

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	BP13.R026	1	14

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

**STRUCTURE  
SUBSURFACE INVESTIGATION**

COUNTY MCDOWELL

PROJECT DESCRIPTION BRIDGE NO. 194 ON SR 1559  
(GOOD RD.) OVER LIMEKILN CREEK

**REFERENCE: SF-580194**

**PROJECT: BP13.R026**

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<u>SHEET NO.</u>	<u>DESCRIPTION</u>
1	TITLE SHEET
2, 2A, 2B, 2C	LEGEND (SOIL & ROCK)
3	BORING LOCATION MAP
4-II	BORE LOGS, CORE LOGS AND CORE PHOTOGRAPHS

PERSONNEL  
ROSS, S. I.  
TOOTHMAN, R.  
TRIGON EXP.

INVESTIGATED BY FALCON ENG.  
DRAWN BY HUNSBERGER, W. S.  
CHECKED BY CROCKETT, S. C.  
SUBMITTED BY FALCON ENG.  
DATE FEBRUARY 2025

**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 PERFORM INDEPENDENT SUBSURFACE INVESTIGATIONS AND MAKE INTERPRETATIONS AS NECESSARY TO CONFIRM CONDITIONS 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.



DocuSigned by:  
Stephen Crockett 2/14/2025  
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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 (PAGE 1 OF 2)

<b>SOIL DESCRIPTION</b>					<b>GRADATION</b>																								
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, <i>VERY STIFF, GRAY, SILTY CLAY, MOIST WITH INTERBEDDED FINE SAND LAYERS, HIGHLY PLASTIC, A-7-6</i>					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.																								
<b>SOIL LEGEND AND AASHTO CLASSIFICATION</b>					<b>ANGULARITY OF GRAINS</b>																								
THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS: ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.					<b>MINERALOGICAL COMPOSITION</b>																								
MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.					<b>COMPRESSIBILITY</b>																								
SLIGHTLY COMPRESSIBLE LL < 31 MODERATELY COMPRESSIBLE LL = 31 - 50 HIGHLY COMPRESSIBLE LL > 50					<b>PERCENTAGE OF MATERIAL</b>																								
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EXCELLENT TO GOOD      FAIR TO POOR      FAIR TO POOR      POOR      UNSUITABLE					▽ WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING ▽ STATIC WATER LEVEL AFTER 2.5 HOURS ▽PW PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA SPRING OR SEEP																								
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<b>SOIL MOISTURE - CORRELATION OF TERMS</b>					AR - AUGER REFUSAL      MED. - MEDIUM      VST - VANE SHEAR TEST BT - BORING TERMINATED      MICA - MICACEOUS      WEA. - WEATHERED CL. - CLAY      MOD. - MODERATELY      ? - UNIT WEIGHT CPT - CONE PENETRATION TEST      NP - NON PLASTIC      1/2 - DRY UNIT WEIGHT CSE. - COARSE      ORG. - ORGANIC DMT - DILATOMETER TEST      PMT - PRESSUREMETER TEST <b>SAMPLE ABBREVIATIONS</b> DPT - DYNAMIC PENETRATION TEST      SAP. - SAPROLITIC      S - BULK e - VOID RATIO      SD. - SAND, SANDY      SS - SAND SPOON F - FINE      SL. - SILT, SILTY      ST - SHELBY TUBE FOSS. - FOSSILIFEROUS      SLI. - SLIGHTLY      RS - ROCK FRAC. - FRACTURED, FRACTURES      TCR - TRICONE REFUSAL      RT - RECOMPACTED TRIAXIAL FRAGS. - FRAGMENTS      w - MOISTURE CONTENT      CBR - CALIFORNIA BEARING RATIO HI. - HIGHLY      v - VERY																								
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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.					CORE SIZE:      HAND TOOLS:																								

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# SUBSURFACE INVESTIGATION

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

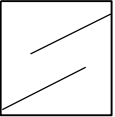
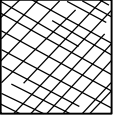


