ECS Southeast, LLP

Bridge Foundation Design Recommendations (Revised)

Bridge No. 016 on SR 1166 (Bethel Church Road) over UT to South Deep Creek

WBS No.: BP11.R010
TIP No.: N/A
Yadkin County, North Carolina

ECS Project No. 09:29600

September 13, 2023
Revised October 23, 2023

September 13, 2023
Revised October 23, 2023

Mr. Matt Foster, PE, PLS
JMT – Johnson, Mirmiran & Thompson, Inc.
514 S. Stratford Road, Suite 220
Winston-Salem, North Carolina 27103

ECS Project No.:09:29600

Reference: Bridge Foundation Design Recommendations (Revised)
Bridge No. 016 on SR 1166 (Bethel Church Road) over UT to South Deep Creek
WBS Number: BP11.R010
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County: Yadkin

Dear Mr. Foster:

ECS Southeast, LLP (ECS) is pleased to submit the revised Bridge Foundation Design Recommendations Report associated with design and construction of Bridge No. 016 on SR 1166 (Bethel Church Road) over UT to South Deep Creek, in Yadkin County, North Carolina. This revised report incorporates NCDOT's review comments. This work was performed in general accordance with Task Order 02 as part of the "Subcontract Agreement" between Vaughn & Melton Consulting Engineers, Inc. (V&M) and ECS Southeast, LLP (ECS) dated March 13,2023.

Our design is based on project information provided to us by V&M / JMT and NCDOT Standard Load Tables. This revised report contains the foundation recommendations, the Structure Subsurface Investigation report prepared by ECS, and supporting calculations.

ECS Southeast, LLP appreciates the opportunity to assist you during this phase of the project. If you have questions concerning this report, please contact our office at 704-525-5152.

Respectfully,

ECS SOUTHEAST, LLP

NORTH CAROLINA PROFESSIONAL SEAL 026917 ENGINEER MICHAEL J. WALKO

10/23/2023

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FOUNDATION RECOMMENDATIONS

Prepared for NCDOT by: ECS Southeast, LLP

WBS NO. BP11.R010

T.I.P. NO. N/A

COUNTY Yadkin

STATION 13+38.00 -L-

DESCRIPTION Bridge No. 016 on SR 1166 (Bethel Church Road) over UT to South Deep Creek

	INITIALS	DATE
DESIGN	MJW	09/12/23
CHECK	KND	09/13/23
REVISED	MJW	10/23/23

SEAL

NORTH CAROLINA PROFESSIONAL SEAL 026917 ENGINEER MICHAEL J. WALKO

10/23/2023

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	STATION	FOUNDATION TYPE	FACTORED LOAD	MISCELLANEOUS DETAILS
END BENT NO. 1	13+01.88 -L-	Cap on HP 12X53 Steel Piles	85 Tons/Pile	Average Bottom of Cap Elevation = 776.4 ft +/- Average Pile Length = 35 ft (LT), 30 ft (RT) 7 Vertical Piles @ 6'-0" Spacing
END BENT NO. 2	13+74.13 -L-	Cap on HP 12X53 Steel Piles	85 Tons/Pile	Average Bottom of Cap Elevation = 776.1 ft +/- Average Pile Length = 30 ft 7 Vertical Piles @ 6'-0" Spacing

(SEE NOTES ON PLANS AND COMMENTS ON FOLLOWING PAGES)

WBS No: BP11.R010 **County:** Yadkin

FOUNDATION RECOMMENDATION NOTES ON PLANS

1) FOR PILES, SEE PILES PROVISION AND SECTION 450 OF THE STANDARD SPECIFICATIONS.

FOUNDATION RECOMMENDATION COMMENTS

1) CLASS II RIP RAP WILL BE USED FOR SCOUR PROTECTION AT END BENT NO. 1 AND END BENT NO. 2.

2) NO WAITING PERIOD IS REQUIRED AT EITHER END BENT PRIOR TO CONSTRUCTION.

3) AVERAGE PILE LENGTHS ARE BASED ON PLUMB PILES FROM THE BOTTOM OF CAP ELEVATION TO THE ANTICIPATED TIP ELEVATION, ROUNDED UP TO THE NEAREST 5 FEET.

4) PDA WILL NOT BE USED TO MONITOR DRIVING STRESSES AT END BENT NO. 1 AND END BENT NO. 2.

5) A DELMAG D19-32 PILE HAMMER WAS UTILIZED AS A COMMON HAMMER TYPE TO DETERMINE POTENTIAL PILE DRIVING STRESSES. THIS HAMMER SHOULD PROVIDE SUFFICIENT ENERGY TO DRIVE THE PILES TO THE REQUIRED DRIVING RESISTANCES AT THE END BENTS. THE ACTUAL HAMMER TO BE UTILIZED WILL NEED TO BE SUBMITTED BY THE CONTRACTOR AND ANALYZED PRIOR TO CONSTRUCTION.

6) THE TYPE I BRIDGE APPROACH FILL DETAIL WILL BE USED.

