



CAROLINAS  
GEOTECHNICAL  
GROUP

## Structure Foundation Recommendations

### Prepared for:

TGS Engineers, Inc.

201 W. Marion Street, Suite 200

Shelby, North Carolina 28150

July 2, 2024





2400 Crownpoint Executive Drive  
Suite 800  
Charlotte, NC 28227



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July 2, 2024

Mr. Jimmy L. Terry, P.E.  
TGS Engineers, Inc.  
201 W. Marion Street, Suite 200  
Shelby, North Carolina 28150

WBS ELEMENT: SF-250208  
T.I.P. NO.: BP6.R021  
I.D. NO.: BP6.R021  
COUNTY: Cumberland  
DESCRIPTION: Replace Structure No. 250208 on SR 2046 (Avery Road) over Turnbull Creek

SUBJECT: Structure Foundation Recommendations

Dear Mr. Terry,

Carolinas Geotechnical Group, PLLC (CG2) has completed the Structure Foundation Recommendations for Structure No. 250208 on SR 2046 (Avery Road) over Turnbull Creek in Cumberland County, North Carolina. Foundation Recommendations Notes on Plans and Comments, the prepared NCDOT Structure Inventory Report, and supporting calculations are presented below and attached.

### **CULVERT -L- 14+27.00**

#### FOUNDATION RECOMMENDATION NOTES ON PLANS:

1. INSTALL PIPE CULVERT IN ACCORDANCE WITH SECTION 300 OF THE STANDARD SPECIFICATIONS.
2. EXCAVATE 12 INCHES BELOW THE BOTTOM OF THE CULVERT AND REPLACE WITH FOUNDATION CONDITIONING MATERIAL IN ACCORDANCE WITH SECTION 414 OF THE STANDARD SPECIFICATIONS. FOUNDATION CONDITIONING MATERIAL SHOULD CONSIST OF SELECT MATERIAL CLASS V OR VI FOR PIPE CULVERTS.
3. IF REQUIRED, UNDERCUT LOOSE SOILS THAT MAY BE ENCOUNTERED BENEATH THE BOTTOM OF THE FOUNDATION CONDITIONING MATERIAL. BACKFILL UNDERCUT AREAS WITH FOUNDATION CONDITIONING MATERIAL.

#### FOUNDATION RECOMMENDATION COMMENTS:

1. The invert elevation at the centerline of the aluminum structural plate pipe arch is 86.5 feet.
2. We anticipate groundwater to impact construction.
3. We recommend a quantity of 110 tons of foundation conditioning material (Class V or VI).

**Structure Foundation Recommendations**

Structure No. 208 on SR 2046 (Avery Road) over Turnbull Creek  
Cumberland County, North Carolina

- 4. We do not anticipate settlement to be a concern.
- 5. Place Select Material Class V or VI when backfilling in water.

**CLOSING**

Please do not hesitate to contact us if you have any questions regarding this report or if you need additional services.

Sincerely,

**Carolinas Geotechnical Group, PLLC**

DocuSigned by:  
*Kelly de Montbrun*  
F7633FB568FE4D7...  
Kelly N. de Montbrun, P.E.  
Senior Project Engineer



DocuSigned by:  
*Michael J. Walko*  
P05E01A6D1912...  
Michael J. Walko, P.E.  
Principal Engineer

**ATTACHMENTS:**

- Structure Subsurface Investigation Report (Prepared by CG2)
- Culvert Survey & Hydraulic Design Report
- Supporting Calculations

# ATTACHMENTS

CULVERT -L- 14+27.00 - STRUCTURE SUBSURFACE INVESTIGATION REPORT  
(PREPARED BY CG2)

REFERENCE: BP6.R021

PROJECT: SF-250208

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

STRUCTURE  
SUBSURFACE INVESTIGATION

COUNTY CUMBERLAND  
PROJECT DESCRIPTION REPLACE STRUCTURE NO. 208  
ON SR 2046 (AVERY ROAD) OVER TURNBULL  
CREEK

SITE DESCRIPTION 14+27 -L-

CONTENTS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	LEGEND (SOIL & ROCK)
3	SITE PLAN
4	BORELOGS

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	BP6.R021	1	4

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.

