



CAROLINAS
GEOTECHNICAL
GROUP

Structure Foundation Recommendations

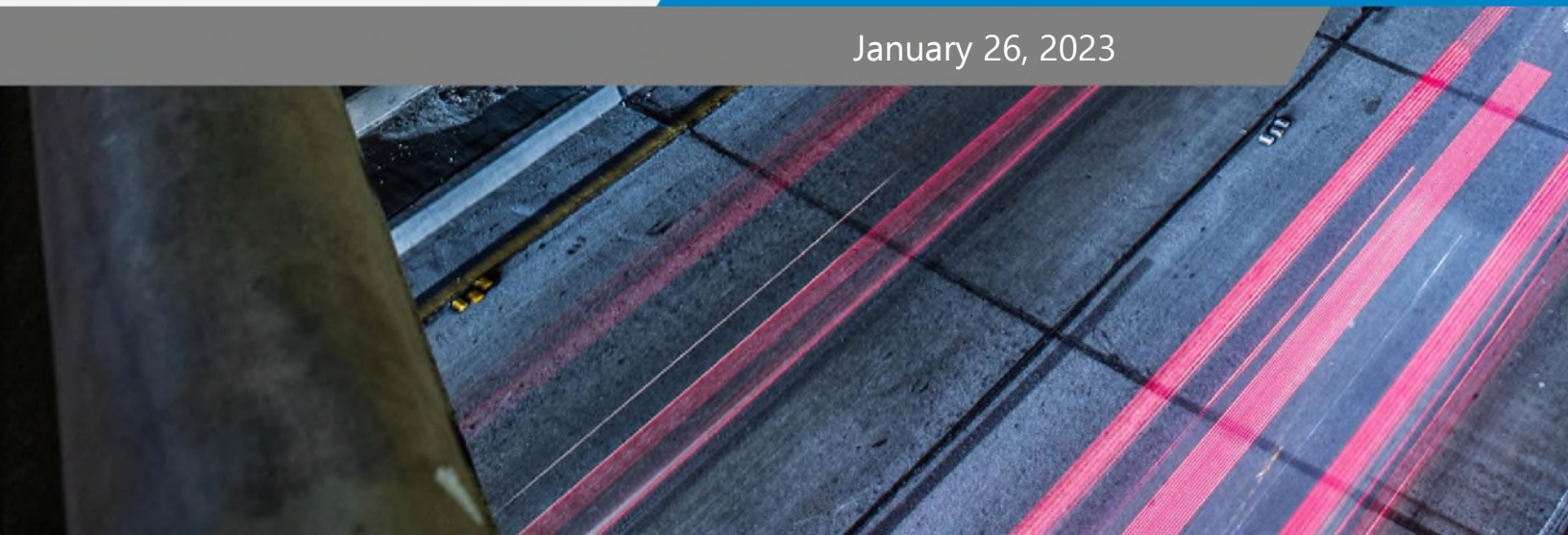
Prepared for:

TGS Engineers, Inc.

201 W. Marion Street, Suite 200

Shelby, North Carolina 28150

January 26, 2023





2400 Crownpoint Executive Drive
Suite 800
Charlotte, NC 28227



(980) 339-8684



contact@carolinasgeotech.com



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January 26, 2023

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

WBS ELEMENT: BP6.R006
T.I.P. NO.: SF-250245
I.D. NO.: SF-250245
COUNTY: Cumberland
DESCRIPTION: Bridge No. 245 on SR 1414 (Raeford Road) over Branson Creek

SUBJECT: Structure Foundation Recommendations

Dear Mr. Terry,

Carolinas Geotechnical Group, PLLC (CG2) has completed the Structure Foundation Recommendations for Structure No. 250245 on SR 1414 (Raeford Road) over Branson Creek in Cumberland County, North Carolina. Foundation Recommendations Notes on Plans and Comments, provided NCDOT Structure Inventory Report, and supporting calculations are presented below and attached.

