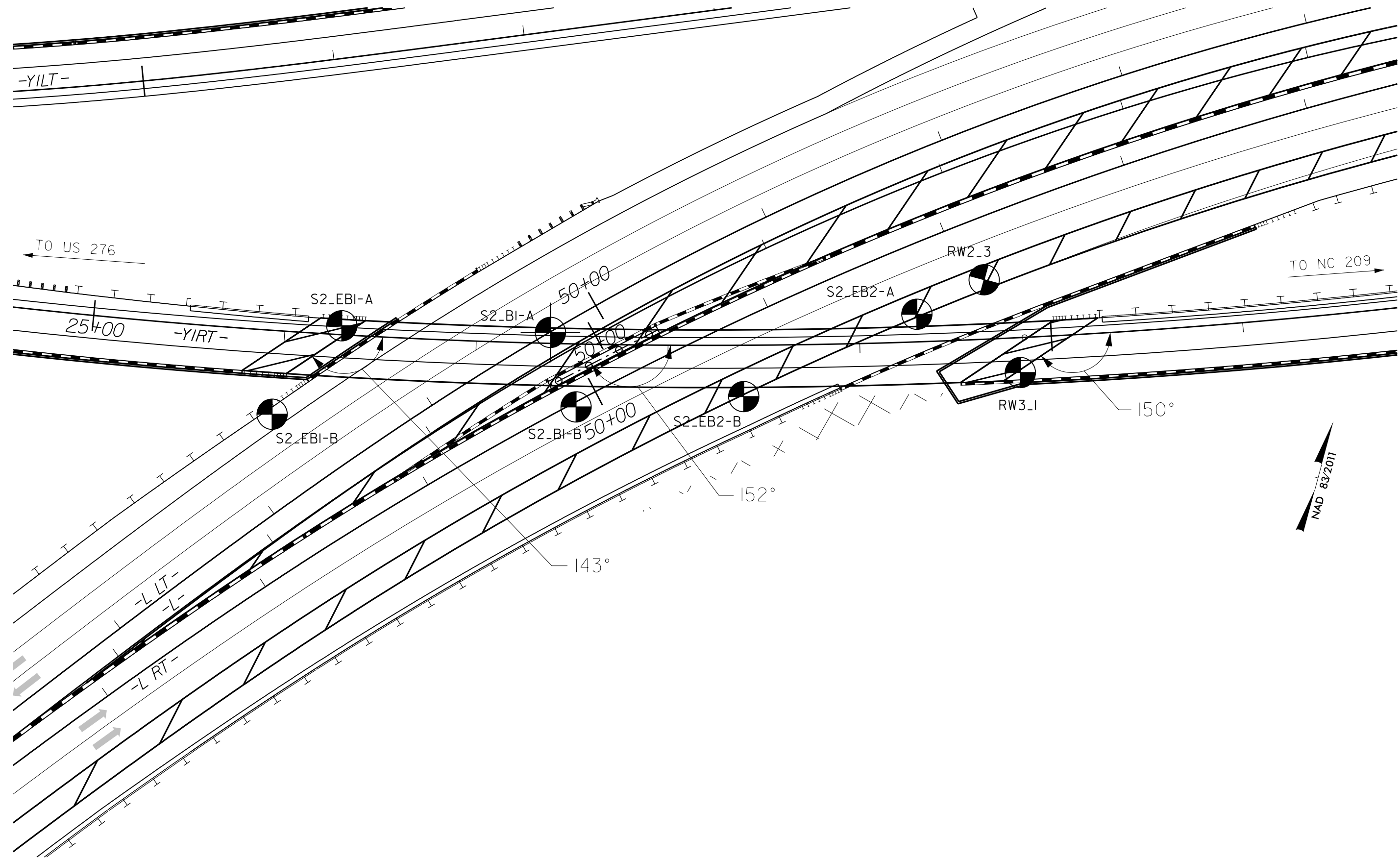
AASHTO LRFD Figure 10.4.6.4-1 — Determination of GSI for Jointed Rock Mass (Marinos and Hoek, 2000)

AASHTO LRFD Figure 10.4.6.4-2 — Determination of GSI for Tectonically Deformed Heterogeneous Rock Masses (Marinos and Hoek, 2000)

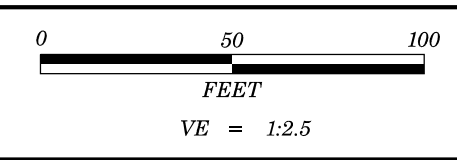
GEOLOGICAL STRENGTH INDEX (GSI) FOR JOINTED ROCKS (Hoek and Marinos, 2000)		SURFACE CONDITIONS					GSI FOR HETEROGENEOUS ROCK MASSES SUCH AS FLYSCH (Marinos, P and Hoek E., 2000)		SURFACE CONDITIONS OF DISCONTINUITIES (Predominantly bedding planes)				
From the lithology, structure and surface conditions of the discontinuities, estimate the average value of GSI. Do not try to be too precise. Quoting a range from 33 to 37 is more realistic than stating that GSI = 35. Note that the table does not apply to structurally controlled failures. Where weak planar structural planes are present in an unfavorable orientation with respect to the excavation face, these will dominate the rock mass behaviour. The shear strength of surfaces in rocks that are prone to deterioration as a result of changes in moisture content will be reduced if water is present. When working with rocks in the fair to very poor categories, a shift to the right may be made for wet conditions. Water pressure is dealt with by effective stress analysis.		VERY GOOD Very rough, fresh unweathered surfaces	GOOD Rough, slightly weathered, iron stained surfaces	FAIR Smooth, moderately weathered and altered surfaces	POOR Slickensided, highly weathered surfaces with compact coatings or fillings or angular fragments	VERY POOR Slickensided, highly weathered surfaces with soft clay coatings or fillings	From a description of the lithology, structure and surface conditions (particularly of the bedding planes), choose a box in the chart. Locate the position in the box that corresponds to the condition of the discontinuities and estimate the average value of GSI from the contours. Do not attempt to be too precise. Quoting a range from 33 to 37 is more realistic than giving GSI = 35. Note that the Hoek-Brown criterion does not apply to structurally controlled failures. Where unfavourably oriented continuous weak planar discontinuities are present, these will dominate the behaviour of the rock mass. The strength of some rock masses is reduced by the presence of groundwater and this can be allowed for by a slight shift to the right in the columns for fair, poor and very poor conditions. Water pressure does not change the value of GSI and it is dealt with by using effective stress analysis.	VERY GOOD - Very Rough, fresh unweathered surfaces	GOOD - Rough, slightly weathered surfaces	FAIR - Smooth, moderately weathered and altered surfaces	POOR - Very smooth, occasionally slickensided surfaces with compact coatings or fillings with angular fragments	VERY POOR - Very smooth, slickensided or highly weathered surfaces with soft clay coatings or fillings	
STRUCTURE		DECREASING SURFACE QUALITY →					COMPOSITION AND STRUCTURE						
INTACT OR MASSIVE - intact rock specimens or massive in situ rock with few widely spaced discontinuities		90			N/A	N/A	<b>A. Thick bedded, very blocky sandstone</b> The effect of pelitic coatings on the bedding planes is minimized by the confinement of the rock mass. In shallow tunnels or slopes these bedding planes may cause structurally controlled instability.	70					
BLOCKY - well interlocked undisturbed rock mass consisting of cubical blocks formed by three intersecting discontinuity sets		80					<b>B. Sandstone with thin inter-layers of siltstone</b>	60					
VERY BLOCKY - interlocked, partially disturbed mass with multi-faceted angular blocks formed by 4 or more joint sets			70				<b>C. Sandstone and siltstone in similar amounts</b>		50				
BLOCKY/DISTURBED/SEAMY - folded with angular blocks formed by many intersecting discontinuity sets. Persistence of bedding planes or schistosity			60				<b>D. Siltstone or silty shale with sandstone layers</b>			40			
DISINTEGRATED - poorly interlocked, heavily broken rock mass with mixture of angular and rounded rock pieces				50			<b>E. Weak siltstone or clayey shale with sandstone layers</b>				30		
LAMINATED/SHEARED - Lack of blockiness due to close spacing of weak schistosity or shear planes				40			<b>F. Tectonically deformed, intensively folded/faulted, sheared clayey shale or siltstone with broken and deformed sandstone layers forming an almost chaotic structure</b>					20	
				30			<b>G. Undisturbed silty or clayey shale with or without a few very thin sandstone layers</b>						10
				20			<b>H. Tectonically deformed silty or clayey shale forming a chaotic structure with pockets of clay. Thin layers of sandstone are transformed into small rock pieces.</b>						
				10									
		N/A	N/A										

→ Means deformation after tectonic disturbance

<b>PROJECT REFERENCE NO.</b>	<b>SHEET NO.</b>
B-3186/B-5898	3
<b>SITE PLAN</b>	
0                      50                      100 FEET	