SUMMARY OF PILE INFORMATION/INSTALLATION

(Blank entries indicate item is not applicable to structure)

End Bent/ Bent No, Pile(s) #-# (e.g., "Bent 1, Piles 1-5")	Factored Resistance per Pile TONS	Pile Cut-Off (Top of Pile) Elevation FT	Estimated Pile Lenth per Pile FT	Scour Critical Elevation FT	Driven Piles			Predrilling for Piles*			Drilled-In Piles		
					Min Pile Tip (Tip No Higher Than) Elev FT	Required Driving Resistance (RDR)** per Pile TONS	Total Pile Redrives Quantity EACH	Predrilling Length per Pile Lin FT	Predrilling Elevation (Elev Not To Predrill Below) FT	Maximum Predrilling Dia INCHES	Pile Excavation (Bottom of Hole) Elev FT	Pile Exc Not In Soil per Pile Lin FT	Pile Exc In Soil per Pile Lin FT
End Bent 1, Piles 1-4	85	See Substructure Plans	35			145							
End Bent 1, Piles 5-7	85		30			145							
End Bent 2, Piles 1-7	85		30			145							

**Predrilling for Piles is required for end bents/bents with a predrilling length and at the Contractor's option for end bents/bents with predrilling information but no predrilling length.

$$^{**}RDR = \frac{Factored\ Resistance + Factored\ Downdrag\ Load + Factored\ Dead\ Load}{Dynamic\ Resistance\ Factor} + Nominal\ Downdrag\ Resistance + \frac{Nominal\ Scour\ Resistance}{Scour\ Resistance\ Factor}$$

PILE DESIGN INFORMATION

(Blank entries indicate item is not applicable to structure)

End Bent/ Bent No, Pile(s) #-# (e.g., "Bent 1, Piles 1-5")	Factored Axial Load per Pile TONS	Factored Downdrag Load per Pile TONS	Factored Dead Load* per Pile TONS	Dynamic Resistance Factor	Nominal Downdrag Resistance per Pile TONS	Nominal Scour Resistance per Pile TONS	Scour Resistance Factor (Default = 1.00)
End Bent 1, Piles 1-7	81			0.60			
EndBent 2, Piles 1-7	81			0.60			

*Factored Dead Load is factored weight of pile above the ground line.

PROJECT NO. BP11.R010

YADKIN COUNTY

STATION: 13+38.00 -L-

NOTES:

1. The Pile Foundation Tables are based on the bridge substructure design and foundation recommendations sealed by a North Carolina Professional Engineer (Michael J. Walko, 026917) on 10-23-2023.
2. Total Pile Driving Equipment Setup quantity (not shown in Pile Foundation Tables) equals the number of driven piles, i.e., the number of piles with a Required Driving Resistance.
3. PDA will not be required.

NORTH CAROLINA PROFESSIONAL SEAL 020123 ENGINEER STEPHEN T. CHAMPION

SIGNATURE DATE

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

PILE FOUNDATION TABLES

REVISIONS							SHEET NO.
NO.	BY:	DATE:	NO.	BY:	DATE:		
1			3				TOTAL SHEETS
2			4				

REPLACE BRIDGE No. 016 ON SR 1166 (BETHEL CHURCH ROAD) OVER UT TO SOUTH DEEP CREEK

SUBSURFACE INVENTORY REPORT

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	BP11.R010	1	8

REFERENCE: SF-980016

PROJECT: BP11.R010

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

STRUCTURE SUBSURFACE INVESTIGATION

COUNTY *YADKIN*

PROJECT DESCRIPTION *BRIDGE NO. 16 ON SR 1166 (BETHEL CHURCH ROAD) OVER U.T. TO SOUTH DEEP CREEK*

SITE DESCRIPTION *STATION 13+38.00 –L–*

CONTENTS

PERSONNEL

B. ROGERS

BRIDGER DRILLING

INVESTIGATED BY *ECS SOUTHEAST, LLP*

DRAWN BY *K. DE MONTBRUN, P.E.*

CHECKED BY *M. WALKO, P.E.*

SUBMITTED BY *ECS SOUTHEAST, LLP*

DATE *SEPTEMBER 2023*

Prepared in the Office of:

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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.

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NOTES:

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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.

NORTH CAROLINA PROFESSIONAL SEAL 045542 ENGINEER KELLY DE MONTBRUN

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Kelly de Montbrun
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9/13/2023
DATE

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PROJECT REFERENCE NO.	SHEET NO.
BP11.R010	2

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)

SOIL DESCRIPTION

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

SOIL LEGEND AND AASHTO CLASSIFICATION

GENERAL CLASS.	GRANULAR MATERIALS (≤ 35% PASSING #200)							SILT-CLAY MATERIALS (> 35% PASSING #200)				ORGANIC MATERIALS		
GROUP CLASS.	A-1		A-3	A-2				A-4	A-5	A-6	A-7	A-1, A-2 A-3	A-4, A-5 A-6, A-7	
	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5, A-7-6			
SYMBOL														
% PASSING #10 #40 #200	50 MX 30 MX 15 MX	50 MX 25 MX	51 MN 10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN	GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
MATERIAL PASSING #40 LL PI	— 6 MX		— NP	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	40 MX 10 MX	41 MN 10 MX	40 MX 11 MN	41 MN 11 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
GROUP INDEX	0		0	0		4 MX		8 MX	12 MX	16 MX	NO MX			
USUAL TYPES OF MAJOR MATERIALS	STONE FRAGS. GRAVEL, AND SAND		FINE SAND	SILTY OR CLAYEY GRAVEL AND SAND				SILTY SOILS		CLAYEY SOILS				
GEN. RATING AS SUBGRADE	EXCELLENT TO GOOD							FAIR TO POOR				FAIR TO POOR	POOR	UNSUITABLE