CULVERT -L- 15+21.00

FOUNDATION RECOMMENDATION NOTES ON PLANS:

1. EXCAVATE 12 INCHES BELOW THE BOTTOM OF THE CULVERT AND REPLACE WITH FOUNDATION CONDITIONING MATERIAL IN ACCORDANCE WITH ARTICLE 414 OF THE STANDARD SPECIFICATIONS. FOUNDATION CONDITIONING MATERIAL SHOULD CONSIST OF SELECT MATERIAL CLASS V OR VI FOR RCBC.
2. 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 reinforced concrete box culvert is 114.9 feet.
2. We anticipate groundwater to impact construction.
3. We recommend a quantity of 130 tons of foundation conditioning material (Class V or VI).
4. We do not anticipate settlement to be a concern. No camber is necessary.
5. Place Select Material Class V or VI when backfilling in water.

Structure Foundation Recommendations

Bridge No. 245 on SR 1414 (Raeford Road) over Branson Creek
Cumberland County, North Carolina

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:
D. Matthew Brewer
386129C0A4C1462...
D. Matthew Brewer, P.E.
Senior Project Engineer

DocuSigned by:
Robert E. Kral
8AD703B2A8484F4...
Robert E. Kral, P.E.
Senior Project Engineer



ATTACHMENTS:

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

ATTACHMENTS

CULVERT -L- 15+21.00 - STRUCTURE SUBSURFACE INVESTIGATION REPORT
(PREPARED BY CG2)

REFERENCE: BP6.R006

PROJECT: 250245

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

STRUCTURE
SUBSURFACE INVESTIGATION

COUNTY CUMBERLAND
PROJECT DESCRIPTION STRUCTURE NO. 250245 OVER
BRANSON CREEK ON SR 1414 (RAEFORD ROAD)

CONTENTS

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	LEGEND (SOIL & ROCK)
3	SITE PLAN
4	BORE LOGS
5	SITE PHOTOS

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	BP6.R006	1	5

CAUTION NOTICE

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- 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

CG2 EXPLORATION

S.N. PATTERSON, P.G.

INVESTIGATED BY CG2, PLLC

DRAWN BY S. N. PATTERSON, P.G.

CHECKED BY M. BREWER, P.E.

SUBMITTED BY CG2, PLLC

DATE JANUARY 2023

Prepared in the Office of:



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



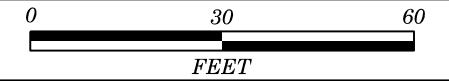
DocuSigned by:
D. Matthew Brewer 01/26/2023
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SIGNATURE DATE

**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

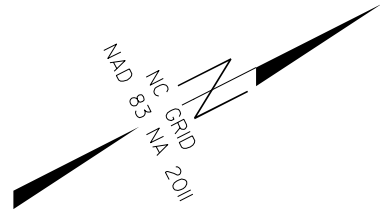
Table with 4 main columns: SOIL DESCRIPTION, GRADATION, ROCK DESCRIPTION, and TERMS AND DEFINITIONS. Includes sub-sections like SOIL LEGEND AND AASHTO CLASSIFICATION, CONSISTENCY OR DENSENESS, TEXTURE OR GRAIN SIZE, SOIL MOISTURE - CORRELATION OF TERMS, PLASTICITY, COLOR, MISCELLANEOUS SYMBOLS, RECOMMENDATION SYMBOLS, ABBREVIATIONS, EQUIPMENT USED ON SUBJECT PROJECT, FRACTURE SPACING, BEDDING, and INDURATION.