PERSONNEL

P. PERRY, EIT

CG2 EXPLORATION

INVESTIGATED BY CG2, PLLC

DRAWN BY K. DE MONTBRUN, P.E.

CHECKED BY M. WALKO, P.E.

SUBMITTED BY CG2, PLLC

DATE JULY 2024

Prepared in the Office of:



**CAROLINAS  
GEOTECHNICAL  
GROUP**  
2400 CROWNPOINT EXECUTIVE DRIVE  
SUITE 800  
CHARLOTTE, NC 28227  
(980) 339-8684



DocuSigned by:

*Kelly de Montbrun*

07/02/2024

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SIGNATURE

DATE

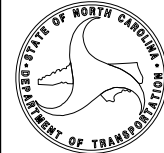
**DOCUMENT NOT CONSIDERED FINAL  
UNLESS ALL SIGNATURES COMPLETED**

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

# SUBSURFACE INVESTIGATION

## SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

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.																																																																																																																									
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Prepared For:

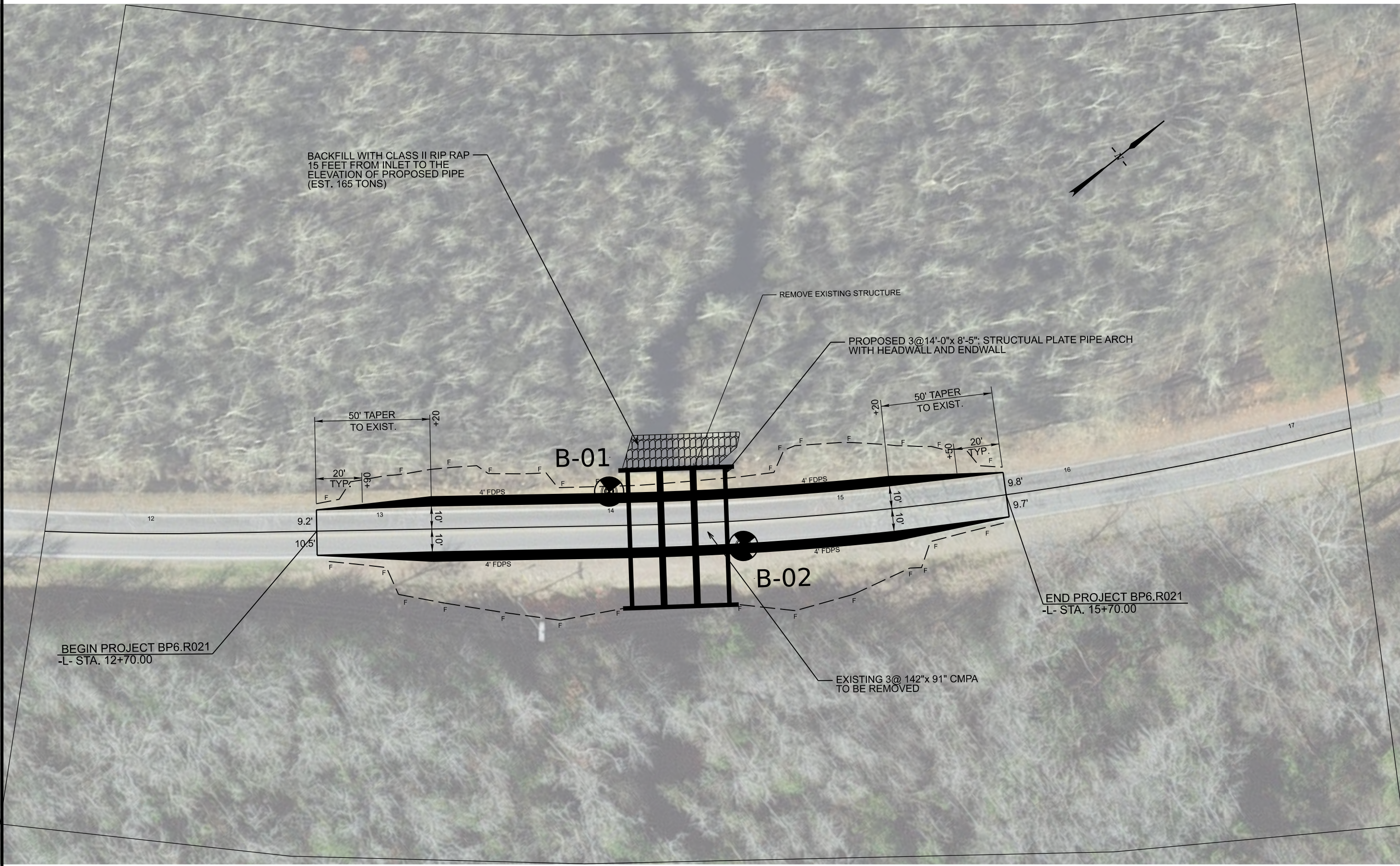


**SF-250208**  
STRUCTURE #208 ON SR2046 OVER TURNBULL CREEK

GOTECHNICAL  
UNIT

PREPARED BY

CAROLINAS  
GOTECHNICAL  
GROUP  
2400 CROWNSHIRT EXECUTIVE DRIVE  
SUITE 800  
CHARLOTTE, NC 28227  
(980) 393-8684





# GEOTECHNICAL BORING REPORT

## BORE LOG

WBS SF-250208		TIP BP6.R021		COUNTY CUMBERLAND		GEOLOGIST P. Perry									
SITE DESCRIPTION Replace Bridge 250208 on SR 2046 (Avery Road) over Turnbull Creek							GROUND WTR (ft)								
BORING NO. B-01		STATION 13+98		OFFSET 15 ft LT		ALIGNMENT -L-									