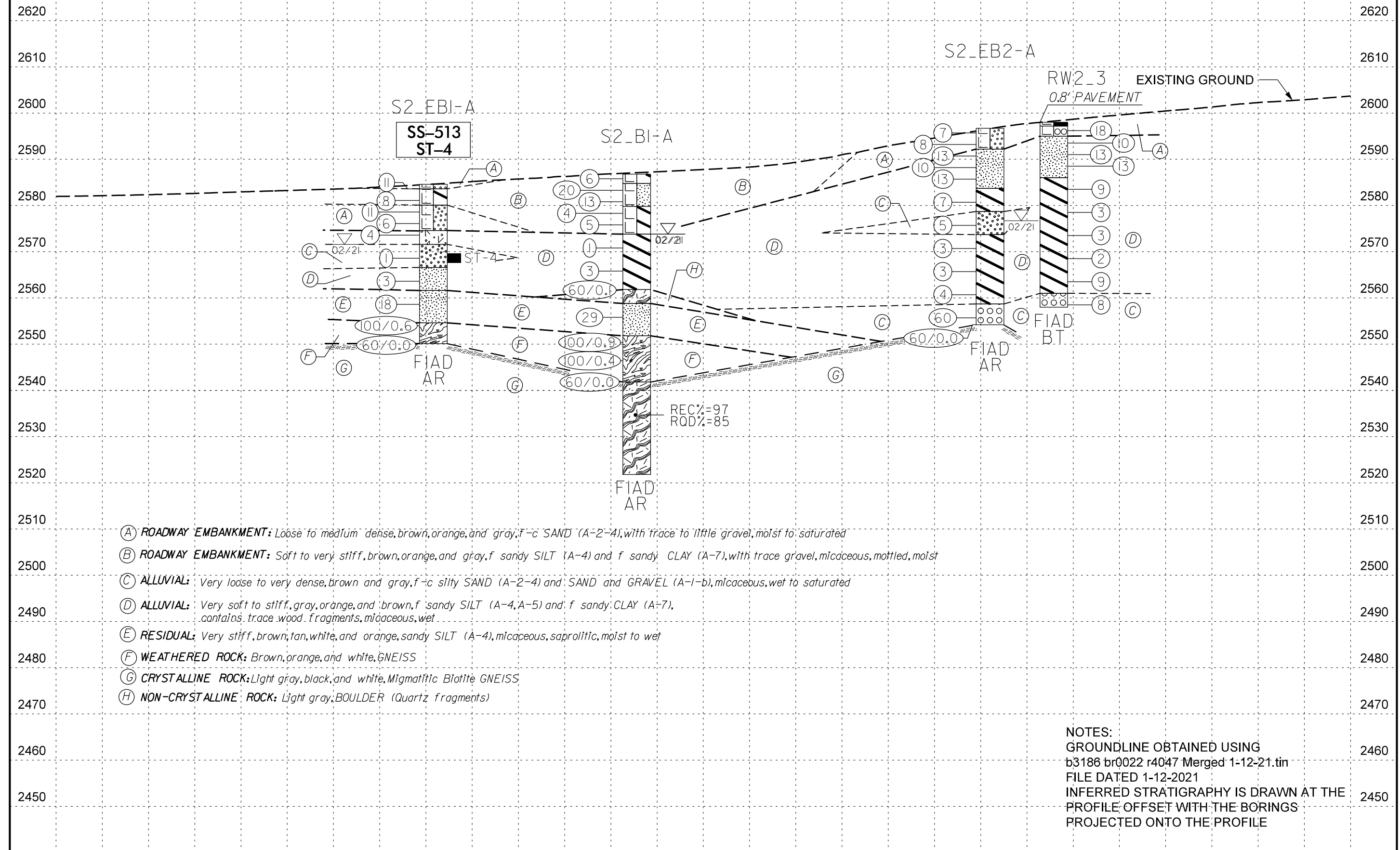






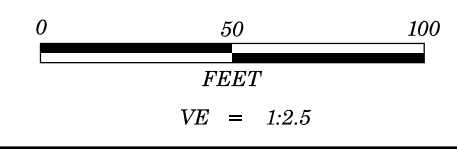
<b>PROJECT REFERENCE NO.</b>	<b>SHEET NO.</b>
B-3816/B-5898	4
<b>BRIDGE NO. 2 PROFILE</b> <b>8' LT OF -YIRT-</b>	

<b>SOIL TEST RESULTS</b>															
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-513	5' LT	26+29	10.0' - 11.5'	A-5 (9)	48	10	4.1	32.5	49.9	13.5	100.0	98.0	74.1	51	-
ST-4	5' LT	26+29	15.0' - 17.0'	A-2-4	27	6	41.2	30.8	7.0	21.0	94.4	66.3	31.2	28	-



- (A) ROADWAY EMBANKMENT: Loose to medium dense, brown, orange, and gray, f-c SAND (A-2-4), with trace to little gravel, moist to saturated
- (B) ROADWAY EMBANKMENT: Soft to very stiff, brown, orange, and gray, f sandy SILT (A-4) and f sandy CLAY (A-7), with trace gravel, micaceous, mottled, moist
- (C) ALLUVIAL: Very loose to very dense, brown and gray, f-c silty SAND (A-2-4) and SAND and GRAVEL (A-1-b), micaceous, wet to saturated
- (D) ALLUVIAL: Very soft to stiff, gray, orange, and brown, f sandy SILT (A-4, A-5) and f sandy CLAY (A-7), contains trace wood fragments, micaceous, wet
- (E) RESIDUAL: Very stiff, brown, tan, white, and orange, sandy SILT (A-4), micaceous, saprolitic, moist to wet
- (F) WEATHERED ROCK: Brown, orange, and white, GNEISS
- (G) CRYSTALLINE ROCK: Light gray, black, and white, Migmatitic Blotite GNEISS
- (H) NON-CRYSTALLINE ROCK: Light gray, BOULDER (Quartz fragments)

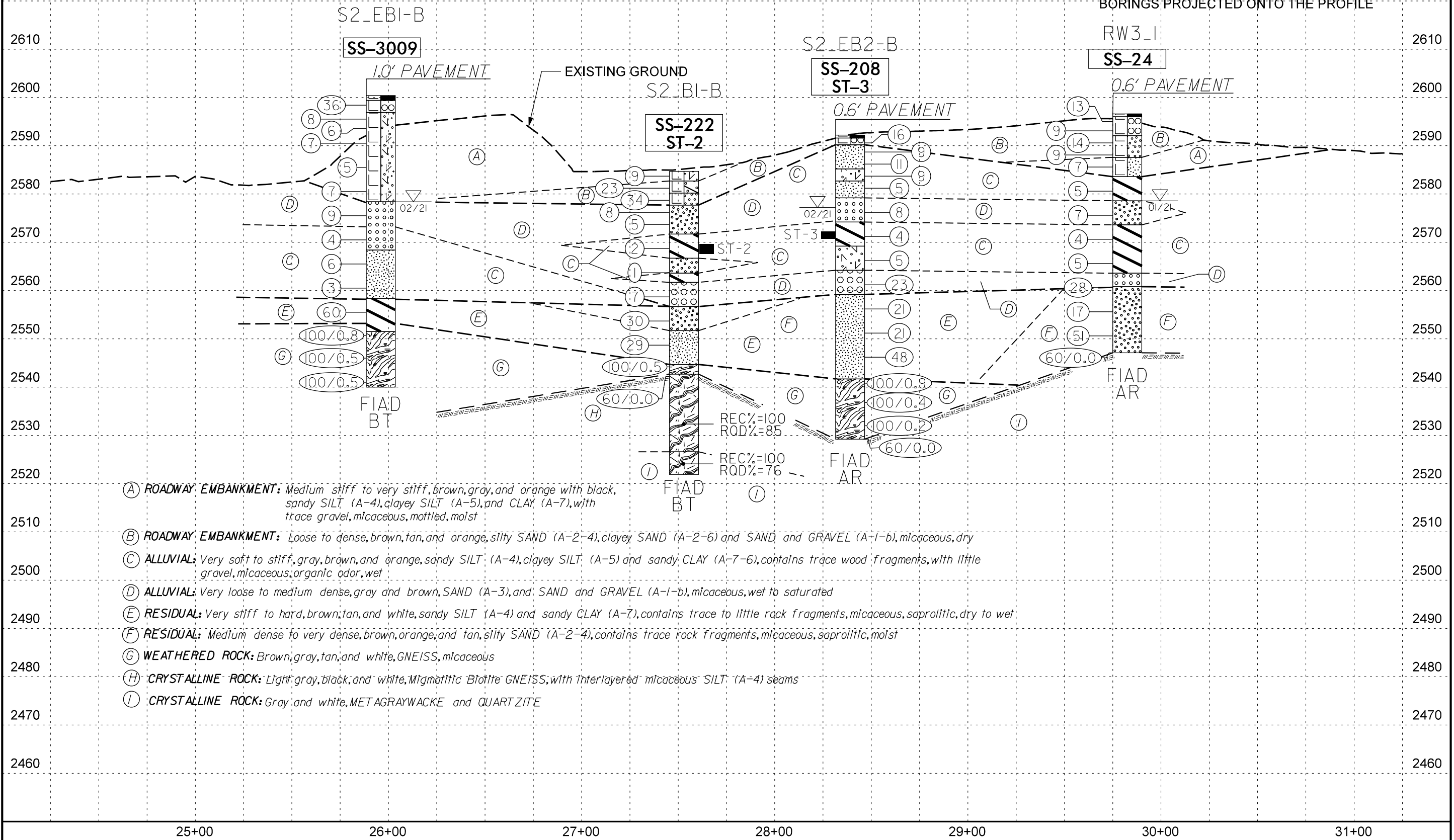
NOTES:  
 GROUNDLINE OBTAINED USING  
 b3186 br0022 r4047 Merged 1-12-21.tin  
 FILE DATED 1-12-2021  
 INFERRED STRATIGRAPHY IS DRAWN AT THE  
 PROFILE OFFSET WITH THE BORINGS  
 PROJECTED ONTO THE PROFILE



<b>PROJECT REFERENCE NO.</b>	<b>SHEET NO.</b>
B-3816/B-5898	5
<b>BRIDGE NO. 2 PROFILE 22' RT OF -YIRT-</b>	

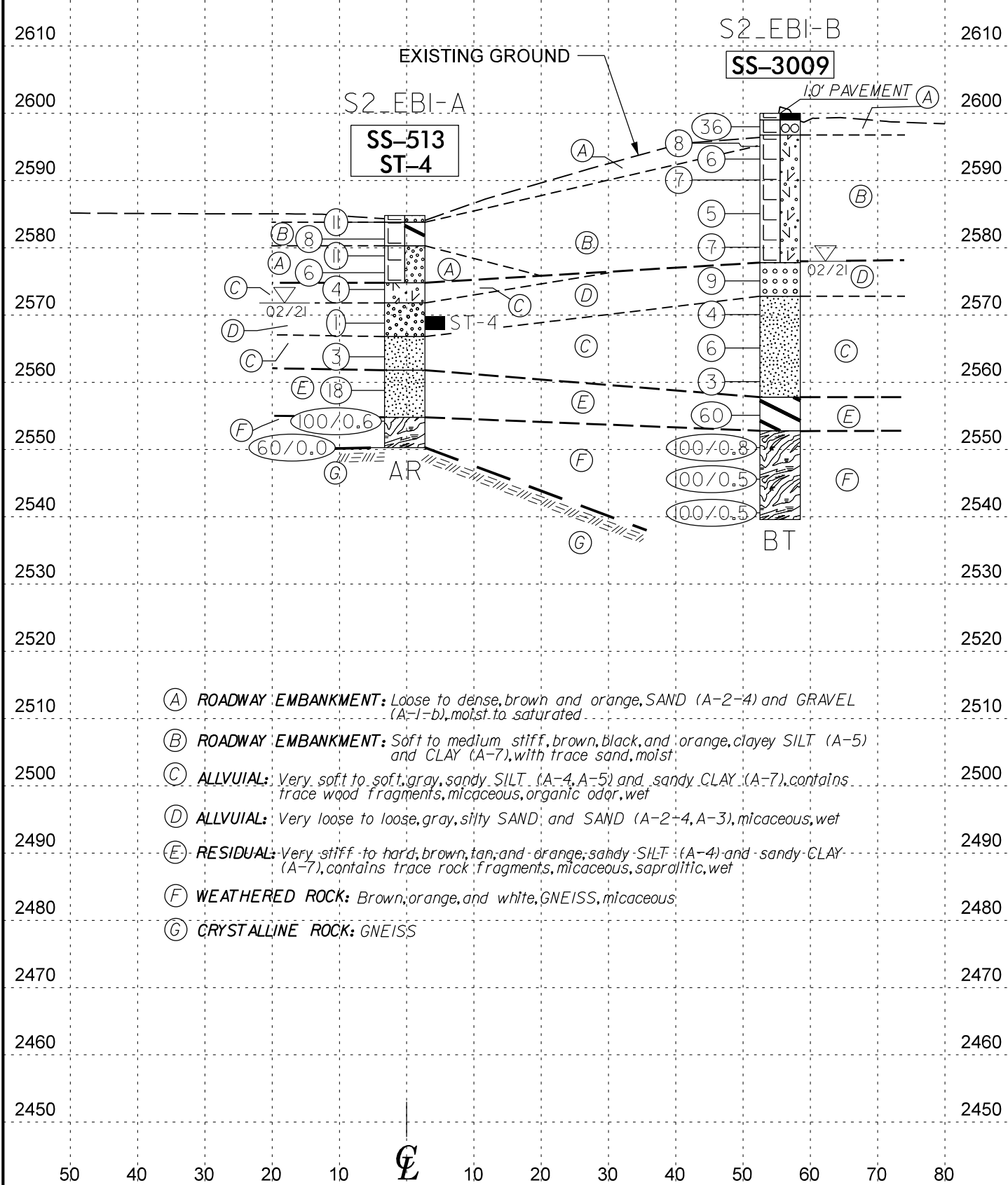
SOIL TEST RESULTS															
SAMPLE NO.	OFFSET	STATION	DEPTH INTERVAL	AASHTO CLASS.	L.L.	P.I.	% BY WEIGHT				% PASSING (SIEVES)			% MOISTURE	% ORGANIC
							C. SAND	F. SAND	SILT	CLAY	10	40	200		
SS-3009	44' RT	25+96	38.9' - 40.4'	A-4	37	8	26.8	36.0	25.4	11.8	86.6	72.3	36.7	43	-
SS-222	33' RT	27+53	15.0' - 16.5'	A-5 (13)	51	10	1.1	21.2	59.5	18.2	100.0	99.5	85.8	62	-
ST-2	33' RT	27+53	15.0' - 17.0'	A-7-5 (16)	57	11	1.3	14.3	66.8	17.6	100.0	99.6	87.3	68	-
SS-208	27' RT	28+39	20.0' - 21.5'	A-7-5 (29)	77	21	2.5	13.1	70.9	13.5	100.0	98.9	89.2	73	-
ST-3	27' RT	28+39	20.0' - 21.5'	A-4	NP	NP	6.7	33.0	38.9	21.4	100	97.2	69.0	46	-
SS-24	7' LT	29+84	15.0' - 16.1'	A-7-6 (11)	47	23	20.8	20.5	23.6	35.1	92.0	79.1	58.5	26	-