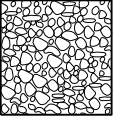

ROCK DESCRIPTION		TERMS AND DEFINITIONS	
<p>HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT REFUSAL IF TESTED. AN INFERRED ROCK LINE INDICATES THE LEVEL AT WHICH NON-COASTAL PLAIN MATERIAL WOULD YIELD SPT REFUSAL. SPT REFUSAL IS PENETRATION BY A SPLIT SPOON SAMPLER EQUAL TO OR LESS THAN 0.1 FOOT PER 60 BLOWS IN NON-COASTAL PLAIN MATERIAL. THE TRANSITION BETWEEN SOIL AND ROCK IS OFTEN REPRESENTED BY A ZONE OF WEATHERED ROCK. ROCK MATERIALS ARE TYPICALLY DIVIDED AS FOLLOWS:</p>		<p><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 (MOT.)</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 (RQD)</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 (SRQD)</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.</p>	
WEATHERED ROCK (WR)		NON-COASTAL PLAIN MATERIAL THAT WOULD YIELD SPT N VALUES > 100 BLOWS PER FOOT IF TESTED.	
CRYSTALLINE ROCK (CR)		FINE TO COARSE GRAIN IGNEOUS AND METAMORPHIC ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES GRANITE, GNEISS, GABBRO, SCHIST, ETC.	
NON-CRYSTALLINE ROCK (NCR)		FINE TO COARSE GRAIN METAMORPHIC AND NON-COASTAL PLAIN SEDIMENTARY ROCK THAT WOULD YIELD SPT REFUSAL IF TESTED. ROCK TYPE INCLUDES PHYLLITE, SLATE, SANDSTONE, ETC.	
COASTAL PLAIN SEDIMENTARY ROCK (CP)		COASTAL PLAIN SEDIMENTS CEMENTED INTO ROCK, BUT MAY NOT YIELD SPT REFUSAL. ROCK TYPE INCLUDES LIMESTONE, SANDSTONE, CEMENTED SHELL BEDS, ETC.	
WEATHERING			
FRESH	ROCK FRESH, CRYSTALS BRIGHT, FEW JOINTS MAY SHOW SLIGHT STAINING. ROCK RINGS UNDER HAMMER IF CRYSTALLINE.		
VERY SLIGHT (V SL.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN. CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.		
SLIGHT (SL.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.		
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.		
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. <i>IF TESTED, WOULD YIELD SPT REFUSAL</i>		
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. <i>IF TESTED, WOULD YIELD SPT N VALUES &gt; 100 BPF</i>		
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE THAT ONLY MINOR VESTIGES OF ORIGINAL ROCK FABRIC REMAIN. <i>IF TESTED, WOULD YIELD SPT N VALUES &lt; 100 BPF</i>		
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.		
ROCK HARDNESS			
VERY HARD	CANNOT BE SCRATCHED BY KNIFE OR SHARP PICK. BREAKING OF HAND SPECIMENS REQUIRES SEVERAL HARD BLOWS OF THE GEOLOGIST'S PICK.		
HARD	CAN BE SCRATCHED BY KNIFE OR PICK ONLY WITH DIFFICULTY. HARD HAMMER BLOWS REQUIRED TO DETACH HAND SPECIMEN.		
MODERATELY HARD	CAN BE SCRATCHED BY KNIFE OR PICK. GOUGES OR GROOVES TO 0.25 INCHES DEEP CAN BE EXCAVATED BY HARD BLOW OF A GEOLOGIST'S PICK. HAND SPECIMENS CAN BE DETACHED BY MODERATE BLOWS.		
MEDIUM HARD	CAN BE GROOVED OR GOUGED 0.05 INCHES DEEP BY FIRM PRESSURE OF KNIFE OR PICK POINT. CAN BE EXCAVATED IN SMALL CHIPS TO PIECES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.		
SOFT	CAN BE GROOVED OR GOUGED READILY BY KNIFE OR PICK. CAN BE EXCAVATED IN FRAGMENTS FROM CHIPS TO SEVERAL INCHES IN SIZE BY MODERATE BLOWS OF A PICK POINT. SMALL, THIN PIECES CAN BE BROKEN BY FINGER PRESSURE.		
VERY SOFT	CAN BE CARVED WITH KNIFE. CAN BE EXCAVATED READILY WITH POINT OF PICK. PIECES 1 INCH OR MORE IN THICKNESS CAN BE BROKEN BY FINGER PRESSURE. CAN BE SCRATCHED READILY BY FINGERNAIL.		
FRACTURE SPACING		BEDDING	
TERM	SPACING	TERM	THICKNESS
VERY WIDE	MORE THAN 10 FEET	VERY THICKLY BEDDED	4 FEET
WIDE	3 TO 10 FEET	THICKLY BEDDED	1.5 - 4 FEET
MODERATELY CLOSE	1 TO 3 FEET	THINLY BEDDED	0.16 - 1.5 FEET
CLOSE	0.16 TO 1 FOOT	VERY THINLY BEDDED	0.03 - 0.16 FEET
VERY CLOSE	LESS THAN 0.16 FEET	THICKLY LAMINATED	0.008 - 0.03 FEET
		THINLY LAMINATED	< 0.008 FEET
INDURATION			
FOR SEDIMENTARY ROCKS, INDURATION IS THE HARDENING OF MATERIAL BY CEMENTING, HEAT, PRESSURE, ETC.			
FRIABLE	RUBBING WITH FINGER FREES NUMEROUS GRAINS; GENTLE BLOW BY HAMMER DISINTEGRATES SAMPLE.		
MODERATELY INDURATED	GRAINS CAN BE SEPARATED FROM SAMPLE WITH STEEL PROBE; BREAKS EASILY WHEN HIT WITH HAMMER.		
INDURATED	GRAINS ARE DIFFICULT TO SEPARATE WITH STEEL PROBE; DIFFICULT TO BREAK WITH HAMMER.		
EXTREMELY INDURATED	SHARP HAMMER BLOWS REQUIRED TO BREAK SAMPLE; SAMPLE BREAKS ACROSS GRAINS.		
		BENCH MARK: BL-4	
		NORTHING: 757250 (ft), EASTING: 1104824 (ft)	
		ELEVATION: 1369.39 FEET	
<b>NOTES:</b>			
F.I.A.D. = FILLED IMMEDIATELY AFTER DRILLING			
DATE: 8-15-14			

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

**SUBSURFACE INVESTIGATION**

**SUPPLEMENTAL LEGEND, GEOLOGICAL STRENGTH INDEX (GSI) TABLES  
FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (PAGE 1 OF 2)**