COLLAR ELEV. 96.3 ft		TOTAL DEPTH 38.8 ft		NORTHING 401,891		EASTING 2,107,484									
DRILL RIG/HAMMER EFF./DATE CG29022 Mobile B-29 92% 04/09/2024		DRILL METHOD Mud Rotary		HAMMER TYPE Automatic											
DRILLER M. Brewer		START DATE 06/17/24		COMP. DATE 06/17/24		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					
100															
95	96.3	0.0	6	5	5								M	ROADWAY EMBANKMENT Loose, Tan-Orange-Brown, Silty Fine to Coarse SAND (A-2-4), with trace organics, asphalt, and gravel	0.0
	94.0	2.3	2	WOH	1								W	ALLUVIAL Very Loose, Tan-Gray-Brown, Silty, Clayey Fine to Coarse SAND (A-2-4), with trace pebbles and organics	2.0
90	89.0	7.3	WOH	WOH	WOH								W	Very Soft, Brown-Black, Fine to Coarse Sandy, Clayey SILT (A-5), with trace organics, wood debris, and gravel	6.0
85	84.0	12.3	2	4	7								W	Medium Dense, Tan-Brown, Silty Fine to Coarse SAND (A-2-4), with trace gravel	10.5
80	79.0	17.3	2	3	6								M	COASTAL PLAIN Loose to Medium Dense, Gray-Black, Silty Fine to Coarse SAND (A-2-4), with trace mica and clay seams (BLACK CREEK FORMATION)	15.5
75	74.0	22.3	4	6	9								M		
70	69.0	27.3	4	8	10								M		
65	64.0	32.3	4	5	7								M	Stiff, Gray-Black, Fine Sandy, Silty CLAY (A-7), with trace organics and mica (BLACK CREEK FORMATION)	30.0
60	59.0	37.3	7	16	25								M	Hard, Gray-Black-Brown, Fine Sandy, Silty CLAY (A-6), with little to some organics, trace mica and organic odor (BLACK CREEK FORMATION)	35.5
													W	Boring Terminated at Elevation 57.5 ft In Coastal Plain Sandy Silty CLAY (A-6) (BLACK CREEK FORMATION)	38.8