NOTES:  
 GROUNDLINE OBTAINED USING b3186 br0022  
 r4047 Merged 1-12-21.tin FILE DATED  
 1-12-2021. INFERRED STRATIGRAPHY IS  
 DRAWN AT THE PROFILE OFFSET WITH THE  
 BORINGS PROJECTED ONTO THE PROFILE

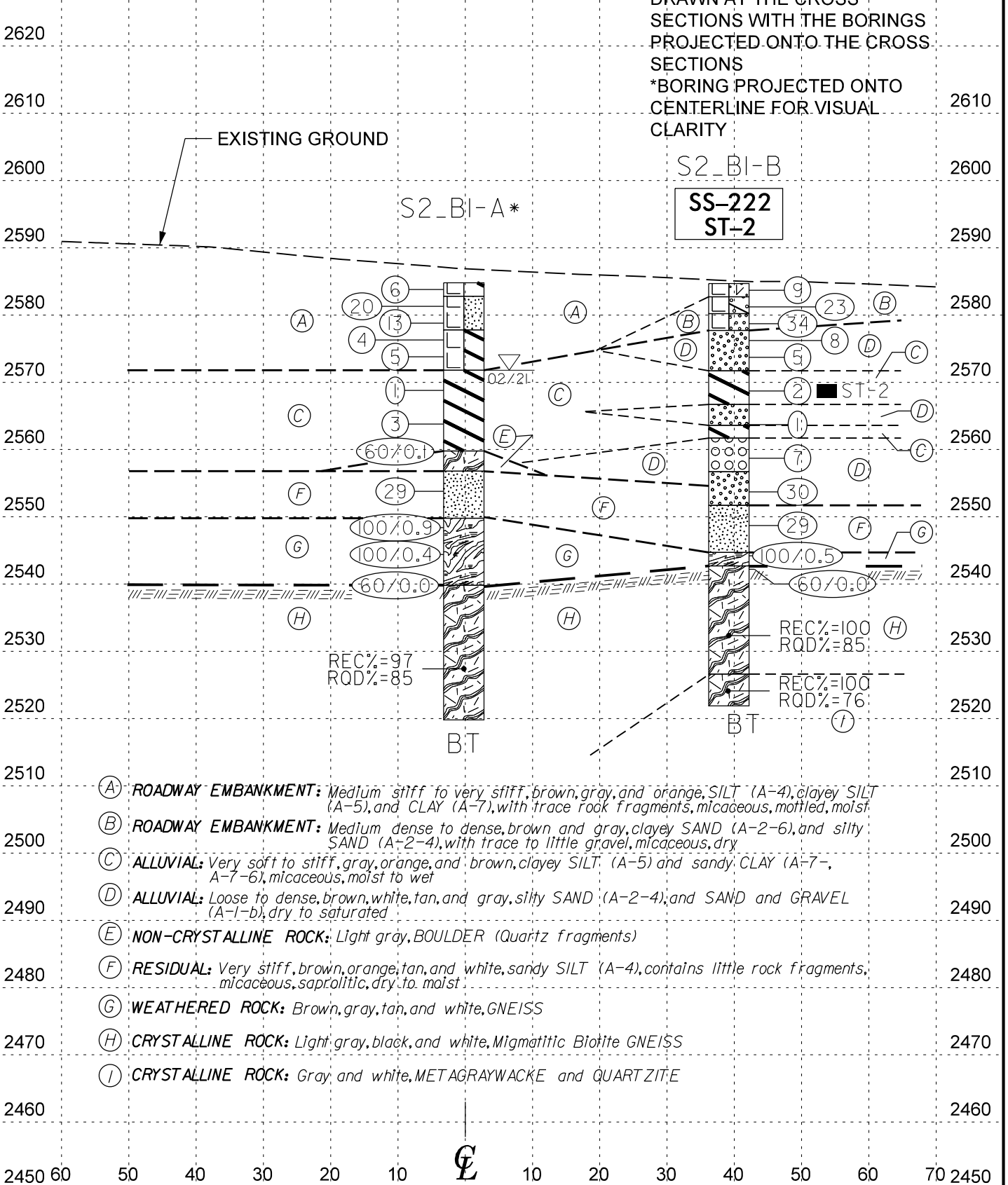


SOIL TEST RESULTS															
SAMPLE NO.	OFFSET	STATION	DEPTH INTERVAL	AASHTO CLASS.	L.L.	P.I.	% BY WEIGHT				% PASSING (SIEVES)			% MOISTURE	% ORGANIC
							C.SAND	F.SAND	SILT	CLAY	10	40	200		
SS-513	5' LT	26+29	10.0' - 11.5'	A-5 (9)	48	10	4.1	32.5	49.9	13.5	100.0	98.0	74.1	51	-
ST-4	5' LT	26+29	15.0' - 17.0'	A-2-4	27	6	41.2	30.8	7.0	21.0	94.4	66.3	31.2	28	-
SS-3009	44' RT	25+96	38.9' - 40.4	A-4	37	8	26.8	36.0	25.4	11.8	86.6	72.3	36.7	43	-
SS-222	33' RT	27+53	15.0' - 16.5'	A-5 (13)	51	10	1.1	21.2	59.5	18.2	100.0	99.5	85.8	62	-
ST-2	33' RT	27+53	15.0' - 17.0'	A-7-5 (16)	57	11	1.3	14.3	66.8	17.6	100.0	99.6	87.3	68	-

**NOTES:**  
 GROUNDLINE OBTAINED USING  
 b3186 br0022 r4047 Merged 1-12-21.tin  
 FILE DATED 1-12-2021  
 INFERRED STRATIGRAPHY IS  
 DRAWN AT THE CROSS  
 SECTIONS WITH THE BORINGS  
 PROJECTED ONTO THE CROSS  
 SECTIONS  
 \*BORING PROJECTED ONTO  
 CENTERLINE FOR VISUAL  
 CLARITY



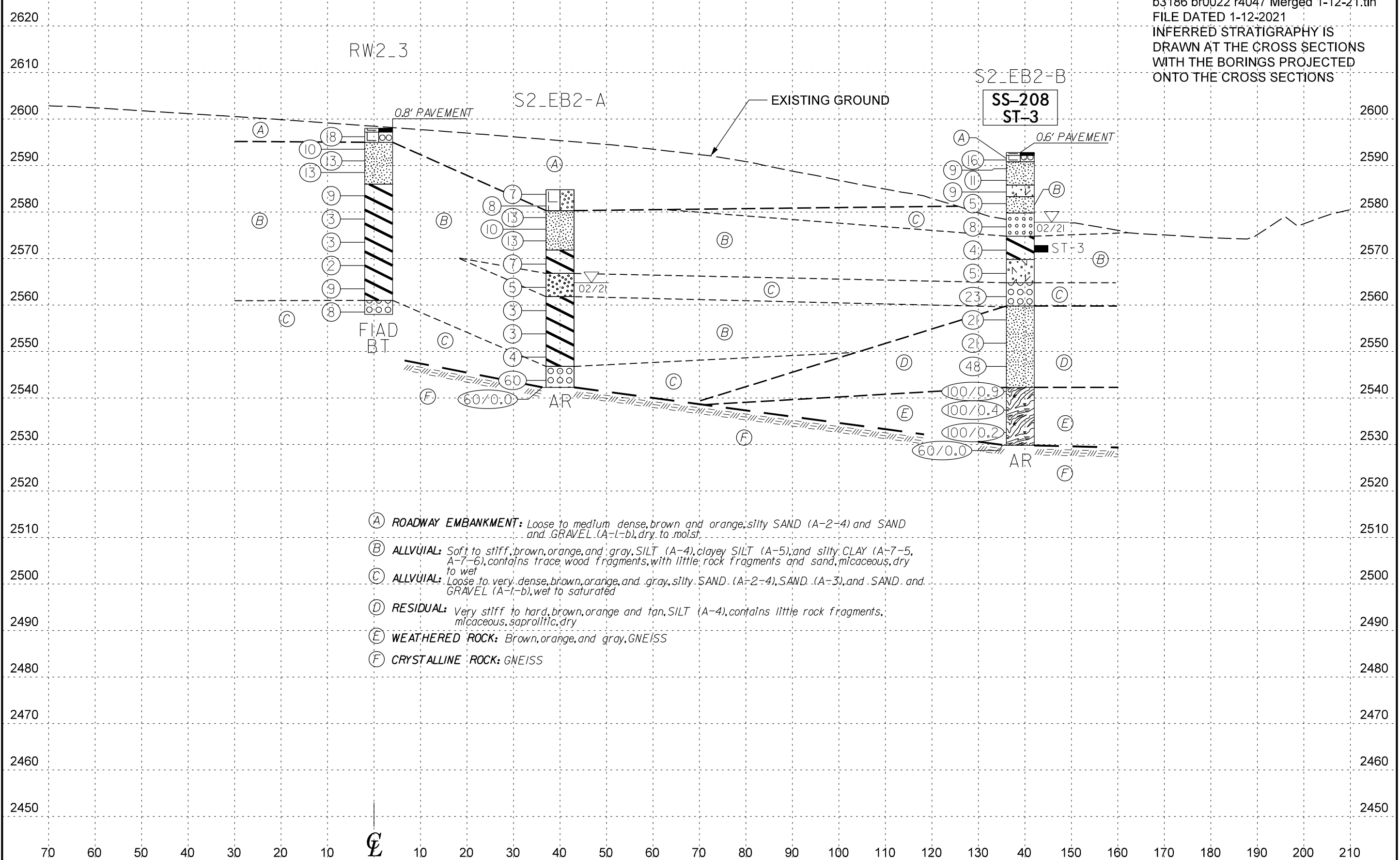
- (A) ROADWAY EMBANKMENT: Loose to dense, brown and orange, SAND (A-2-4) and GRAVEL (A-1-b), moist to saturated
- (B) ROADWAY EMBANKMENT: Soft to medium stiff, brown, black, and orange, clayey SILT (A-5) and CLAY (A-7), with trace sand, moist
- (C) ALLUVIAL: Very soft to soft, gray, sandy SILT (A-4, A-5) and sandy CLAY (A-7), contains trace wood fragments, micaceous, organic odor, wet
- (D) ALLUVIAL: Very loose to loose, gray, silty SAND and SAND (A-2-4, A-3), micaceous, wet
- (E) RESIDUAL: Very stiff to hard, brown, tan, and orange, sandy SILT (A-4) and sandy CLAY (A-7), contains trace rock fragments, micaceous, saprolitic, wet
- (F) WEATHERED ROCK: Brown, orange, and white, GNEISS, micaceous
- (G) CRYSTALLINE ROCK: GNEISS