SITE PLAN

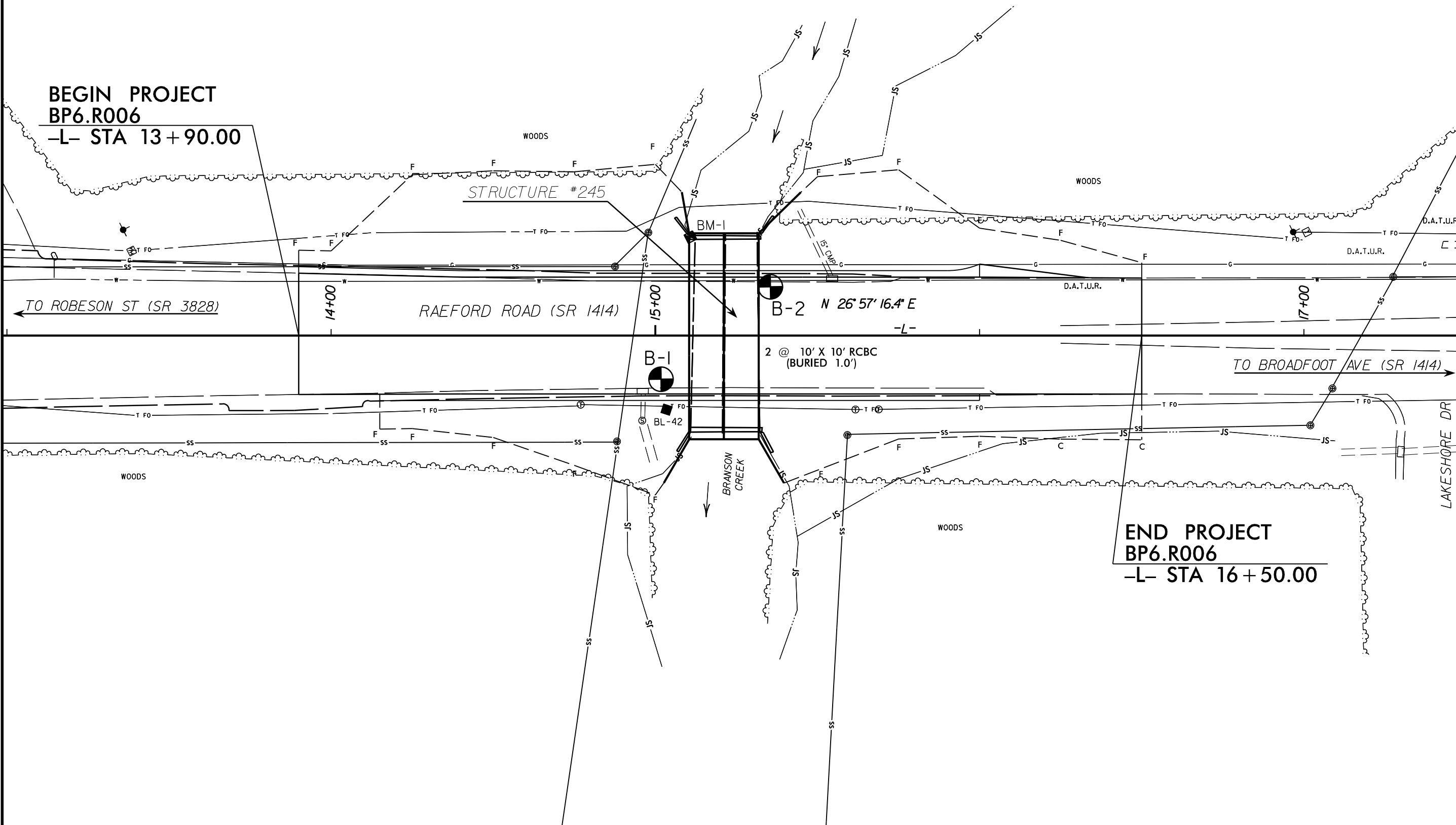


STRUCTURE NO. 250245 OVER
BRANSON CREEK ON SR 1414
(RAEFORD ROAD)

SKEW = 90 DEGREES



BEGIN PROJECT
BP6.R006
-L- STA 13+90.00



END PROJECT
BP6.R006
-L- STA 16+50.00

GEOTECHNICAL BORING REPORT

BORE LOG

WBS BP6.R006		TIP 250245		COUNTY CUMBERLAND		GEOLOGIST S. N. Patterson										
SITE DESCRIPTION Structure No. 250245 over Branson Creek on SR 1414 (Raeford Road)							GROUND WTR (ft)									
BORING NO. B-1		STATION 15+02		OFFSET 13 ft RT		ALIGNMENT -L-										
COLLAR ELEV. 127.9 ft		TOTAL DEPTH 35.0 ft		NORTHING 473,193		EASTING 2,025,725										
DRILL RIG/HAMMER EFF./DATE CG29022 Mobile B-29 86% 04/08/2022			DRILL METHOD H.S. Augers			HAMMER TYPE Automatic										
DRILLER M. Brewer		START DATE 12/01/22		COMP. DATE 12/01/22		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						
130																
125	126.8	1.1	2	3	3											
	124.8	3.1	1	WOH	1											
	121.9	6.0	WOH	WOH	2											
120	119.4	8.5	WOH	WOH	1											
115	114.4	13.5	WOH		1											
110	109.4	18.5	3	2	1											
105	104.4	23.5	8	12	16											
100	99.4	28.5	7	11	17											
95	94.4	33.5	10	17	19											