WBS SF-250208		TIP BP6.R021		COUNTY CUMBERLAND		GEOLOGIST P. Perry									
SITE DESCRIPTION Replace Bridge 250208 on SR 2046 (Avery Road) over Turnbull Creek							GROUND WTR (ft)								
BORING NO. B-02		STATION 14+55		OFFSET 11 ft RT		ALIGNMENT -L-									
COLLAR ELEV. 97.6 ft		TOTAL DEPTH 39.2 ft		NORTHING 401,922		EASTING 2,107,539									
DRILL RIG/HAMMER EFF./DATE CG29022 Mobile B-29 92% 04/09/2024		DRILL METHOD Mud Rotary		HAMMER TYPE Automatic											
DRILLER M. Brewer		START DATE 06/17/24		COMP. DATE 05/30/24		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					
100															
95	97.6	0.0	8	7	8								M	ROADWAY EMBANKMENT Medium Dense, Orange-Tan, Silty Fine to Coarse SAND (A-2-4), with trace gravel	0.0
	94.9	2.7	2	3	10								W	ALLUVIAL Medium Dense, Orange-Tan, Silty Fine to Coarse SAND (A-2-4), with trace pebbles and gravel	2.0
90	89.9	7.7	30	9	1								M	Stiff, Black, Fine to Coarse Sandy, Clayey SILT (A-5), with little to some organics, trace roots, and organic odor	6.0
85	84.9	12.7	15	9	9								M	Very Loose to Medium Dense, Tan-White-Orange-Gray, Silty Fine to Coarse SAND (A-2-4), with trace pebbles and organics	10.5
80	79.9	17.7	2	WOH	1								W		
75	74.9	22.7	4	9	11								M	COASTAL PLAIN Very Stiff, Dark Gray, Silty CLAY (A-7) (BLACK CREEK FORMATION)	22.0
70	69.9	27.7	7	11	16								M	Medium Dense, Light Gray-Black, Silty Fine to Coarse SAND (A-2-4), with trace mica, clay pockets, and wood debris (BLACK CREEK FORMATION)	23.2
65	64.9	32.7	6	9	13								M		
60	59.9	37.7	8	11	18								M		
													M	Boring Terminated at Elevation 58.4 ft In Coastal Plain Silty SAND (A-2-4) (BLACK CREEK FORMATION)	39.2

Notes:  
1) Boulders encountered ~ 4 feet.

# CULVERT SURVEY & HYDRAULIC DESIGN REPORT



# CULVERT SURVEY & HYDRAULIC DESIGN REPORT

NC DEPARTMENT OF TRANSPORTATION  
DIVISION OF HIGHWAYS  
HYDRAULICS UNIT  
RALEIGH, NC

State Proj Reference No. BP6.R021    WBS Proj No. SF-250208    Proj Station 14+27-L-

County CUMBERLAND    Bridge over TURNBULL CREEK    Struct Inv No. 250208

On Highway (AVERY ROAD)    between (TURNBULL ROAD)    and (AVERY CUMBERLAND COUNTY ROAD(DEAD END))

Recommended Structure 3@14'-0"x 8'-5"; ALUMINUM STRUCTURAL PLATE PIPE ARCH WITH HEADWALL AND ENDWALL

Recommended Width of Roadway 32' SHOULDER PT. TO SHOULDER PT.    Skew 90°

Recommended Location is (A) Upstream of, (B) Downstream of Existing Crossing

Latitude 34.85377    Longitude -78.64162

Statewide Tier     Regional Tier     Sub-Regional Tier

Bench Mark is BM-1- STA. 15+07.2 -L-; RR SPIKE 25.8' LEFT IN BASE OF 20" OAK

Northing 401986.3984    Easting 2107536.3179    Elevation 95.40 ft Datum NAVD 88

Temporary Crossing NOT REQUIRED (STAGED CONSTRUCTION DOWNSTREAM)



Designed by RUSTY LASSITER

Assisted by Date 6/6/2024 | 11:20 AM EDT

TGS ENGINEERS  
706 HILLSBOROUGH ST.  
SUITE 200  
RALEIGH, NC 27603  
PH (919) 773-8887



Reviewed by *Craig J. Lee*

Date 6/6/2024 | 11:22 AM EDT

## SITE DATA

Drainage Area 11.8 SQ. MI.    Source STREAM STATS/ JEROME QUAD

River Basin CAPE FEAR    Character RURAL: COASTAL PLAIN (REGION 4)