- (A) ROADWAY EMBANKMENT: Medium stiff to very stiff, brown, gray, and orange, SILT (A-4), clayey SILT (A-5), and CLAY (A-7), with trace rock fragments, micaceous, mottled, moist
- (B) ROADWAY EMBANKMENT: Medium dense to dense, brown and gray, clayey SAND (A-2-6), and silty SAND (A-2-4), with trace to little gravel, micaceous, dry
- (C) ALLUVIAL: Very soft to stiff, gray, orange, and brown, clayey SILT (A-5) and sandy CLAY (A-7, A-7-6), micaceous, moist to wet
- (D) ALLUVIAL: Loose to dense, brown, white, tan, and gray, silty SAND (A-2-4), and SAND and GRAVEL (A-1-b), dry to saturated
- (E) NON-CRYSTALLINE ROCK: Light gray, BOULDER (Quartz fragments)
- (F) RESIDUAL: Very stiff, brown, orange, tan, and white, sandy SILT (A-4), contains little rock fragments, micaceous, saprolitic, dry to moist
- (G) WEATHERED ROCK: Brown, gray, tan, and white, GNEISS
- (H) CRYSTALLINE ROCK: Light gray, black, and white, Migmatitic Biotite GNEISS
- (I) CRYSTALLINE ROCK: Gray and white, METAGRAYWACKE and QUARTZITE

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-208	27' RT	28+39	20.0' - 21.5'	A-7-5 (29)	77	21	2.5	13.1	70.9	13.5	100.0	98.9	89.2	73	-
ST-3	27' RT	28+39	20.0' - 21.5'	A-4	NP	NP	6.7	33.0	38.9	21.4	100	97.2	69.0	46	-

**NOTES:**  
 GROUNDLINE OBTAINED USING:  
 b3186 br0022 r4047 Merged 1-12-21.tin  
 FILE DATED 1-12-2021  
 INFERRED STRATIGRAPHY IS  
 DRAWN AT THE CROSS SECTIONS  
 WITH THE BORINGS PROJECTED  
 ONTO THE CROSS SECTIONS



- (A) **ROADWAY EMBANKMENT:** Loose to medium dense, brown and orange, silty SAND (A-2-4) and SAND and GRAVEL (A-1-b), dry to moist.
- (B) **ALLUVIAL:** Soft to stiff, brown, orange, and gray, SILT (A-4), clayey SILT (A-5), and silty CLAY (A-7-5, A-7-6), contains trace wood fragments, with little rock fragments and sand, micaceous, dry to wet.
- (C) **ALLUVIAL:** Loose to very dense, brown, orange, and gray, silty SAND (A-2-4), SAND (A-3), and SAND and GRAVEL (A-1-b), wet to saturated.
- (D) **RESIDUAL:** Very stiff to hard, brown, orange and tan, SILT (A-4), contains little rock fragments, micaceous, saprolitic, dry.
- (E) **WEATHERED ROCK:** Brown, orange, and gray, GNEISS.
- (F) **CRYSTALLINE ROCK:** GNEISS.

# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST C. Swafford											
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)							GROUND WTR (ft)										
BORING NO. S2_EB1-A		STATION 26+29		OFFSET 5 ft LT		ALIGNMENT -Y1RT-											
COLLAR ELEV. 2,584.6 ft		TOTAL DEPTH 34.5 ft		NORTHING 666,917		EASTING 819,274											
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80% (11/24/2020)				DRILL METHOD H.S. Augers		HAMMER TYPE Automatic											
DRILLER L. Wanstrath		START DATE 02/25/21		COMP. DATE 02/25/21		SURFACE WATER DEPTH N/A											
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)			
			0.5ft	0.5ft	0.5ft	0	25	50	75	100							
2585	2,584.6	0.0	5	7	4									2,584.6	0.0	GROUND SURFACE	
	2,582.1	2.5	3	4	4									2,583.6	1.0	ROADWAY EMBANKMENT Medium dense, brown, f SAND (A-2-4), with trace gravel	
2580	2,579.6	5.0	6	5	6									2,580.1	4.5	Soft, brown and orange, CLAY (A-7) Loose to medium dense, gray, f-c SAND (A-2-4)	
	2,577.1	7.5	3	3	3									2,574.6	10.0	ALLUVIAL Soft, gray, SILT (A-5)(9), micaceous	
2575	2,574.6	10.0	3	2	2									2,571.6	13.0	Very loose, gray, f silty SAND (A-2-4), micaceous	
	2,569.6	15.0	1	WOH	1									2,566.6	18.0	Soft, gray, f sandy SILT (A-4), micaceous	
2565	2,564.6	20.0	1	1	2									2,561.6	23.0	RESIDUAL Very stiff, brown and orange, f sandy SILT (A-4), micaceous, saprolitic	
2560	2,559.6	25.0	4	7	11									2,554.6	30.0	WEATHERED ROCK Brown, orange, and white, GNEISS	
2555	2,554.6	30.0	90	10/0.1										2,550.1	34.5	Boring Terminated with Standard Penetration Test Refusal at Elevation 2,550.1 ft on Crystalline Rock (GNEISS)	
	2,550.1	34.5	60/0.0											2,550.1	34.5	Other Samples: ST-4 (15.0 - 17.0)	

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST C. Swafford											
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)							GROUND WTR (ft)										
BORING NO. S2_EB1-B		STATION 25+96		OFFSET 44 ft RT		ALIGNMENT -Y1RT-											
COLLAR ELEV. 2,600.4 ft		TOTAL DEPTH 60.4 ft		NORTHING 666,863		EASTING 819,251											
DRILL RIGHAMMER EFF./DATE GTC3277 CME-75 83% (09/15/2020)				DRILL METHOD Mud Rotary		HAMMER TYPE Automatic											
DRILLER K. Boone		START DATE 02/27/21		COMP. DATE 02/27/21		SURFACE WATER DEPTH N/A											
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)			
			0.5ft	0.5ft	0.5ft	0	25	50	75	100							
2605														2,600.4	0.0	GROUND SURFACE	
														2,599.4	1.0	ROADWAY EMBANKMENT 1.0' PAVEMENT	
2600	2,599.4	1.0	11	20	16									2,596.9	3.5	ROADWAY EMBANKMENT Dense, brown, GRAVEL (A-1-b)	
	2,596.5	3.9	6	4	4									2,594.6	5.8	Medium stiff, orange and brown with black, clayey SILT (A-5), with trace sand	
2595	2,594.6	5.8	6	3	3									2,591.5	8.9		
	2,586.5	13.9	3	2	3									2,581.5	18.9		
2585	2,581.5	18.9	3	3	4									2,576.5	23.9		
	2,576.5	23.9	4	4	5									2,571.5	28.9		
2575	2,571.5	28.9	3	3	1									2,566.5	33.9		
	2,566.5	33.9	1	3	3									2,561.5	38.9		
2560	2,561.5	38.9	WOH	1	2									2,558.4	42.0	RESIDUAL Hard, tan and brown, sandy CLAY (A-7), contains trace rock fragments, micaceous, saprolitic	
	2,558.4	42.0												2,551.5	48.9	WEATHERED ROCK Brown, GNEISS, micaceous	
2555	2,556.5	43.9	18	27	33									2,551.5	48.9		
	2,551.5	48.9	32	68/0.3										2,546.5	53.9		
2545	2,546.5	53.9	86	14/0.0										2,541.5	58.9		
	2,541.5	58.9	79	21/0.0										2,540.0	60.4		
2540	2,540.0	60.4												2,540.0	60.4	Boring Terminated at Elevation 2,540.0 ft in Weathered Rock (GNEISS)	

NCDOT BORE DOUBLE B3186\_GEO\_SITE 2.GPJ NC\_DOT.GDT 11/23/21

# GEOTECHNICAL BORING REPORT

## BORE LOG

# GEOTECHNICAL BORING REPORT

## CORE LOG

WBS 38332.1.FS1				TIP B-3186 / B-5898		COUNTY HAYWOOD			GEOLOGIST C. Swafford						
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)								GROUND WTR (ft)							
BORING NO. S2_B1-A			STATION 27+39		OFFSET 6 ft LT		ALIGNMENT -Y1RT-		0 HR. 13.0						
COLLAR ELEV. 2,586.8 ft			TOTAL DEPTH 65.0 ft		NORTHING 666,942		EASTING 819,380		24 HR. FIAD						
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)				DRILL METHOD SPT Core Boring				HAMMER TYPE Automatic							
DRILLER L. Wanstrath			START DATE 02/26/21		COMP. DATE 02/27/21		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					
2590														2,586.8	0.0
GROUND SURFACE															
ROADWAY EMBANKMENT															
2585	2,584.3	2.5	3	3	3							M	2,584.8	2.0	Medium stiff, brown and orange, CLAY (A-7), micaceous
	2,581.8	5.0	5	10	10							M			Stiff to very stiff, brown and gray, sandy SILT (A-4) with trace clay and gravel, micaceous, mottled
2580	2,579.3	7.5	10	6	7							M	2,579.8	7.0	Medium stiff, orange, CLAY (A-7) with trace sand, mottled
	2,576.8	10.0	2	1	3							M			
2575	2,573.8	13.0	1	2	3							M	2,573.8	13.0	ALLUVIAL
	2,571.8	15.0	1	WOH	1							W			Very soft to soft, gray and brown, sandy CLAY (A-7), micaceous
2570	2,566.8	20.0	1	1	2							W			
2565	2,561.8	25.0	60/0.1									W			
2560	2,558.8	30.0													
2555	2,551.8	35.0	11	13	16							M	2,551.8	35.0	NON-CRYSTALLINE ROCK
	2,546.8	40.0	100/0.4												Light gray, BOULDER (Quartz fragments)
2545	2,541.8	45.0													
2540															
2535															
2530															
2525															
Boring Terminated at Elevation 2,521.8 ft in Crystalline Rock (Migmatitic Biotite GNEISS)															
NOTES															
0.5' topsoil															