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

<p><b>GEOLOGICAL STRENGTH INDEX (GSI) FOR JOINTED ROCKS (Hoek and Marinos, 2000)</b></p> <p>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.</p> <p><b>STRUCTURE</b></p>	<p><b>SURFACE CONDITIONS</b></p>	<p><b>VERY GOOD</b> Very rough, fresh unweathered surfaces</p>	<p><b>GOOD</b> Rough, slightly weathered, iron stained surfaces</p>	<p><b>FAIR</b> Smooth, moderately weathered and altered surfaces</p>	<p><b>POOR</b> Slackensided, highly weathered surfaces with compact coatings or fillings or angular fragments</p>	<p><b>VERY POOR</b> Slackensided, highly weathered surfaces with soft clay coatings or fillings</p>
		<p>DECREASING SURFACE QUALITY →</p>				
 <p>INTACT OR MASSIVE - intact rock specimens or massive in situ rock with few widely spaced discontinuities</p>	<p><b>DECREASING INTERLOCKING OF ROCK PIECES</b></p> <p>↓</p>	90			N/A	N/A
 <p>BLOCKY - well interlocked undisturbed rock mass consisting of cubical blocks formed by three intersecting discontinuity sets</p>		80				
 <p>VERY BLOCKY - interlocked, partially disturbed mass with multi-faceted angular blocks formed by 4 or more joint sets</p>		70				
 <p>BLOCKY/DISTURBED/SEAMY - folded with angular blocks formed by many intersecting discontinuity sets. Persistence of bedding planes or schistosity</p>		60				
 <p>DISINTEGRATED - poorly interlocked, heavily broken rock mass with mixture of angular and rounded rock pieces</p>		50				
 <p>LAMINATED/SHEARED - Lack of blockiness due to close spacing of weak schistosity or shear planes</p>		40				
		30				
		20				
		10				
		N/A	N/A			

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

# **SUBSURFACE INVESTIGATION**

## **SUPPLEMENTAL LEGEND, GEOLOGICAL STRENGTH INDEX (GSI) TABLES FROM AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS (PAGE 2 OF 2)**

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

**GSI FOR HETEROGENEOUS ROCK MASSES SUCH AS FLYSCH (Marinos, P and Hoek E., 2000)**

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.

**SURFACE CONDITIONS OF DISCONTINUITIES**  
(Predominantly bedding planes)

**VERY GOOD** - Very Rough, fresh unweathered surfaces

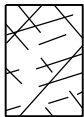
**GOOD** - Rough, slightly weathered surfaces

**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

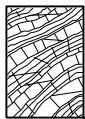
**COMPOSITION AND STRUCTURE**



**A.** Thick bedded, very blocky sandstone. 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.



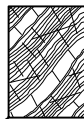
**B.** Sandstone with thin inter-layers of siltstone



**C.** Sandstone and siltstone in similar amounts



**D.** Siltstone or silty shale with sandstone layers



**E.** Weak siltstone or clayey shale with sandstone layers

**C, D, E, and G** - may be more or less folded than illustrated but this does not change the strength. Tectonic deformation, faulting and loss of continuity moves these categories to **F** and **H**.



**F.** Tectonically deformed, intensively folded/faulted, sheared clayey shale or siltstone with broken and deformed sandstone layers forming an almost chaotic structure