WBS BP6.R006		TIP 250245		COUNTY CUMBERLAND		GEOLOGIST S. N. Patterson										
SITE DESCRIPTION Structure No. 250245 over Branson Creek on SR 1414 (Raeford Road)							GROUND WTR (ft)									
BORING NO. B-2		STATION 15+35		OFFSET 15 ft LT		ALIGNMENT -L-										
COLLAR ELEV. 128.2 ft		TOTAL DEPTH 35.0 ft		NORTHING 473,236		EASTING 2,025,715										
DRILL RIG/HAMMER EFF./DATE CG29022 Mobile B-29 86% 04/08/2022			DRILL METHOD H.S. Augers			HAMMER TYPE Automatic										
DRILLER M. Brewer		START DATE 12/01/22		COMP. DATE 12/01/22		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						
130																
	126.6	1.6	3	2	1											
125	124.7	3.5	1	1	1											
	122.2	6.0	WOH	1	1											
120	119.7	8.5	WOH	1	2											
115	114.7	13.5	WOH	WOH	1											
110	109.7	18.5	WOH	1	2											
105	104.7	23.5	6	6	8											
100	99.7	28.5	11	23	33											
95	94.7	33.5	12	19	22											

NCDOT BORE DOUBLE CUMBERLAND245.GPJ NC_DOT.GDT 1/25/23

SITE PHOTOS



PHOTO #1: END BENT 1 OF EXISTING STRUCTURE NO. 250245 LOOKING NORTHEAST (UPSTATION)

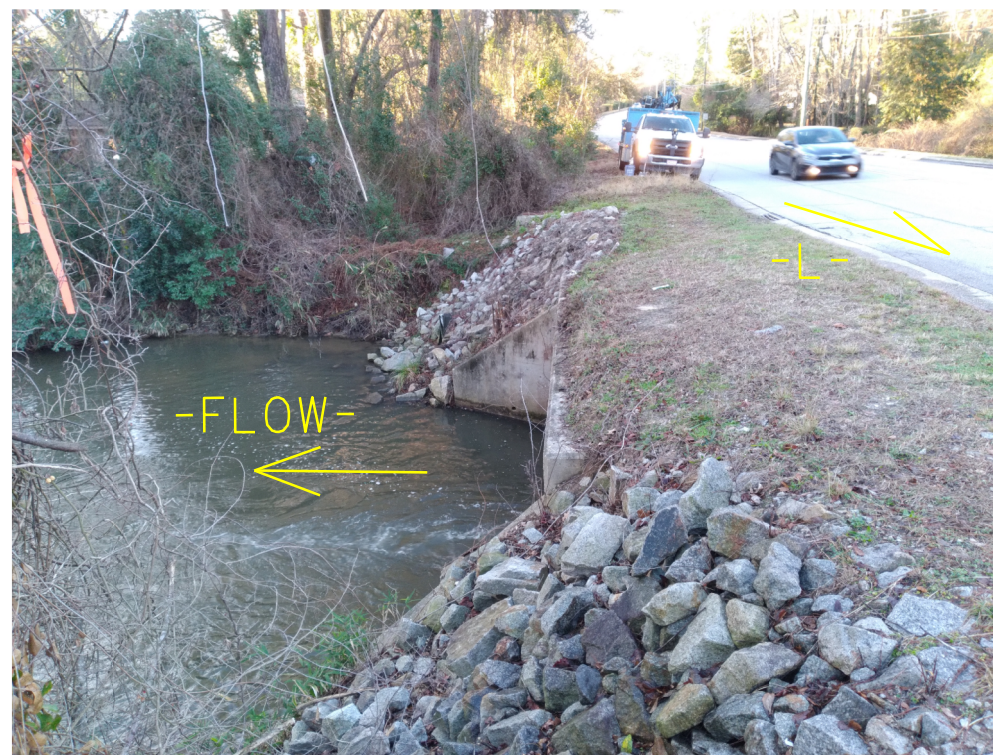


PHOTO #2: END BENT 2 OF EXISTING STRUCTURE NO. 250242 LOOKING SOUTHWEST (DOWNSTATION)