WBS 38332.1.FS1				TIP B-3186 / B-5898		COUNTY HAYWOOD			GEOLOGIST C. Swafford			
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)								GROUND WTR (ft)				
BORING NO. S2_B1-A			STATION 27+39		OFFSET 6 ft LT		ALIGNMENT -Y1RT-		0 HR. 13.0			
COLLAR ELEV. 2,586.8 ft			TOTAL DEPTH 65.0 ft		NORTHING 666,942		EASTING 819,380		24 HR. FIAD			
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)				DRILL METHOD SPT Core Boring				HAMMER TYPE Automatic				
DRILLER L. Wanstrath			START DATE 02/26/21		COMP. DATE 02/27/21		SURFACE WATER DEPTH N/A					
CORE SIZE NQ2				TOTAL RUN 20.0 ft				LOG	DESCRIPTION AND REMARKS	DEPTH (ft)		
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	REC. (ft) %	RQD (ft) %	SAMP. NO.				STRATA REC. (ft) %	RQD (ft) %
2541.8		45.0	4.0	2:07	(3.4) 85%	(2.6) 65%		(19.4) 97%	(17.0) 85%	2,541.8	45.0	Begin Coring @ 45.0 ft
2540	2,541.8	45.0	4.0	1:47								CRYSTALLINE ROCK
	2,537.8	48.0	5.0	2:06								Light gray, black and white, Migmatitic Biotite GNEISS, slight weathering, hard, very close to close fracture spacing
	2,537.8	49.0	5.0	2:00								Very severe weathering, highly micaceous; 0.6' core loss at 48.0' Slight weathering, close fracture spacing at 49.0'
2535				1:39	(5.0) 100%	(4.3) 86%						
	2,532.8	54.0		4:00								
				1:44								
	2,532.8	54.0		2:36								
				2:03								
				1:53	(5.0) 100%	(4.8) 96%	RS-14					
2530				2:05								
				2:16								
	2,527.8	59.0		2:20								
				2:22								
				1:46	(5.0) 100%	(4.3) 86%						
2525				2:15								
	2,522.8	64.0		2:24								
	2,521.8	65.0	1.0	1:54	(1.0) 100%	(1.0) 100%						
				2:10								
Boring Terminated at Elevation 2,521.8 ft in Crystalline Rock (Migmatitic Biotite GNEISS)												
NOTES												
0.5' topsoil												

NCDOT BORE DOUBLE B3186\_GEO\_SITE 2.GPJ NC\_DOT.GDT 11/23/21

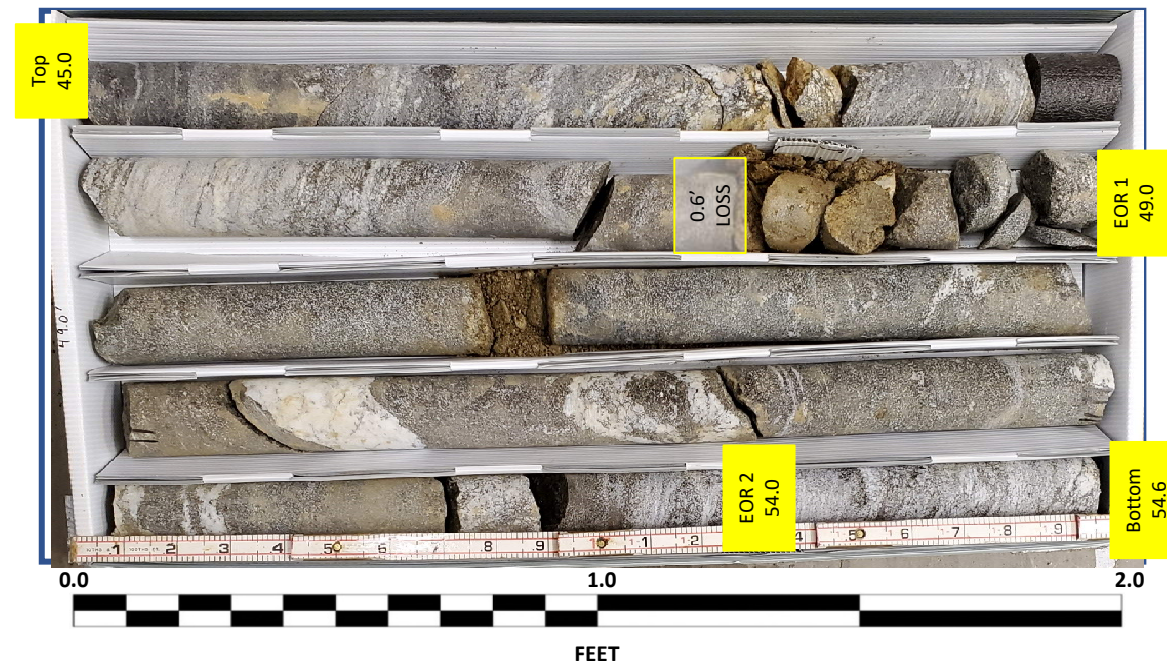


# CORE PHOTOGRAPHIC RECORD

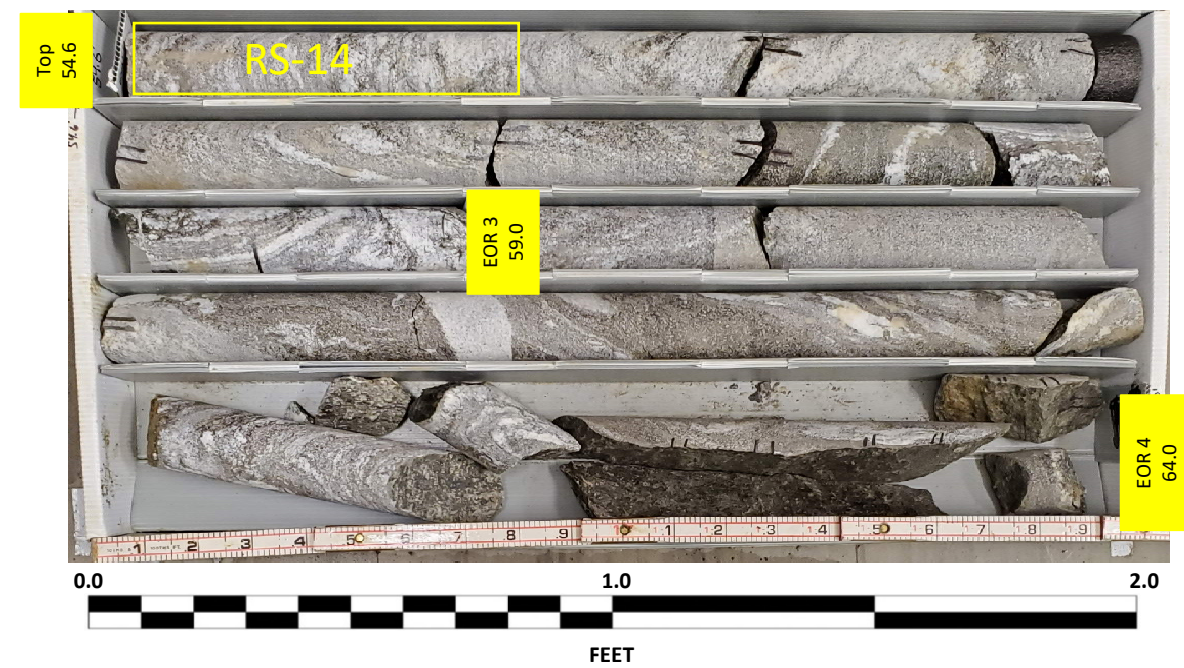
38330.1.FS1 (B-3186/B-5898)

US 23/ US 74 Great Smokey Mountain Highway

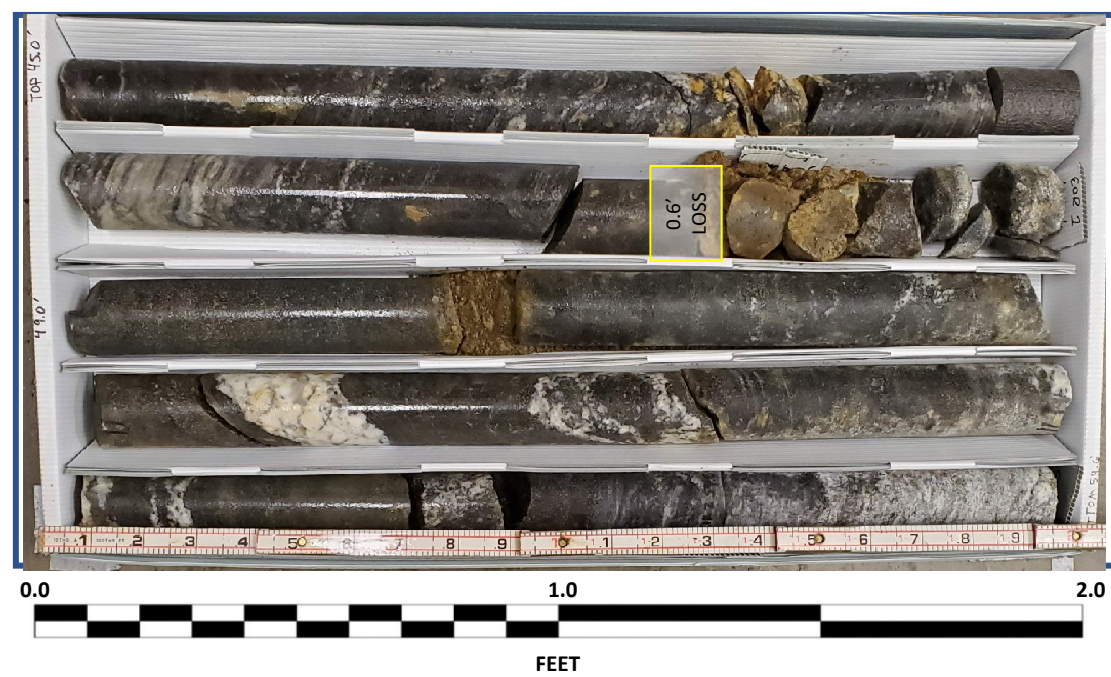
**S2\_B1-A**  
**Box 1 of 3: 45.0 – 54.6 FEET**  
**DRY**



**S2\_B1-A**  
**Box 2 of 3: 54.6 – 64.0 FEET**  
**DRY**



**S2\_B1-A**  
**Box 1 of 3: 45.0 – 54.6 FEET**  
**WET**



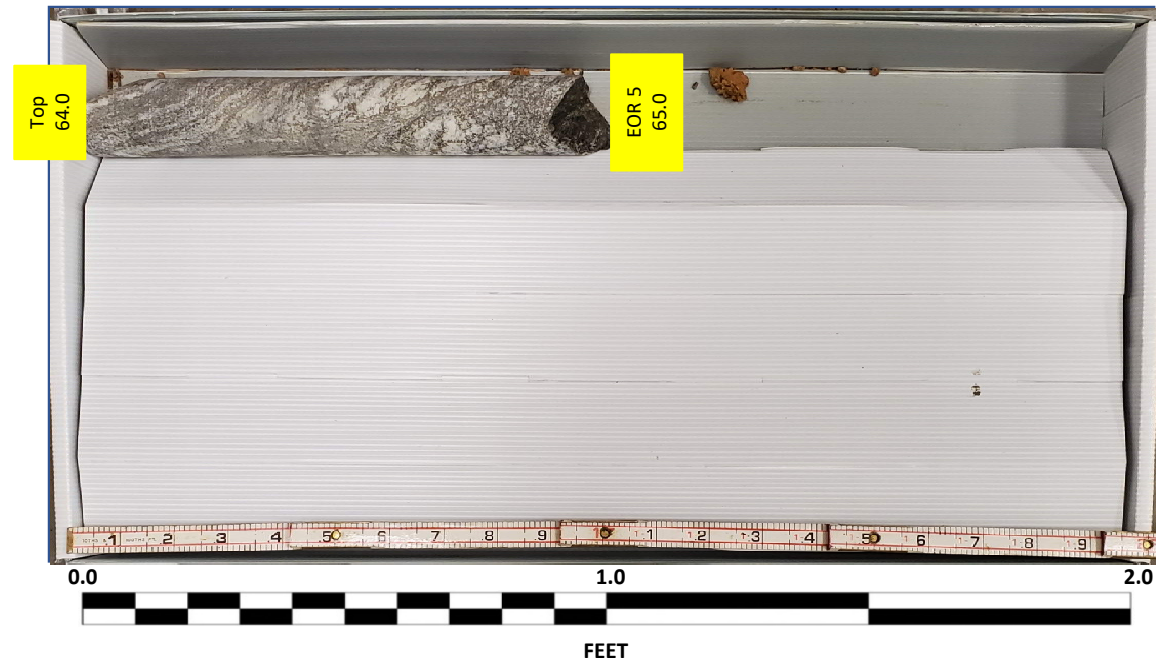
**S2\_B1-A**  
**Box 2 of 3: 54.6 – 64.0 FEET**  
**WET**