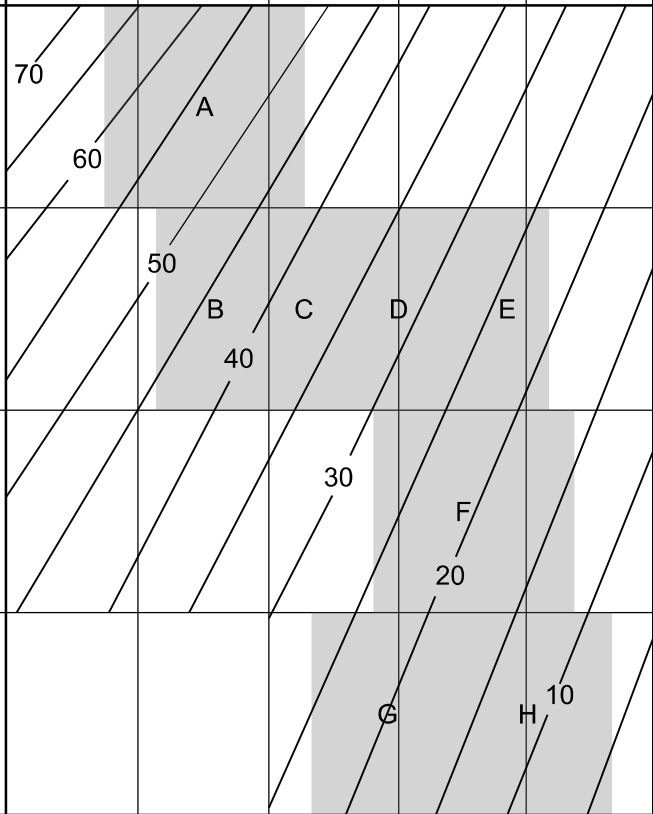


**G.** Undisturbed silty or clayey shale with or without a few very thin sandstone layers

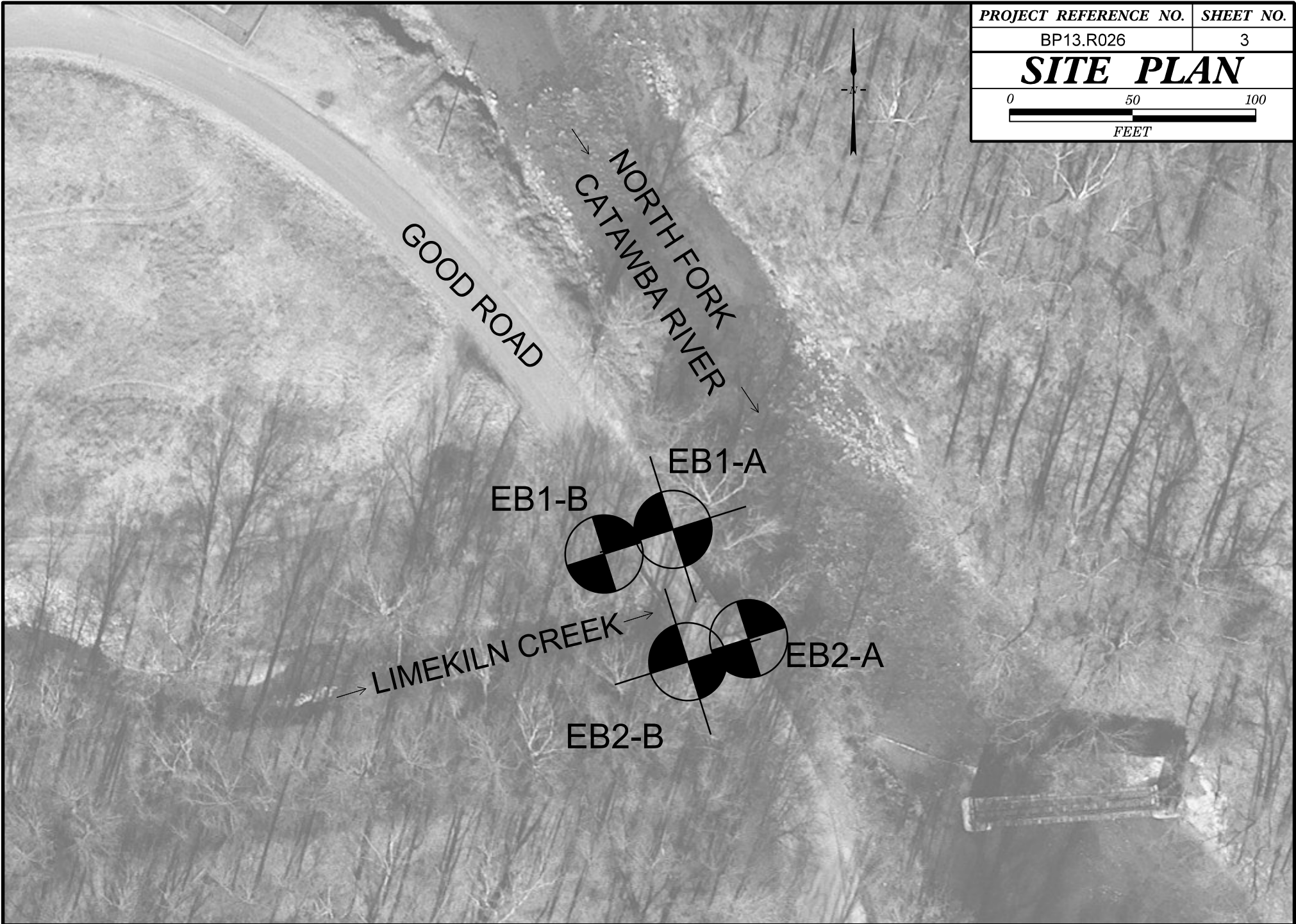


**H.** Tectonically deformed silty or clayey shale forming a chaotic structure with pockets of clay. Thin layers of sandstone are transformed into small rock pieces.

➔ Means deformation after tectonic disturbance



<i>PROJECT REFERENCE NO.</i>	<i>SHEET NO.</i>
BP13.R026	3
<b>SITE PLAN</b>	
0 50 100 FEET	



# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS BP13.R026	TIP SF-580194	COUNTY McDOWELL	GEOLOGIST GOODNIGHT, D
SITE DESCRIPTION BRIDGE NO. 194 ON SR 1559 (GOOD ROAD) OVER LIMEKILN CREEK			GROUND WTR (ft)
BORING NO. EB1-A	STATION N/A	OFFSET N/A	ALIGNMENT -L-
COLLAR ELEV. 1,368.8 ft	TOTAL DEPTH 20.7 ft	NORTHING 757,232	EASTING 1,104,834
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 83% 05/09/2022		DRILL METHOD Core Boring	HAMMER TYPE Automatic
DRILLER Toothman, R.	START DATE 06/06/24	COMP. DATE 06/06/24	SURFACE WATER DEPTH N/A