Stream Classification (e.g., Trout, High Quality Water) C

Data on Existing Structure 3@ 142"x 91" CORRUGATED METAL PIPE ARCHES

Total Waterway Opening 213 ft<sup>2</sup>

Debris Potential: Low  Moderate  High     Waterway Opening Below 100-yr WS Elev 213 ft<sup>2</sup>

Data on Structures Up and Down Stream UPSTREAM- 2@ 95"x 67" CMPA (SQUATTING BEAR DRIVE)

DOWNSTREAM- (SR 1328); (#080099) 2@ 30' CORED SLAB BRIDGE ON H-PILES (OAL-60')

Gage Station No N/A    Period of Records N/A

Max Discharge N/A cfs    Date N/A    Frequency N/A

Historical Flood Information:

Date	9/14/18	Elev	95.6	ft	Est Freq	-100	yr	Source	NCDOT (BRIDGE MAINTENANCE)	Period of Knowledge	25	YRS
Date		Elev		ft	Est Freq		yr	Source		Period of Knowledge		YRS
Date		Elev		ft	Est Freq		yr	Source		Period of Knowledge		YRS

Allowable HW Elev (EXIST. 25YR)- 94.4 ft    Normal Water Surface Elev 92.2 ft

Manning's n: Left OB 0.15    Channel 0.07    Right OB 0.15    Source FIELD OBSERVATION

Flood Study / Status NO FLOOD STUDY (CUMBERLAND CO. PANEL #1400)

Flood Study 100-yr Discharge N/A cfs    WS Elev: Floodway N/A ft    Without Floodway N/A ft    River Station N/A

## DESIGN DATA

Hydrological Method SIR 2023- 5006 (RURAL-COASTAL PLAIN)

Hydraulic Design Method HEC RAS 6.1.0 (PROJECT: 250208 TurnbullCreek SR2046)

\*Design Tailwater: Q<sub>10</sub> 6.9 ft    Q<sub>25</sub> 7.3 ft    Q<sub>50</sub> N/A ft    Q<sub>100</sub> 7.8 ft    Q<sub>500</sub> 8.3 ft

\*TAILWATER DEPTHS BASED ON WSEL AT RS1100 (DS TOE MINUS INVERT AT OUTLET)

FREQUENCY	Q (cfs)	INLET CONTROL			OUTLET CONTROL		REMARKS (BASED ON 8.42' HT OF PIPE)
		HW/D	HW	WSEL	HW	WSEL	
10-YEAR	890	N/A	3.1	89.8'	6.8	93.5'	OUTLET CTRL(HW/D-0.81)
25-YEAR	1260	N/A	4.5	91.2'	7.4	94.1'	OUTLET CTRL(HW/D-0.88)
100-YEAR	1950	N/A	6.5	93.2'	8.8	95.5'	OUTLET CTRL(HW/D-1.05)
500-YEAR	2820	N/A	8.9	95.6'	9.5	96.2'	OUTLET CTRL(HW/D-1.13)

Total Proposed Waterway Opening 270.9 sf

Outlet Velocity 3.8 (10YR) fps    Natural Channel Velocity 2.2 (10YR) fps

Required Outlet Protection NONE REQUIRED

State Floodway Compliance Type N/A

## INFORMATION TO BE SHOWN ON PLANS

HYDRAULIC DATA	
DESIGN DISCHARGE	= 1260 C.F.S.
FREQUENCY OF DESIGN FLOOD	= 25 YRS.
DESIGN HIGH WATER ELEVATION	= 94.1'
DRAINAGE AREA	= 11.8 SQ. MI.
BASIC DISCHARGE (Q100)	= 1940 C.F.S.
BASIC HIGH WATER ELEVATION	= 95.5'

OVERTOPPING FLOOD DATA	
OVERTOPPING DISCHARGE	= 1710 C.F.S.
FREQUENCY OF OVERTOPPING FLOOD	= 100 YRS.
OVERTOPPING FLOOD ELEVATION	= 95.2'

\*SHOULDER POINT RIGHT OF 10+84 -L-  
WS EL. Taken @ River Station 1192

## ADDITIONAL INFORMATION AND COMPUTATIONS

DA-11.8SQ. MI.    RURAL: COASTAL PLAIN

RURAL COASTAL PLAIN    SIR 2023- 5006 (100%-REGION 4) (STREAM STATS)  
SIR 2023-5006 (HR4)