CULVERT SURVEY & HYDRAULIC DESIGN REPORT

CULVERT SURVEY & HYDRAULIC DESIGN REPORT

N. C. DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
HYDRAULICS UNIT
RALEIGH, N. C.



State Proj. Reference No. SF-250245 WBS Project No. BP6.R006 Proj. Station -L- 15+21
 County CUMBERLAND Culvert On BRANSON CREEK Struct. Inv. No. 250245
 On Highway (RAEFORD RD.) Between (ROBESON ST.) and (MORGANTON RD.)
 Recommended Structure 2 @ 10' X 10' RCBC; BURIED 1.0' WITH SILLS AND 6" TOP EDGE BEVEL
 Recommended Width of Roadway 52' SHOULDER POINT TO SHOULDER POINT Skew 90°
 Recommended Location is (Up/At/Down) Stream from Existing Crossing
 Latitude 35.05022 Longitude -78.91406

Statewide Tier Regional Tier Sub-Regional Tier
 Bench Mark is BM-1: -L- STA. 15+10.81 30.33' LT, PK NAIL IN HEADWALL
 Northing 473220.67 Easting 2025690.20 Elev. 127.23 ft. Datum: NAVD 88
 Temporary Crossing NONE (OFFSITE DETOUR)



Drainage Area 4.24 SQ. MI. Source STREAMSTATS /USGS QUAD
 River Basin CAPE FEAR Character URBAN; COASTAL PLAIN
 Stream Classification (Such as Trout, High Quality Water, etc.) C
 Data on Existing Structure 2 @ 10'x7' RCBC; O.A.L.=60.5', HT. CR. TO BED=11.0', BUILT 1940
 Total Waterway Opening 140 s.f.
 Waterway Opening Below 100yr. WS EL. 140 s.f.

Debris Potential: Low Moderate X High
 Data on Structures Up and Down Stream
 US STRUCTURE: 0.3 MI. US ON MCBAIN DR. NO NCDOT STR. #, 2 @ 9'-6" X 6'-5" SPPA;
 HT CR TO BED=10.0'; O.A.L.=60.0'
 DS STRUCTURE: 0.1 MI. DS ON WINTERLOCHEN RD., NCDOT STR. #250181, 2 @ 10' X 8' RCBC;
 HT CR TO BED=14.0', O.A.L.=66.5'

Gage Station No. N/A Period of Records N/A
 Max. Discharge N/A c.f.s. Date N/A Frequency N/A

Historical Flood Information: (SEE ADDITIONAL INFORMATION AND COMPUTATIONS)
 Date 10/08/16 Elev. 127.8 ft. Est. Freq. 500 yr. Source (NCDOT BRG MAINT SUPERVISOR) DANIEL LEGGETT Period of Knowledge 7 yrs.
 Date 10/08/16 Elev. 128.0 ft. Est. Freq. 500 yr. Source (LOCAL RESIDENT) JAMES HARPER Period of Knowledge 64 yrs.
 Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.
 Allowable HW Elev. 129.13' *FEMA CORRECTED PRELIMINARY 100-YR WSEL AT HEC-RAS RS 7680.0 (US TOE) Normal Water Surface Elev. 118.7 ft.
 Manning's n: Left O.B. 0.07-0.11 Channel 0.05 Right O.B. 0.07-0.12 Source FEMA MODEL/FIELD OBSERV.
 Flood Study /Status DETAILED (PRELIMINARY - NO FIS AVAILABLE)
 Flood Study 100 yr. Discharge 1932 c.f.s.; WS Elev.: With Floodway 129.95 ft. Without Floodway 129.77 ft.
 @ River Station 7857.9

DESIGN DATA

Hydrological Method SIR 2014-5030 URBAN (COASTAL PLAIN; REGION 4)
 Hydraulic Design Method HEC_RAS 6.1.0

*Design Tailwater: Q₁₀ 7.1 ft.; Q₂₅ 7.7 ft.; Q₅₀ N/A ft.; Q₁₀₀ 8.3 ft.; Q₅₀₀ 9.1 ft.
 *TAILWATER DEPTHS BASED ON WSEL AT RS 7525.0 (DS TOE) MINUS INVERT OUT (TOP OF SILL)