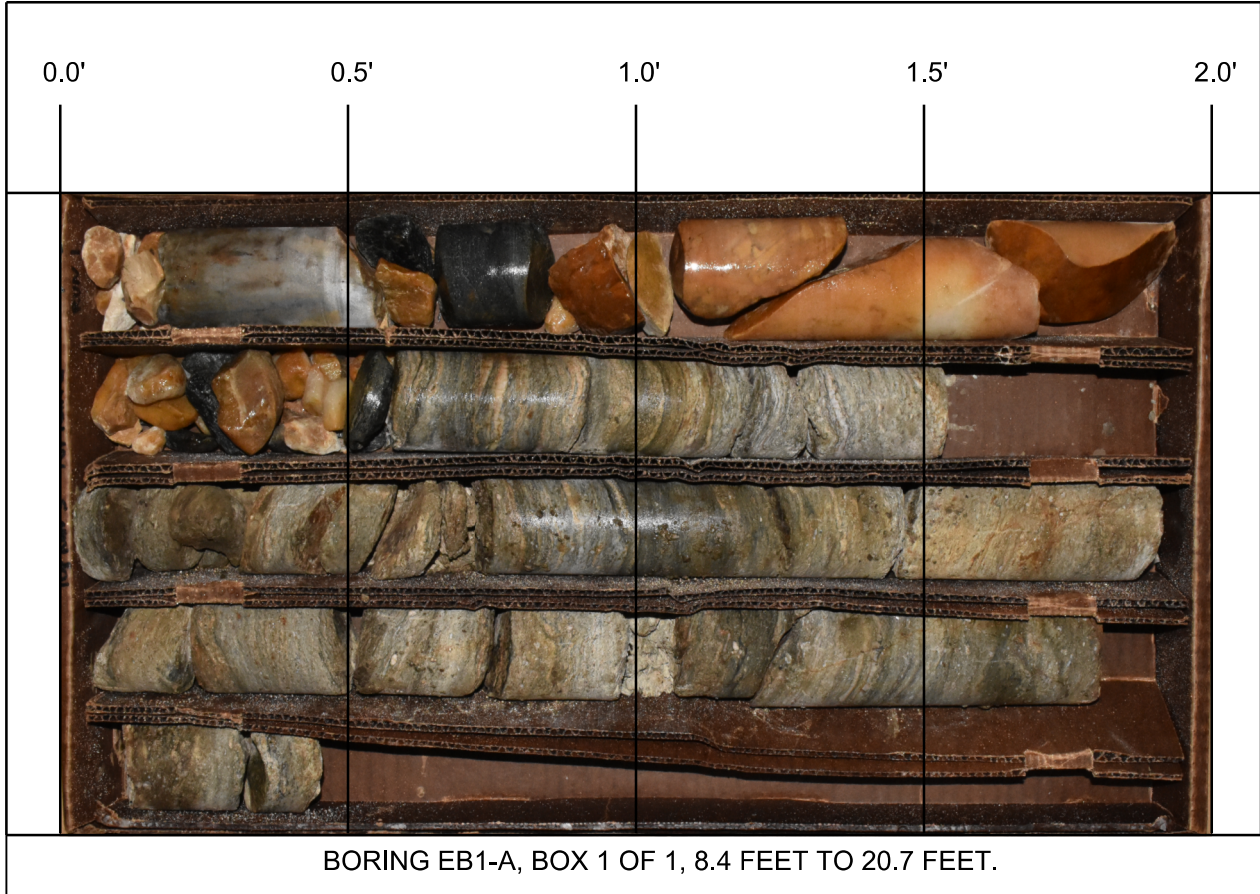
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100					
1370															
	1,367.8	1.0												GROUND SURFACE	0.0
	1,365.3	3.5	3	3	8	11								<b>ROADWAY EMBANKMENT</b> TAN TO BROWN, MED. DENSE TO V. DENSE, SILTY SAND (A-2-4) WITH SOME GRAVEL AND COBBLES	
	1,362.8	6.0	20	11	15	26									
	1,360.8	8.0	27	33	30	63									
1360	1,360.4	8.4	100/0.2											<b>COLLUVIAL</b> TAN AND GRAY, CRYSTALLINE ROCK DOLOMITIC AND GNEISSIC BOULDERS AND COBBLES	8.4
	1,360.1		60/0.1												
1355															
	1,354.2													<b>CRYSTALLINE ROCK</b> MODERATE WEATHERING, MODERATELY HARD, GRAY AND TAN BIOTITE GNEISS WITH VERY CLOSE TO CLOSE FRACTURE SPACING	14.6
1350															
	1,348.1													<b>CRYSTALLINE ROCK</b> MODERATE WEATHERING, MODERATELY HARD, GRAY AND TAN BIOTITE GNEISS WITH VERY CLOSE TO CLOSE FRACTURE SPACING GSI = 45	20.7
														Boring Terminated at Elevation 1,348.1 ft IN CRYSTALLINE ROCK: BIOTITE GNEISS	