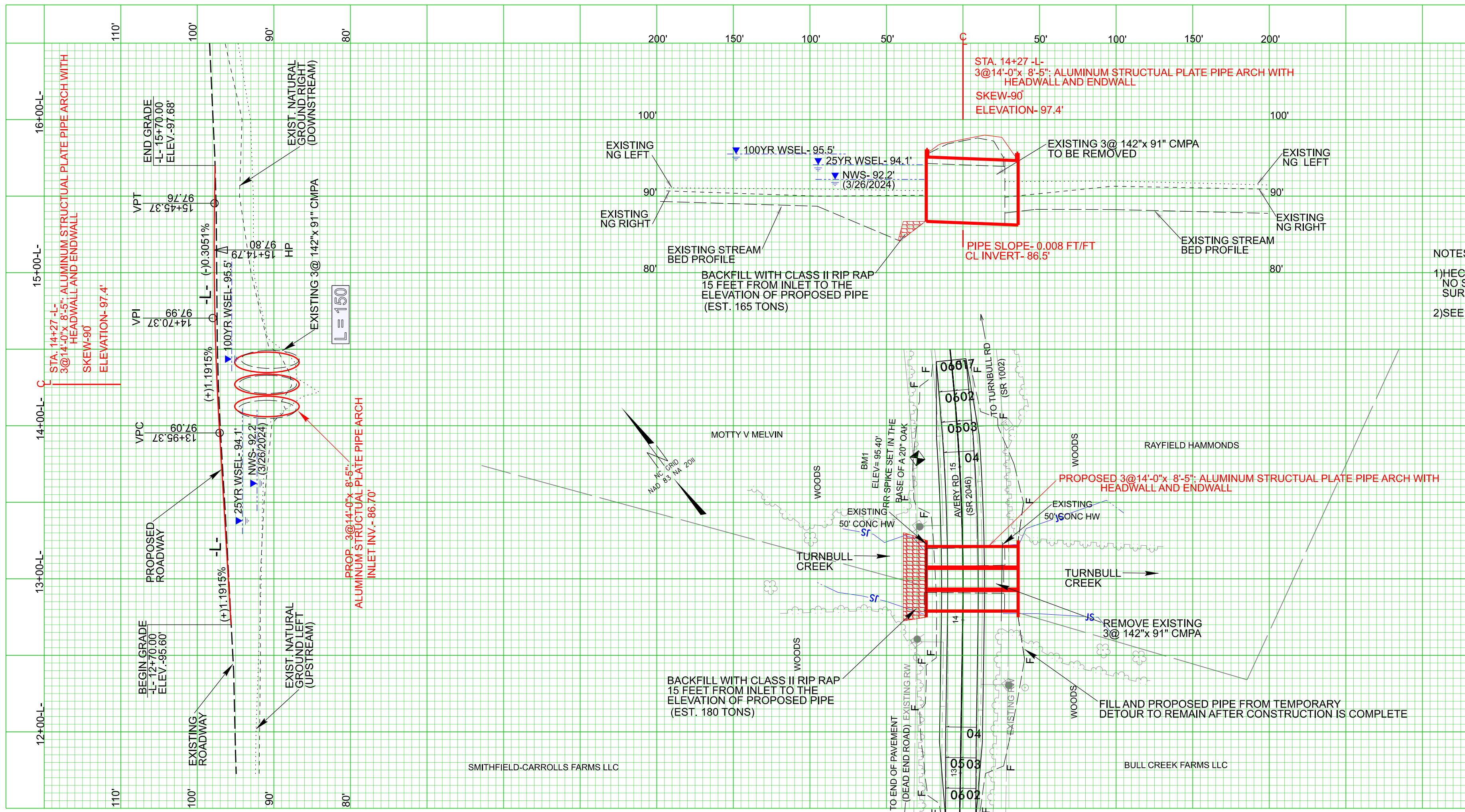
Q<sub>10</sub> = 191 (11.8)<sup>0.623</sup> = 889- 890cfs