INV. IN EL.=116.1 (TOP OF SILL), INV. OUT EL.=115.7 (TOP OF SILL) SIZE & TYPE: 2 @ 10' X 10' RCBC (BURIED 1.0') @ RS 7680.0, APPROX. 42' UPSTREAM OF CULVERT.							
FREQUENCY	Q (cfs)	Inlet Control			Outlet Control		Remarks
		HWD	H.W.	WSEL	H.W.	WSEL	
10 YR	800	0.62	5.6	121.7	7.4	123.5	OUTLET CONTROL
25 YR	950	0.71	6.4	122.5	8.2	124.3	DESIGN, OUTLET CONTROL
100 YR	1100	0.79	7.1	123.2	8.9	125.0	OUTLET CONTROL
500 YR	1300	0.89	8.0	124.1	9.9	126.0	OUTLET CONTROL

Total Proposed Waterway Opening 180 s.f.
 Outlet Velocity (V₁₀) 5.7 f.p.s. Natural Channel Velocity (V₁₀) 2.3 f.p.s.
 Required Outlet Protection CLASS 'II' RIP-RAP AS SHOWN
 State Floodway Compliance Type SFC TYPE B (MAX DECREASE OF 0.13' FROM RS 8233.9 TO 7680.0)

INFORMATION TO BE SHOWN ON PLANS

HYDRAULIC DATA		
DESIGN DISCHARGE	= 950	C.F.S.
FREQUENCY OF DESIGN FLOOD	= 25	YRS.
DESIGN HIGH WATER ELEVATION	= 124.3	FT.
DRAINAGE AREA	= 4.2	SQ. MI.
BASIC DISCHARGE (Q100)	= 1100	C.F.S.
BASIC HIGH WATER ELEVATION	= 125.0	FT.
OVERTOPPING FLOOD DATA		
OVERTOPPING DISCHARGE	= NA	C.F.S.
FREQUENCY OF OVERTOPPING FLOOD	= >500	YRS.
OVERTOPPING FLOOD ELEVATION*	= 128.6	FT
*CL @ -L- STA. 13+90		
WS EL. Taken @ River Station 7680.0 (US TOE)		

ADDITIONAL INFORMATION AND COMPUTATIONS

HISTORICAL FLOOD INFORMATION:
 DANIEL LEGGETT, BRIDGE MAINTENANCE SUPERVISOR, STATED DURING HURRICANE MATTHEW (OCTOBER 2016) WATER GOT UP ON THE SHOULDER BUT NEVER IN THE ROADWAY ON THE INLET SIDE OF THE CROSSING.
 JAMES HARPER, LOCAL RESIDENT, STATED DURING HURRICANE MATTHEW WATER WAS UP TO THE APARTMENT DRIVE AT RAEFORD ROAD HOMES.

HYDROLOGY:
 USGS SIR 2014-5030 URBAN REGRESSION EQUATIONS, HYDROLOGIC REGION 4 (COASTAL PLAIN)
 DA=4.24 SQ. MI., %IMP=30%, 24-HR, 50-YR MAX PRECIP.=7.58 IN
 Q₁₀=51.8 (DA)^{0.777} * 10^{0.00000000} * 10^{0.00000000} = 792, SAY 800 CFS; Q_{FEMA}=1244 CFS
 Q₂₅=67.1 (DA)^{0.777} * 10^{0.00000000} * 10^{0.00000000} = 931, SAY 950 CFS; Q_{FEMA}=1524 CFS
 Q₁₀₀=78.4 (DA)^{0.777} * 10^{0.00000000} * 10^{0.00000000} = 1026, SAY 1000 CFS; Q_{FEMA}=1745 CFS
 Q₅₀₀=90.5 (DA)^{0.777} * 10^{0.00000000} * 10^{0.00000000} = 1120, SAY 1100 CFS; Q_{FEMA}=1932 CFS
 Q₁₀₀₀=119 (DA)^{0.777} * 10^{0.00000000} * 10^{0.00000000} = 1320, SAY 1300 CFS; Q_{FEMA}=2449 CFS

BECAUSE OF THE LARGE DISCREPANCY BETWEEN Q(USGS) AND Q(FEMA) DISCHARGES, Q(USGS) WAS USED FOR DESIGN AND Q(FEMA) WAS USED FOR FEMA COMPLIANCE.