NCDOT BORE SINGLE G22053.04.GPJ NC\_DOT.GDT 2/10/25

# GEOTECHNICAL BORING REPORT CORE LOG

WBS BP13.R026				TIP SF-580194				COUNTY McDOWELL				GEOLOGIST GOODNIGHT, D			
SITE DESCRIPTION BRIDGE NO. 194 ON SR 1559 (GOOD ROAD) OVER LIMEKILN CREEK											GROUND WTR (ft)				
BORING NO. EB1-A				STATION N/A				OFFSET N/A				ALIGNMENT -L-			
COLLAR ELEV. 1,368.8 ft				TOTAL DEPTH 20.7 ft				NORTHING 757,232				EASTING 1,104,834			
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 83% 05/09/2022								DRILL METHOD Core Boring				HAMMER TYPE Automatic			
DRILLER Toothman, R.				START DATE 06/06/24				COMP. DATE 06/06/24				SURFACE WATER DEPTH N/A			
CORE SIZE NQ				TOTAL RUN 12.3 ft											
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN		SAMP. NO.	STRATA		L O G	DESCRIPTION AND REMARKS				
					REC. (ft) %	RQD (ft) %		REC. (ft) %	RQD (ft) %		ELEV. (ft)	DEPTH (ft)			
1360.4												Begin Coring @ 8.4 ft			
	1,360.4	8.4	2.3	00:34/0.3	(1.9)	(0.3)		(2.4)	(0.3)		1,360.4	8.4			
	1,358.1	10.7		03:30/1.0 6:24/1.0	83%	13%		39%	5%		COLLUVIAL TAN AND GRAY, CRYSTALLINE ROCK DOLOMITIC AND GNEISSIC BOULDERS AND COBBLES				
			5.0	1:40/1.0 1:12/1.0 2:20/1.0 3:52/1.0 2:07/1.0	(1.6)	(0.3)					1,354.2	14.6			
1355	1,353.1	15.7						(5.2)	(1.9)						
			5.0	2:00/1.0 1:18/1.0 1:50/1.0 1:41/1.0 1:53/1.0	(4.1)	(1.6)		85%	31%		CRYSTALLINE ROCK MODERATE WEATHERING, MODERATELY HARD, GRAY AND TAN BIOTITE GNEISS WITH VERY CLOSE TO CLOSE FRACTURE SPACING GSI= 45				
1350	1,348.1	20.7									1,348.1	20.7			
												Boring Terminated at Elevation 1,348.1 ft IN CRYSTALLINE ROCK: BIOTITE GNEISS			

NCDOT CORE SINGLE G22053.04.GPJ NC\_DOT.GDT 2/10/25



BORING EB1-A, BOX 1 OF 1, 8.4 FEET TO 20.7 FEET.



FALCON ENGINEERING, INC.  
1210 TRINITY ROAD, SUITE 110  
CARY, NC 27513  
PHONE: 919.871.0800  
www.falconengineers.com

ROCK CORE PHOTOS

BRIDGE NO. 194 ON SR 1559  
(GOOD RD.) OVER LIMEKILN CREEK  
MCDOWELL COUNTY, NC  
TIP NO.: BP13.R026  
FALCON PROJECT NO. G22053.04

# GEOTECHNICAL BORING REPORT BORE LOG

<b>WBS</b> BP13.R026			<b>TIP</b> SF-580194			<b>COUNTY</b> McDOWELL			<b>GEOLOGIST</b> GOODNIGHT, D							
<b>SITE DESCRIPTION</b> BRIDGE NO. 194 ON SR 1559 (GOOD ROAD) OVER LIMEKILN CREEK									<b>GROUND WTR (ft)</b>							
<b>BORING NO.</b> EB1-B			<b>STATION</b> N/A			<b>OFFSET</b> N/A			<b>ALIGNMENT</b> -L-							
<b>COLLAR ELEV.</b> 1,368.1 ft			<b>TOTAL DEPTH</b> 8.5 ft			<b>NORTHING</b> 757,222			<b>EASTING</b> 1,104,806							
<b>DRILL RIG/HAMMER EFF./DATE</b> TRI0055 CME-55 83% 05/09/2022						<b>DRILL METHOD</b> H.S. Augers			<b>HAMMER TYPE</b> Automatic							
<b>DRILLER</b> Toothman, R.			<b>START DATE</b> 06/06/24			<b>COMP. DATE</b> 06/06/24			<b>SURFACE WATER DEPTH</b> N/A							
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
1370																
	1,367.1	1.0													1,368.1	0.0
1365	1,364.6	3.5	6	9	5								M			
	1,362.1	6.0	3	4	4								M			
1360	1,360.1	8.0	14	40	54								M			
													Sat.		1,360.6	7.5
															1,359.6	8.5