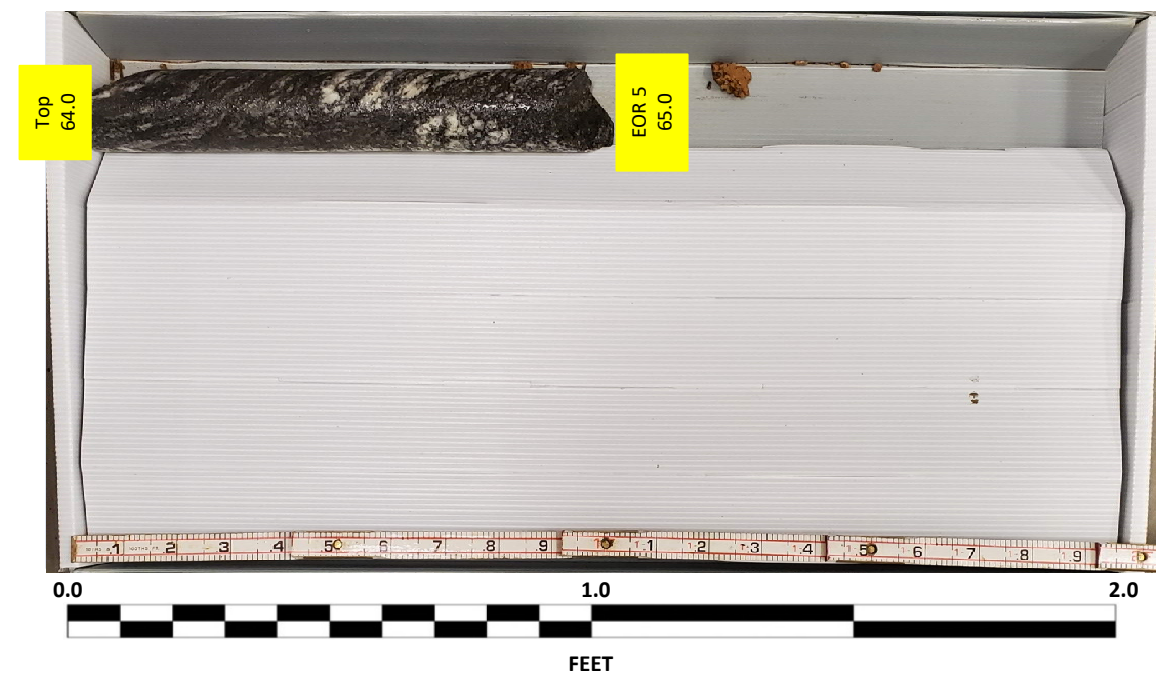


CORE PHOTOGRAPHIC RECORD  
38330.1.FS1 (B-3186/B-5898)  
US 23/ US 74 Great Smokey Mountain Highway

**S2\_B1-A**  
**Box 3 of 3: 64.0 – 65.0 FEET**  
**DRY**



**S2\_B1-A**  
**Box 3 of 3: 64.0 – 65.0 FEET**  
**WET**



# GEOTECHNICAL BORING REPORT BORE LOG

# GEOTECHNICAL BORING REPORT CORE LOG

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST R. Dugger									
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)							GROUND WTR (ft)								
BORING NO. S2_B1-B		STATION 27+53		OFFSET 33 ft RT		ALIGNMENT -Y1RT-									
COLLAR ELEV. 2,584.7 ft		TOTAL DEPTH 62.8 ft		NORTHING 666,908		EASTING 819,403									
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)		DRILL METHOD SPT Core Boring		HAMMER TYPE Automatic											
DRILLER L. Wanstrath		START DATE 02/10/21		COMP. DATE 02/27/21		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					
2585	2,584.7	0.0	2	4	5								2,584.7	GROUND SURFACE	0.0
	2,582.2	2.5	7	12	11								2,582.7	ROADWAY EMBANKMENT Stiff, brown and orange, clayey SILT (A-5), micaceous	2.9
2580	2,579.7	5.0	18	18	16								2,580.2	Medium dense, brown, clayey SAND (A-2-6) with trace gravel	4.5
	2,577.2	7.5	4	4	4								2,577.7	Dense, brown and gray, silty SAND (A-2-4) with little gravel, micaceous	7.0
2575	2,574.7	10.0	2	2	3									ALLUVIAL Loose, brown and gray, silty SAND (A-2-4), micaceous	
2570	2,569.7	15.0	1	1	1								2,571.7	Very soft, gray, silty CLAY (A-7-5)(16) and SILT (A-5)(13), micaceous	13.0
			1	1	1						SS-222		2,566.7	Very loose, brown and gray, silty SAND (A-2-4)	18.0
2565	2,564.7	20.0	WOH	WOH	1								2,563.6	Very soft, brown and gray, CLAY (A-7-6)	21.1
2560	2,559.7	25.0	7	5	2								2,561.7	Loose, gray, SAND and GRAVEL (A-1-b)	23.0
2555	2,554.7	30.0	9	16	14								2,556.7	RESIDUAL Medium dense to dense, brown, white, and tan, silty SAND (A-2-4) with little rock fragments	28.0
2550	2,549.7	35.0	15	15	14								2,551.7	Very stiff, brown, orange, and tan, sandy SILT (A-4) with little rock fragments, micaceous, saprolitic	33.0
2545	2,544.7	40.0	100/0.5										2,544.7	WEATHERED ROCK	40.0
	2,542.2	42.5	60/0.0										2,542.7	Brown, gray, and white, GNEISS	42.0
2540														CRYSTALLINE ROCK No Recovery, begin rock coring at 42.0' Light to dark gray and white with trace pink, Migmatitic Biotite GNEISS	
2535											RS-13				
2530															
2525													2,526.6	Grey and white, METAGRAYWACKE and QUARTZITE	58.1
													2,521.9	Boring Terminated at Elevation 2,521.9 ft in Crystalline Rock (METAGRAYWACKE and QUARTZITE)	62.8
<p style="text-align: center;"><b>NOTES</b></p> <p>15.0- 17.0': ST-2 lab classified as (A-7-5)(16) in offset hole ~3' upstation 15.0 - 16.5': SS-222 lab classified as (A-5)(13)</p> <p>Other Samples: ST-2 (15.0 - 17.0)</p>															

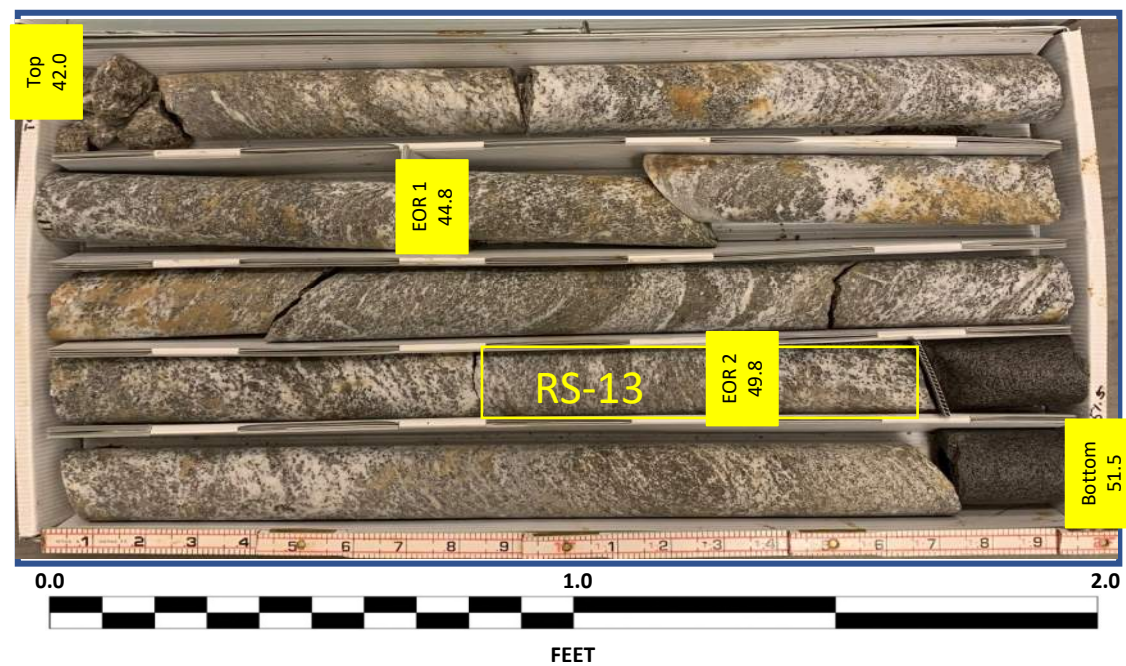
WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST R. Dugger						
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)							GROUND WTR (ft)					
BORING NO. S2_B1-B		STATION 27+53		OFFSET 33 ft RT		ALIGNMENT -Y1RT-						
COLLAR ELEV. 2,584.7 ft		TOTAL DEPTH 62.8 ft		NORTHING 666,908		EASTING 819,403						
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)		DRILL METHOD SPT Core Boring		HAMMER TYPE Automatic								
DRILLER L. Wanstrath		START DATE 02/10/21		COMP. DATE 02/27/21		SURFACE WATER DEPTH N/A						
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	TOTAL RUN		SAMP. NO.	STRATA		LOG	DESCRIPTION AND REMARKS	DEPTH (ft)
					REC. (ft)	RQD (ft)		REC. (ft)	RQD (ft)			
2542.7	2,542.7	42.0	2.8	0:36/0.8 1:43/1.0 2:21/1.0	(2.8)	(2.6)		(16.1)	(13.7)		Begin Coring @ 42.0 ft	
2540	2,539.9	44.8	5.0	1:41/1.0 1:30/1.0 1:39/1.0 1:29/1.0 2:20/1.0	(5.0)	(5.0)		100%	85%		CRYSTALLINE ROCK Light to dark grey and white with trace pink, Migmatitic Biotite GNEISS, with trace garnet porphyroblasts, slight to very slight weathering, hard, moderately close to close fracture spacing	42.0
2535	2,534.9	49.8	5.0	1:55/1.0 1:52/1.0 1:45/1.0 2:14/1.0 2:20/1.0	(5.0)	(2.8)	RS-13	100%	56%		RS-13 49.5' - 50.2' GSI= 75 - 85 Qu= 17,889 psi	
2530	2,529.9	54.8	5.0	1:44/1.0 2:04/1.0 2:22/1.0 2:38/1.0 2:46/1.0	(5.0)	(4.5)		100%	90%		Moderately severe to severe weathering, very close fracture spacing (80-90° joint), with trace epidote along fracture plane Very slight to slight weathering, wide fracture spacing	
2525	2,524.9	59.8	3.0	3:16/1.0 3:15/1.0 2:30/1.0	(3.0)	(2.4)		(4.5)	(3.4)		Grey and white, METAGRAYWACKE and QUARTZITE (eye fold), slight weathering, hard, close to moderately close fracture spacing, with few healed fractures (variable orientations), foliations oriented 55-65°	58.1
	2,521.9	62.8									Boring Terminated at Elevation 2,521.9 ft in Crystalline Rock (METAGRAYWACKE and QUARTZITE)	62.8
<p style="text-align: center;"><b>NOTES</b></p> <p>15.0- 17.0': ST-2 lab classified as (A-7-5)(16) in offset hole ~3' upstation 15.0 - 16.5': SS-222 lab classified as (A-5)(13)</p> <p>Other Samples: ST-2 (15.0 - 17.0)</p>												