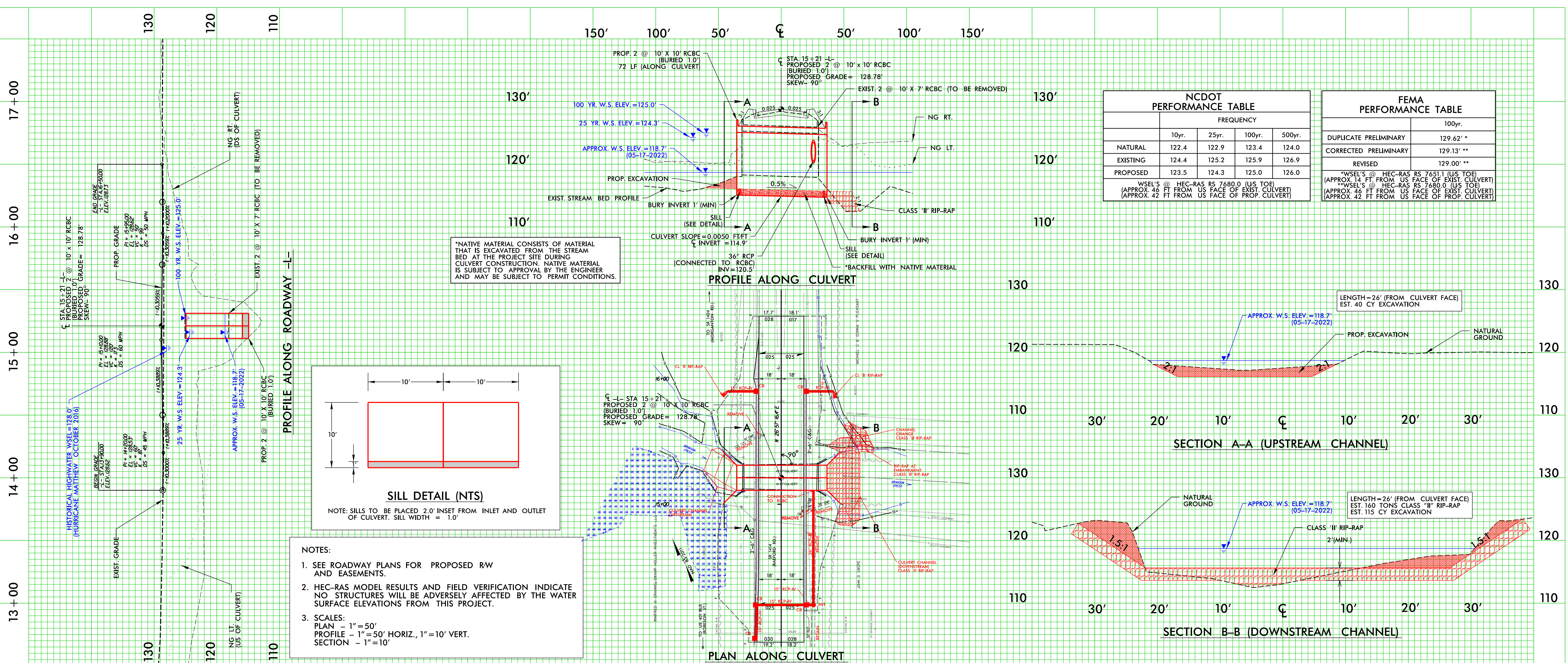
EXISTING CULVERT NOTES:
 WEEP HOLES IN THE ORIGINAL CULVERT ARE 3.2' ABOVE THE INVERT (APPROX. ELEV. = 121.5'). A WATERMARK WAS SEEN ON THE CULVERT WALLS 1.0' BELOW THESE WEEP HOLES (APPROX. ELEV. = 120.5').

NATIVE MATERIAL SPECIFICATION FOR BACKFILLING NOTE
 The Engineer, in consultation with DEO staff, shall review all material to be used as backfill prior to conducting the backfill activity. Backfill shall consist of native material only unless the Engineer, in consultation with DEO staff, determines that (1) the native material is unsuitable, or (2) additional material is required to supplement the native material. The chosen backfill material shall not have adverse effects to aquatic life, aquatic life passage, or water quality. Native material consists of material that is excavated from the stream bed or floodplain at the project site during culvert construction.