GROUND SURFACE

**ROADWAY EMBANKMENT**  
BROWN, LOOSE TO V. DENSE, SILTY SAND (A-2-4) WITH SOME GRAVEL AND COBBLES

**ALLUVIAL**  
TAN AND GRAY CRYSTALLINE ROCK BOULDERS, COBBLES, AND GRAVEL WITH SOME TAN SAND (A-1-a)

Boring Terminated at Elevation 1,359.6 ft IN CRYSTALLINE ROCK BOULDERS

NOTE: BORING TERMINATED DUE TO SHEARED CHAIN COUPLER

NCDOT BORE SINGLE G22053.04.GPJ NC\_DOT.GDT 2/10/25

# GEOTECHNICAL BORING REPORT BORE LOG

WBS BP13.R026	TIP SF-580194	COUNTY McDOWELL	GEOLOGIST GOODNIGHT, D
SITE DESCRIPTION BRIDGE NO. 194 ON SR 1559 (GOOD ROAD) OVER LIMEKILN CREEK			GROUND WTR (ft)
BORING NO. EB2-A	STATION N/A	OFFSET N/A	ALIGNMENT -L-
COLLAR ELEV. 1,368.1 ft	TOTAL DEPTH 7.2 ft	NORTHING 757,188	EASTING 1,104,865
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 83% 05/09/2022		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic
DRILLER Toothman, R.	START DATE 06/07/24	COMP. DATE 06/07/24	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						
1370																
	1,367.1	1.0													1,368.1	0.0
1365	1,364.6	3.5	10	8	13								M	ROADWAY EMBANKMENT BROWN, MED. DENSE TO V. DENSE, SILTY SAND (A-2-4) WITH SOME GRAVEL, COBBLES, AND CRYSTALLINE ROCK BOULDERS		
	1,362.1	6.0	14	9	10								M			
			23	45	55/0.2								M		1,360.9	7.2
															Boring Terminated at Elevation 1,360.9 ft IN CRYSTALLINE ROCK BOULDERS	

NCDOT BORE SINGLE G220653.04.GPJ NC\_DOT.GDT 2/10/25

# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS BP13.R026			TIP SF-580194			COUNTY McDOWELL			GEOLOGIST GOODNIGHT, D							
SITE DESCRIPTION BRIDGE NO. 194 ON SR 1559 (GOOD ROAD) OVER LIMEKILN CREEK									GROUND WTR (ft)							
BORING NO. EB2-B			STATION N/A			OFFSET N/A			ALIGNMENT -L-							
COLLAR ELEV. 1,368.5 ft			TOTAL DEPTH 20.7 ft			NORTHING 757,178			EASTING 1,104,840							
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 83% 05/09/2022						DRILL METHOD Core Boring			HAMMER TYPE Automatic							
DRILLER Toothman, R.			START DATE 06/07/24			COMP. DATE 06/07/24			SURFACE WATER DEPTH N/A							
ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT			BLOWS PER FOOT					SAMP. NO.	LOG MOI	L O G	SOIL AND ROCK DESCRIPTION	DEPTH (ft)	
			0.5ft	0.5ft	0.5ft	0	25	50	75	100						
1370																
	1,367.5	1.0														
1365	1,365.0	3.5	4	8	6								M	GROUND SURFACE	0.0	
			48	10	20								M	ROADWAY EMBANKMENT BROWN, MED. DENSE TO DENSE, SILTY SAND (A-2-4) WITH SOME GRAVEL, COBBLES, AND BOULDERS	5.0	
1360														COLLUVIAL TAN AND GRAY CRYSTALLINE ROCK QUARTZITE AND GNEISSIC BOULDERS, COBBLES, AND GRAVEL		
1355																
1350														CRYSTALLINE ROCK MOD. SEV. WEATHERING, MOD. HARD TO HARD, BROWN AND GRAY BIOTITE GNEISS, WITH V. CLOSE FRACTURE SPACING GSI = 25	15.7	
														MOD. SEV. WEATHERING, MOD. HARD TO HARD, BROWN AND GRAY BIOTITE GNEISS, WITH V. CLOSE FRACTURE SPACING GSI = 25	18.6	
														V. SLIGHT WEATHERING, HARD, WHITE AND GRAY BIOTITE GNEISS, WITH MOD. CLOSE FRACTURE SPACING GSI = 65	20.7	
														Boring Terminated at Elevation 1,347.8 ft IN CRYSTALLINE ROCK: BIOTITE GNEISS		