NCDOT BORE DOUBLE B3186\_GEO\_SITE 2.GPJ NC\_DOT.GDT 11/23/21

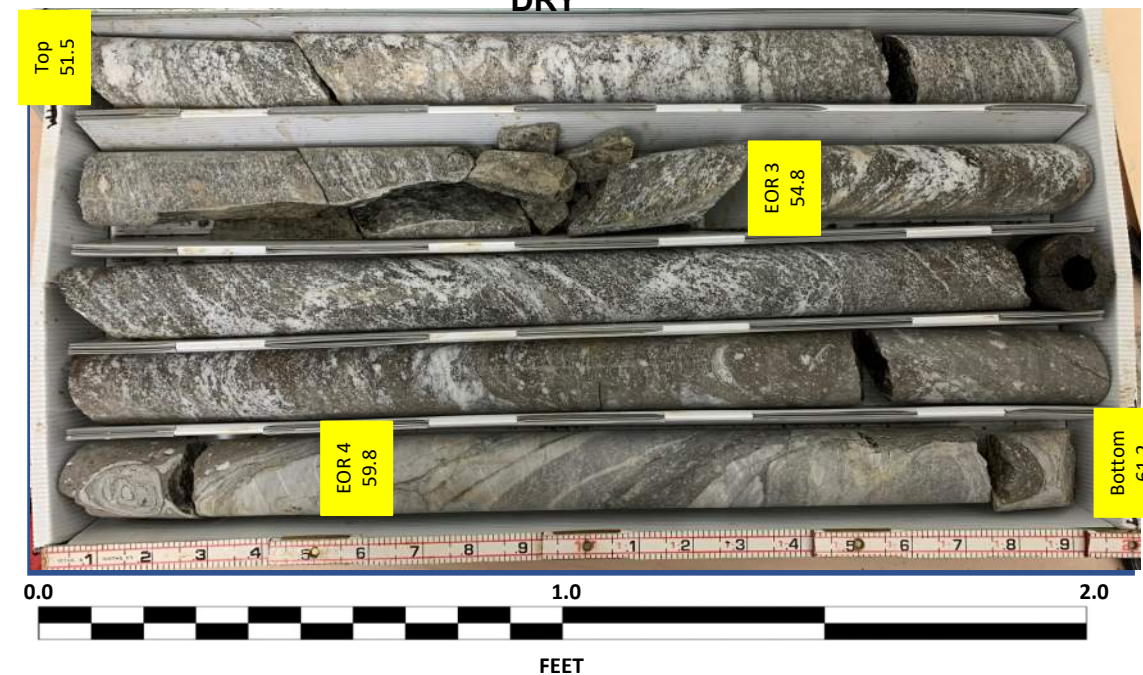


CORE PHOTOGRAPHIC RECORD  
38330.1.FS1 (B-3186/B-5898)  
US 23/ US 74 Great Smokey Mountain Highway

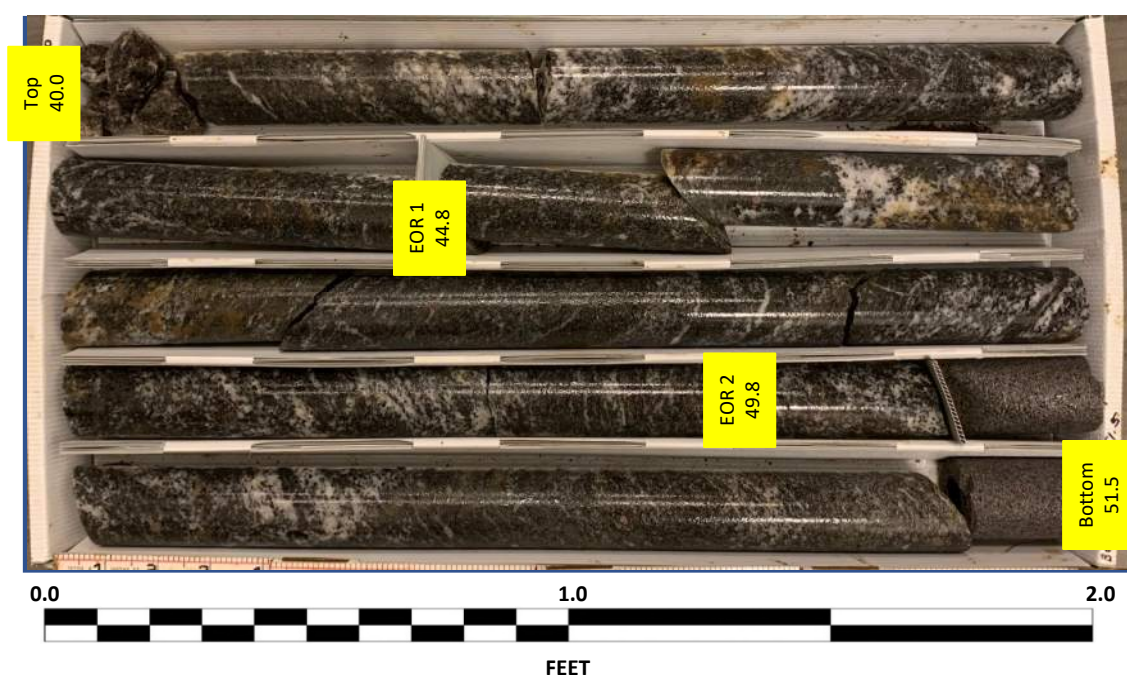
S2\_B1-B  
Box 1 of 3: 42.0 – 51.5 FEET  
DRY



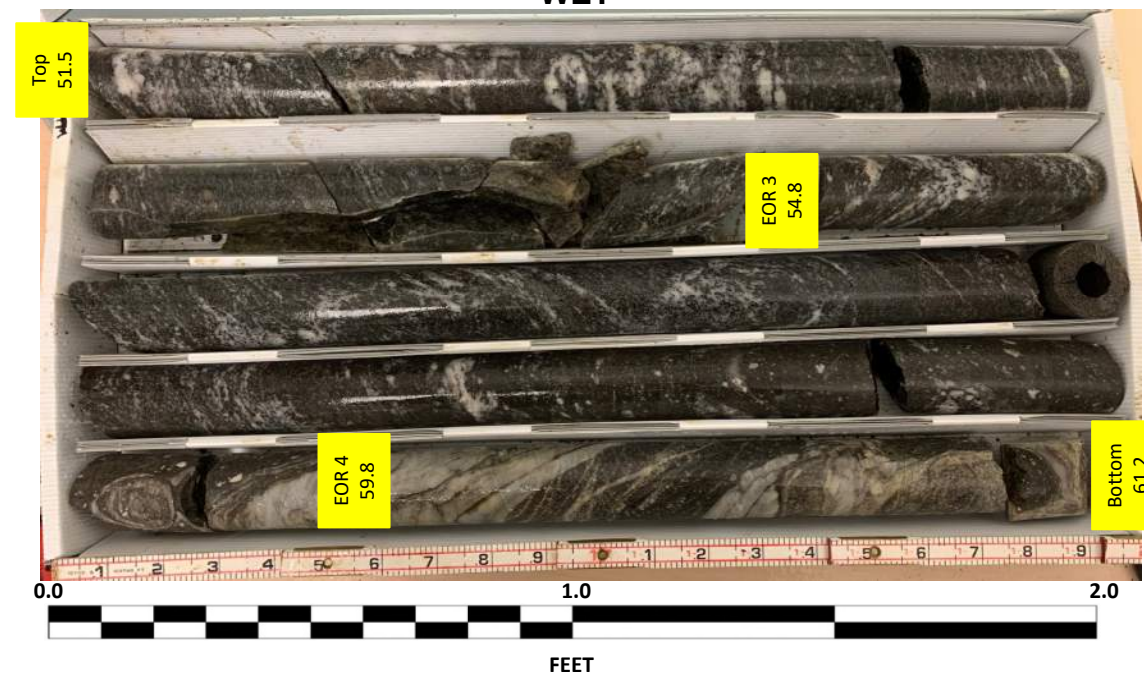
S2\_B1-B  
Box 2 of 3: 51.5 – 61.2 FEET  
DRY



S2\_B1-B  
Box 1 of 3: 42.0 – 51.5 FEET  
WET



S2\_B1-B  
Box 2 of 3: 51.5 – 61.2 FEET  
WET



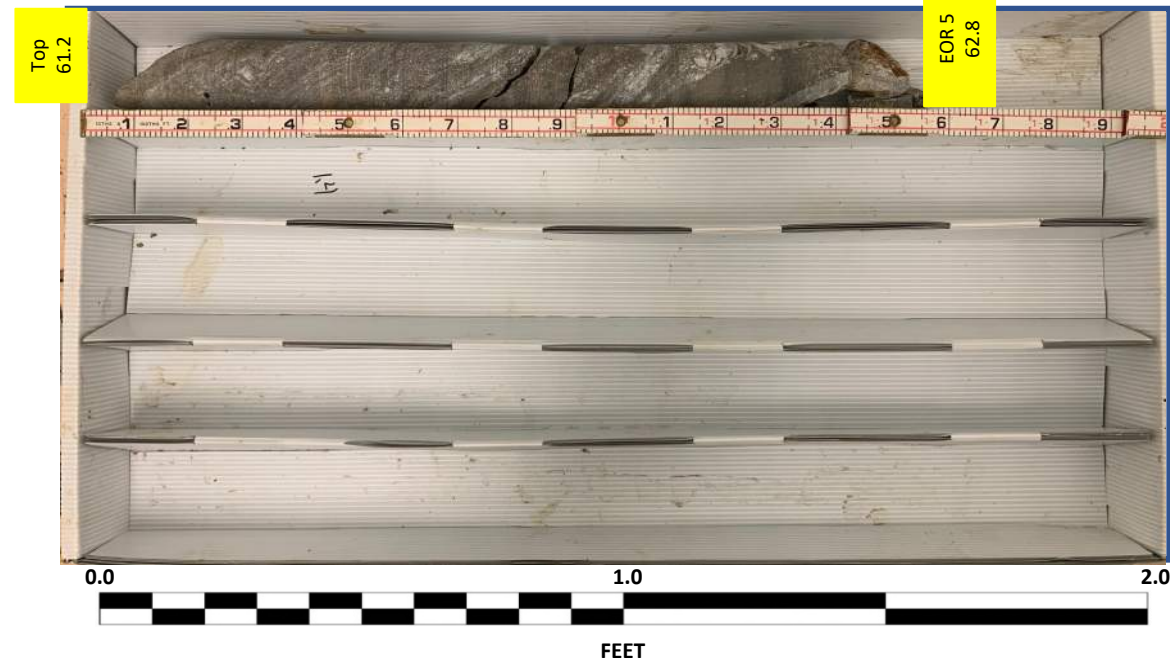


# CORE PHOTOGRAPHIC RECORD

38330.1.FS1 (B-3186/B-5898)