Q<sub>25</sub> = 275 (11.8)<sup>0.615</sup> = 1255- 1260cfs

Q<sub>50</sub> = 355 (11.8)<sup>0.610</sup> = 1600- 1600cfs

Q<sub>100</sub> = 437 (11.8)<sup>0.605</sup> = 1945- 1950cfs

Q<sub>500</sub> = 646 (11.8)<sup>0.597</sup> = 2819- 2820cfs



NCDOT PERFORMANCE TABLE					
	10-YEAR	25-YEAR	50-YEAR	100-YEAR	500-YEAR
NATURAL	93.3'	93.6'	N/A	94.2'	94.8'
EXISTING	93.6'	94.4'	N/A	95.8'	96.4'
PROPOSED	93.5'	94.1'	N/A	95.5'	96.2'

SECTION 1192  
21 FEET FROM UPSTREAM FACE OF CULVERT

NOTES:  
1)HEC RAS MODEL RESULTS AND FIELD VERIFICATION INDICATE NO STRUCTURES WILL BE ADVERSELY AFFECTED BY THE WATER SURFACE ELEVATIONS FROM THIS PROJECT.  
2)SEE ROADWAY PLANS FOR PROPOSED RW AND EASEMENTS

# CULVERT -L- 14+27.00 - SUPPORTING CALCULATIONS



Replace Structure No. 208 on SR 2046 (Avery Road)

JOB NAME over Turnbull Creek BP6.R021 COMPUTED BY Kelly de Montbrun, P.E.  
SUBJECT Culvert Recommendations Calculations CHECKED BY Michael Walko, P.E.

### **Structure on SR 2046 (Avery Road) over Turnbull Creek at -L- Station 14+27.00**

#### **PROVIDED INFORMATION**

Station 14+27.00 -L-  
Structure Type 3 @ 14-ft x 8-ft 5-in Aluminum Structural Plate Pipe  
Invert Elevation @ CL of -L- 86.50 ft  
Length 60.0 ft  
Width 32.0 ft  
Slope 0.008 ft/ft

#### **ESTIMATED INFORMATION**

Foundation Conditioning Material Thickness Assumed 1.0 ft  
Bottom of Culvert Elevation along Culvert Centerline  
(looking upstation) 86.7 ft (LT)  
86.5 ft (CT)  
86.2 ft (RT)  
Bottom of Excavation along Culvert Centerline  
(looking upstation) = 85.7 ft (LT)  
= 85.5 ft (CT)  
= 85.2 ft (RT)

We anticipate culvert excavation will be within roadway embankment and alluvial materials. The soils generally consisted of the following:

**Roadway embankment** - Loose to medium dense, silty sand (A-2-4), with trace gravel, asphalt, and organics throughout.

**Alluvial** - Very soft to stiff, clayey silt (A-5) and very loose to medium dense silty fine to coarse sand (A-2-4), with trace pebbles, gravel, and organics throughout.

Groundwater was encountered between approximate elevations 91.7 and 91.9 ft. We anticipate groundwater to impact construction.

We do not anticipate WR and CR to impact construction based on the prepared (enclosed) Structure Subsurface Investigation Report.

Based on Borings B-01 and B-02, the culvert will be founded on very loose to medium dense silty sand. The proposed structure is generally within the existing structure footprint with minimal fill anticipated (< 1 ft). We do not anticipate settlement to be a concern.

#### **ESTIMATED QUANTITIES**

Foundation Condition Material (Class V or VI) – Backfilling in Water, assume up to 1.0 ft of FCM is placed.

Total Estimated Volume of FCM: 60.0 ft (length) \* 32.0 ft (outside width of undercut excavation) \* 1.0 ft (undercut) = 1,920.0 ft<sup>3</sup> / (27 ft<sup>3</sup>/yd<sup>3</sup>) = 71.1 yd<sup>3</sup>, **say 80 yd<sup>3</sup>**

Total Weight of FCM: 71.1 yd<sup>3</sup> \* 1.485 tons/yd<sup>3</sup> = 105.6 tons, **say 110 tons**



**CAROLINAS  
GEOTECHNICAL  
GROUP**