Designed by: BEN HENEGAR, PE
 Assisted by: RUSTY LASSITER; CALVIN HAMBLET, EI
 Date 08-16-22
 DocuSigned by: Benjamin J. Henegar
 8/16/2022 11:53 AM EDT
 QA Review by:



Date 8/16/2022 | 12:18 PM EDT



NCDOT PERFORMANCE TABLE				
FREQUENCY	FREQUENCY			
	10yr.	25yr.	100yr.	500yr.
NATURAL	122.4	122.9	123.4	124.0
EXISTING	124.4	125.2	125.9	126.9
PROPOSED	123.5	124.3	125.0	126.0

WSELS @ HEC-RAS RS 7680.0 (US TOE) (APPROX. 42 FT FROM US FACE OF EXIST. CULVERT)
 WSELS @ HEC-RAS RS 7651.1 (US TOE) (APPROX. 14 FT FROM US FACE OF EXIST. CULVERT)
 WSELS @ HEC-RAS RS 7680.0 (US TOE) (APPROX. 46 FT FROM US FACE OF EXIST. CULVERT)
 WSELS @ HEC-RAS RS 7680.0 (US TOE) (APPROX. 42 FT FROM US FACE OF PROP. CULVERT)

FEMA PERFORMANCE TABLE	
100yr.	
DUPLICATE PRELIMINARY	129.62' *
CORRECTED PRELIMINARY	129.13' **
REVISED	129.00' **

*WSEL'S @ HEC-RAS RS 7651.1 (US TOE) (APPROX. 14 FT FROM US FACE OF EXIST. CULVERT)
 **WSEL'S @ HEC-RAS RS 7680.0 (US TOE) (APPROX. 46 FT FROM US FACE OF EXIST. CULVERT)
 WSEL'S @ HEC-RAS RS 7680.0 (US TOE) (APPROX. 42 FT FROM US FACE OF PROP. CULVERT)

CULVERT -L- 15+21.00 - SUPPORTING CALCULATIONS



Bridge No. 245 on SR 1414 (Raeford Road) over
JOB NAME Branson Creek BP6.R006 COMPUTED BY Robert E. Kral, P.E.
SUBJECT Culvert Recommendations Calculations CHECKED BY D. Matthew Brewer, P.E.

Structure on SR 1414 (Raeford Road) over Branson Creek at -L- Station 15+21.00

PROVIDED INFORMATION

Station	15+21.00 -L-
Structure Type	2 @ 10.0 ft Span x 10.0 ft Rise RCBC
Invert Elevation	@ CL of -L- 114.9 ft
Length	63.5 ft
Width	24.0 ft (outside width of culvert) + 4.0 ft (additional width per NCDOT FCM for Box Culvert Memo dated 12/12/2011) = 28.0 ft
Slope	0.5 %

ESTIMATED INFORMATION

Culvert Concrete Thickness	Assumed 1.0 ft
Bottom of Culvert Elevation along Culvert Centerline (looking upstation)	115.1 ft - 1.0 ft Thick Culvert = 114.1 ft (LT)
	114.9 ft - 1.0 ft Thick Culvert = 113.9 ft (CT)
	114.7 ft - 1.0 ft Thick Culvert = 113.7 ft (RT)
Bottom of Excavation along Culvert Centerline (looking upstation)	= 113.1 ft (LT)
	= 112.9 ft (CT)
	= 112.7 ft (RT)

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

Roadway embankment - Very soft to medium stiff, sandy clay (A-6), with trace gravel throughout.

Undivided Coastal Plan - Stiff, sandy silt (A-4) and loose to very dense, silty fine sand (A-3 & A-2-4), with little gravel and cobbles throughout.

Groundwater was encountered between approximate elevations 117.9 ft and 118.5 ft. We anticipate groundwater to impact construction.

We do not anticipate WR and CR to impact construction based on the provided Structure Investigation Report.

Based on Borings B-1 and B-2, the culvert will be founded on very soft silty clay and very loose 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 nor the need for a camber in the culvert.

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: 63.5 ft (length) * 28.0 ft (outside width of undercut excavation) * 1.0 ft (undercut) = 1,778.0 ft³ / (27 ft³/yd³) = 65.9 yd³, **say 70 yd³**

Total Weight of FCM: 65.9 yd³ * 1.904 tons/yd³ = 125.4 tons, **say 130 tons**



**CAROLINAS
GEOTECHNICAL
GROUP**