US 23/ US 74 Great Smokey Mountain Highway

**S2\_B1-B**  
**Box 3 of 3: 61.2 – 62.8 FEET**  
**DRY**



**S2\_B1-B**  
**Box 3 of 3: 61.2 – 62.8 FEET**  
**WET**



# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST R. Dugger									
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)							GROUND WTR (ft)								
BORING NO. S2_EB2-A		STATION 29+30		OFFSET 14 ft LT		ALIGNMENT -Y1RT-									
COLLAR ELEV. 2,596.7 ft		TOTAL DEPTH 42.5 ft		NORTHING 667,001		EASTING 819,562									
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)			DRILL METHOD H.S. Augers			HAMMER TYPE Automatic									
DRILLER L. Wanstrath		START DATE 02/10/21		COMP. DATE 02/10/21		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					
2600															
	2,596.7	0.0	2	3	4									2,596.7	0.0
2595	2,594.2	2.5	3	4	4								M	ROADWAY EMBANKMENT Loose, brown and orange, f-c silty SAND (A-2-4), with little gravel	4.5
	2,591.7	5.0	3	6	7								D	ALLUVIAL Stiff, brown and orange, SILT (A-4), micaceous	
2590	2,589.2	7.5	4	4	6								D		
	2,586.7	10.0	7	6	7								D		
2585	2,581.7	15.0	3	3	4								D	Medium stiff, brown and gray, f silty CLAY (A-7-6), micaceous	13.0
2580	2,576.7	20.0	3	3	2								M	Loose, brown and gray, f-c silty SAND (A-2-4), micaceous	18.0
2575	2,571.7	25.0	1	1	2								M	Soft to medium stiff, gray, CLAY (A-7-6), contains trace wood fragments, micaceous	23.0
2570	2,566.7	30.0	1	1	2								M		
2565	2,561.7	35.0	1	2	2								M		
2560	2,556.7	40.0	9	25	35								M	Very dense, gray, SAND and GRAVEL (A-1-b)	38.0
2555	2,554.2	42.5											W	Boring Terminated with Standard Penetration Test Refusal at Elevation 2,554.2 ft on Crystalline Rock (GNEISS). A.R. at a depth of 42.5'.	42.5

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST R. Dugger									
SITE DESCRIPTION US 23/ US 74 (Great Smoky Mountain Highway)							GROUND WTR (ft)								
BORING NO. S2_EB2-B		STATION 28+39		OFFSET 27 ft RT		ALIGNMENT -Y1RT-									
COLLAR ELEV. 2,592.2 ft		TOTAL DEPTH 63.0 ft		NORTHING 666,936		EASTING 819,486									
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)			DRILL METHOD H.S. Augers			HAMMER TYPE Automatic									
DRILLER L. Wanstrath		START DATE 02/09/21		COMP. DATE 02/09/21		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					
2595															
	2,592.2	0.0												2,592.2	0.0
2590	2,589.7	2.5	3	5	4								D	ROADWAY EMBANKMENT Medium dense, brown and orange, SAND and GRAVEL (A-1-b)	2.0
	2,587.2	5.0	3	5	6								D	ALLUVIAL Stiff, brown and orange, SILT (A-4), micaceous	7.0
2585	2,584.7	7.5	2	4	5								D	Stiff, brown and orange, clayey SILT (A-5) with little gravel, micaceous	9.5
	2,582.2	10.0	2	2	3								D	Medium stiff, brown, orange and white, SILT (A-4) with little gravel and sand, micaceous	13.0
2580	2,577.2	15.0	2	4	4								W	Loose, gray, SAND (A-3)	18.0
2575	2,572.2	20.0	1	2	2								SS-208	Soft, gray, CLAY (A-7-5)(29), micaceous	23.0
2570	2,567.2	25.0	2	2	3								W	Medium stiff, gray and brown, clayey SILT (A-5), micaceous	28.0
2565	2,562.2	30.0	13	12	11								Sat.	Medium dense, brown and gray, SAND and GRAVEL (A-1-b)	33.0
2560	2,557.2	35.0	5	9	12								D	RESIDUAL Very stiff to hard, brown, orange and tan, SILT (A-4) with little rock fragments, micaceous, saprolitic	50.5
2555	2,552.2	40.0	11	10	11								D		
2550	2,547.2	45.0	12	13	35								D		
2545	2,542.2	50.0	37	48	52/0.4								D		
2540	2,537.2	55.0											SS-214	WEATHERED ROCK Brown, orange, and gray, GNEISS	63.0
2535	2,532.2	60.0													
2530	2,529.2	63.0													

NCDOT BORE DOUBLE B3186\_GEO\_SITE 2.GPJ NC\_DOT.GDT 11/23/21

**NOTES**  
ST-3 was classified as gray, sandy SILT (A-4)  
Other Samples:  
ST-3 (20.0 - 21.5)



# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST N. Yacobi	
SITE DESCRIPTION Retaining Wall No. 2 from -L_RT- STA 51+63 to 53+56							GROUND WTR (ft)
BORING NO. RW2_3		STATION 54+92		OFFSET 28 ft RT		ALIGNMENT -RW2-	
COLLAR ELEV. 2,598.0 ft		TOTAL DEPTH 40.0 ft		NORTHING 667,028		EASTING 819,591	
DRILL RIGHAMMER EFF./DATE GTC3277 CME-75 83%(09/15/2020)				DRILL METHOD H.S. Augers		HAMMER TYPE Automatic	
DRILLER K. Boone		START DATE 02/10/21		COMP. DATE 02/10/21		SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
2600															
	2,597.2	0.8		9	12	6									2,598.0 GROUND SURFACE 0.0
															2,597.2 0.8' PAVEMENT 0.8
2595	2,594.5	3.5		5	5	5									2,595.0 Medium dense, brown, SAND and GRAVEL (A-1-b), micaceous 3.0
	2,592.0	6.0		5	6	7									ALLUVIAL
2590	2,589.5	8.5		7	6	7									Stiff, brown and tan, SILT (A-4), with trace sand and gravel, micaceous
	2,586.0	12.0													2,586.0 Soft to stiff, gray, silty CLAY (A-7-6), with trace sand, micaceous 12.0
2585	2,584.5	13.5		4	4	5									
	2,579.5	18.5		2	1	2									
2580	2,574.5	23.5		1	1	2									
	2,569.5	28.5		1	1	1									
2575	2,564.5	33.5		0	4	5									
	2,559.5	38.5		0	3	5									
2560															
															2,561.0 Loose, brown, orange, and red, SAND and GRAVEL (A-1-b) 37.0
															2,558.0 Boring Terminated at Elevation 2,558.0 ft in SAND and GRAVEL 40.0

WBS 38332.1.FS1		TIP B-3186 / B-5898		COUNTY HAYWOOD		GEOLOGIST R. Dugger	
SITE DESCRIPTION Retaining Wall No. 3 from -Y1RT- STA 29+35 to 40+54							GROUND WTR (ft)
BORING NO. RW3_1		STATION 29+84		OFFSET 7 ft LT		ALIGNMENT -RW3-	
COLLAR ELEV. 2,596.6 ft		TOTAL DEPTH 49.5 ft		NORTHING 666,986		EASTING 819,622	
DRILL RIGHAMMER EFF./DATE GTC9083 CME-550X 80%(11/24/2020)				DRILL METHOD H.S. Augers		HAMMER TYPE Automatic	
DRILLER L. Wanstrath		START DATE 01/28/21		COMP. DATE 01/28/21		SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
2600															
	2,596.6	0.6		8	7	6									2,596.6 GROUND SURFACE 0.0
															2,596.0 0.6' PAVEMENT 0.6
2595	2,594.1	2.5		3	4	5									2,592.1 ROADWAY EMBANKMENT Loose to medium dense, brown and orange, SAND and GRAVEL (A-1-b), micaceous 4.5
	2,591.6	5.0		7	7	7									2,587.6 Loose to medium dense, brown, tan and orange, silty SAND (A-2-4), with trace gravel, micaceous 9.0
2590	2,589.1	7.5		6	5	4									2,583.6 Medium stiff to stiff, brown and tan, SILT (A-4), with trace sand, micaceous 13.0
	2,586.6	10.0		3	3	4									
2585	2,581.6	15.0		3	2	3									2,578.6 ALLUVIAL Medium stiff, tan and gray, sandy CLAY (A-7-6)(11) 18.0
	2,576.6	20.0		3	3	4									2,573.6 Loose, brown and gray, silty SAND (A-2-4), micaceous 23.0
2580	2,571.6	25.0		1	2	2									2,563.6 Soft to medium stiff, brown, CLAY (A-7-6), micaceous 33.0
	2,566.6	30.0	WOH	2	3										2,560.8 Medium dense, gray, SAND (A-3) 35.8
2575	2,561.6	35.0		4	15	13									RESIDUAL Medium dense to very dense, brown, orange, and tan, silty SAND (A-2-4), contains trace rock fragments, micaceous, saprolitic 37.0
	2,556.6	40.0		5	7	10									
2570	2,551.6	45.0		18	19	32									
	2,547.1	49.5													2,547.1 Boring Terminated with Standard Penetration Test Refusal at Elevation 2,547.1 ft on Crystalline Rock (GNEISS). A.R. at a depth of 49.5' 49.5

NCDOT BORE DOUBLE B3186\_GEO\_RWAL.GPJ NC\_DOT.GDT 11/23/21



REPORT ON SAMPLES OF: Rock For Quality

PROJECT: B-3186 / B-5898  
 DATE SAMPLED: 05/11/2021  
 SAMPLED FROM: Test Borings  
 SUBMITTED BY: HDR

COUNTY: Haywood  
 RECEIVED: 5/11/2021  
 REPORTED: 5/12/2021  
 BY / CERT NO: Kevin E. Walker

BORING NO	SAMPLE NO	DEPTH (FT)	ROCK TYPE	LENGTH (IN)	DIAMETER (IN)	UNIT WEIGHT (PCF)	UNCONFINED COMPRESSIVE STRENGTH (PSI)
S2_B1-A	RS-13	49.5-50.2	Migmatitic Biotite Gneiss	4.20	1.86	177.20	17,889
S2_B1-B	RS-14	54.6-55.2	Migmatitic Biotite Gneiss	4.22	1.86	171.90	16,778