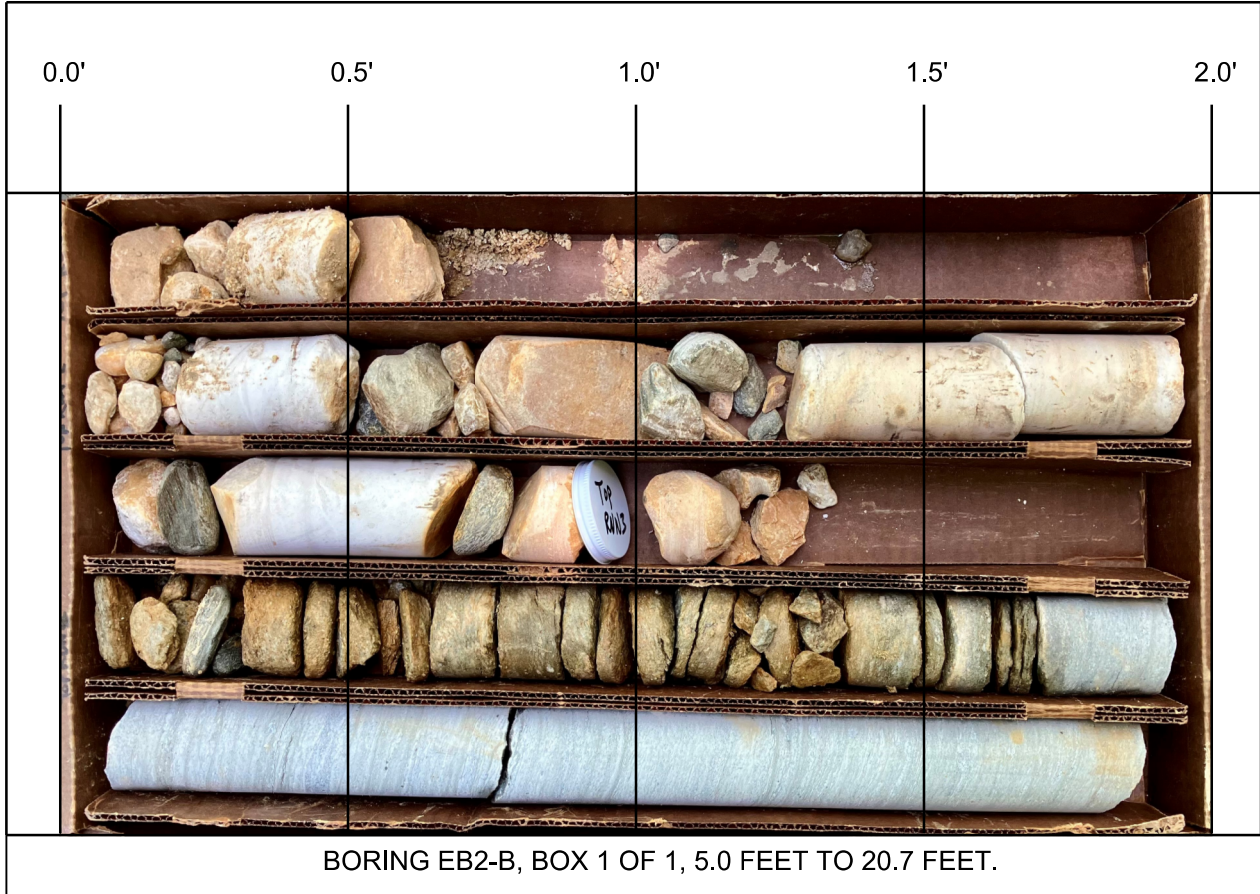
NCDOT BORE SINGLE G220653.04.GPJ NC\_DOT.GDT 2/10/25

# GEOTECHNICAL BORING REPORT

## CORE LOG

WBS BP13.R026			TIP SF-580194			COUNTY McDOWELL			GEOLOGIST GOODNIGHT, D		
SITE DESCRIPTION BRIDGE NO. 194 ON SR 1559 (GOOD ROAD) OVER LIMEKILN CREEK										GROUND WTR (ft)	
BORING NO. EB2-B			STATION N/A			OFFSET N/A			ALIGNMENT -L-		
COLLAR ELEV. 1,368.5 ft			TOTAL DEPTH 20.7 ft			NORTHING 757,178			EASTING 1,104,840		
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 83% 05/09/2022						DRILL METHOD Core Boring			HAMMER TYPE Automatic		
DRILLER Toothman, R.			START DATE 06/07/24			COMP. DATE 06/07/24			SURFACE WATER DEPTH N/A		
CORE SIZE NQ			TOTAL RUN 15.7 ft								
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN		STRATA		L O G	DESCRIPTION AND REMARKS	DEPTH (ft)
					REC. (ft) %	RQD (ft) %	REC. (ft) %	RQD (ft) %			
1363.48	1,363.5	5.0	0.7	3:03/0.7	(0.6)	(0.0)	(3.5)	(1.1)	OO	Begin Coring @ 5.0 ft	
	1,362.8	5.7	5.0	1:49/1.0 2:47/1.0 4:06/1.0 10:10/1.0	86%	0%	33%	10%	OO	<b>COLLUVIAL</b> CRYSTALLINE ROCK BOULDERS: TAN AND GRAY QUARTZITE AND GNEISSIC BOULDERS, COBBLES, AND GRAVEL	5.0
1360	1,357.8	10.7	5.0	3:03/1.0	(2.7)	(1.1)			OO		
				1:45/1.0 1:05/1.0 1:32/1.0 1:16/1.0	4%	0%			OO		
1355	1,352.8	15.7	5.0	2:14/1.0 1:41/1.0 1:55/1.0 7:20/1.0 4:49/1.0	(3.8)	(2.1)	(1.8)	(0.0)	OO	<b>CRYSTALLINE ROCK</b> MOD. SEV. WEATHERING, MOD. HARD TO HARD, BROWN AND GRAY BIOTITE GNEISS, WITH V. CLOSE FRACTURE SPACING GSI = 25	15.7
					76%	42%	62%	0%	OO		
1350	1,347.8	20.7					(2.1)	(2.1)	OO	V. SLIGHT WEATHERING, HARD, WHITE AND GRAY BIOTITE GNEISS, WITH MOD. CLOSE FRACTURE SPACING GSI = 65	18.6
							100%	100%	OO	Boring Terminated at Elevation 1,347.8 ft IN CRYSTALLINE ROCK: BIOTITE GNEISS	20.7

NCDOT CORE SINGLE G22053.04.GPJ NC\_DOT.GDT 2/10/25



FALCON ENGINEERING, INC.  
1210 TRINITY ROAD, SUITE 110  
CARY, NC 27513  
PHONE: 919.871.0800  
www.falconengineers.com

ROCK CORE PHOTOS

BRIDGE NO. 194 ON SR 1559  
(GOOD RD.) OVER LIMEKILN CREEK  
MCDOWELL COUNTY, NC  
TIP NO.: BP13.R026  
FALCON PROJECT NO. G22053.04