PI OF A-7-5 SUBGROUP IS ≤ LL - 30 ; PI OF A-7-6 SUBGROUP IS > LL - 30

CONSISTENCY OR DENSENESS

PRIMARY SOIL TYPE	COMPACTNESS OR CONSISTENCY	RANGE OF STANDARD PENETRATION RESISTANCE (N-VALUE)	RANGE OF UNCONFINED COMPRESSIVE STRENGTH ($TONS/FT^2$)
GENERALLY GRANULAR MATERIAL (NON-COHESIVE)	VERY LOOSE LOOSE MEDIUM DENSE DENSE VERY DENSE	< 4 4 TO 10 10 TO 30 30 TO 50 > 50	N/A
GENERALLY SILT-CLAY MATERIAL (COHESIVE)	VERY SOFT SOFT MEDIUM STIFF STIFF VERY STIFF HARD	< 2 2 TO 4 4 TO 8 8 TO 15 15 TO 30 > 30	< 0.25 0.25 TO 0.5 0.5 TO 1.0 1 TO 2 2 TO 4 > 4

TEXTURE OR GRAIN SIZE

U.S. STD. SIEVE SIZE	4	10	40	60	200	270
OPENING (MM)	4.76	2.00	0.42	0.25	0.075	0.053

BOULDER (BLDR.)	COBBLE (COB.)	GRAVEL (GR.)	COARSE SAND (CSE. SD.)	FINE SAND (F SD.)	SILT (SL.)	CLAY (CL.)

GRAIN SIZE	MM	305	75	2.0	0.25	0.05	0.005
	IN.	12	3				

SOIL MOISTURE - CORRELATION OF TERMS

SOIL MOISTURE SCALE (ATTERBERG LIMITS)	FIELD MOISTURE DESCRIPTION	GUIDE FOR FIELD MOISTURE DESCRIPTION
	- SATURATED - (SAT.)	USUALLY LIQUID; VERY WET, USUALLY FROM BELOW THE GROUND WATER TABLE
LL — LIQUID LIMIT PLASTIC RANGE (PI) PL — PLASTIC LIMIT	- WET - (W)	SEMISOLID; REQUIRES DRYING TO ATTAIN OPTIMUM MOISTURE
OM — OPTIMUM MOISTURE SL — SHRINKAGE LIMIT	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NON PLASTIC	0-5	VERY LOW
SLIGHTLY PLASTIC	6-15	SLIGHT
MODERATELY PLASTIC	16-25	MEDIUM
HIGHLY PLASTIC	26 OR MORE	HIGH

COLOR

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.

GRADATION

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.

ANGULARITY OF GRAINS

THE ANGULARITY OR ROUNDNESS OF SOIL GRAINS IS DESIGNATED BY THE TERMS: ANGULAR, SUBANGULAR, SUBROUNDED, OR ROUNDED.

MINERALOGICAL COMPOSITION

MINERAL NAMES SUCH AS QUARTZ, FELDSPAR, MICA, TALC, KAOLIN, ETC. ARE USED IN DESCRIPTIONS WHEN THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LL < 31
MODERATELY COMPRESSIBLE	LL = 31 - 50
HIGHLY COMPRESSIBLE	LL > 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS	OTHER MATERIAL	
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%	TRACE	1 - 10%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%	LITTLE	10 - 20%
MODERATELY ORGANIC	5 - 10%	12 - 20%	SOME	20 - 35%
HIGHLY ORGANIC	> 10%	> 20%	HIGHLY	35% AND ABOVE

GROUND WATER

- WATER LEVEL IN BORE HOLE IMMEDIATELY AFTER DRILLING
- STATIC WATER LEVEL AFTER 24 HOURS
- PW — PERCHED WATER, SATURATED ZONE, OR WATER BEARING STRATA
- SPRING OR SEEP

MISCELLANEOUS SYMBOLS

- ROADWAY EMBANKMENT (RE) WITH SOIL DESCRIPTION
- SOIL SYMBOL
- ARTIFICIAL FILL (AF) OTHER THAN ROADWAY EMBANKMENT
- INFERRED SOIL BOUNDARY
- INFERRED ROCK LINE
- ALLUVIAL SOIL BOUNDARY
- 25/025 — DIP & DIP DIRECTION OF ROCK STRUCTURES
- SPT, DPT, DMT, VST, PMT — TEST BORING
- AUGER BORING
- CORE BORING
- MW — MONITORING WELL
- PIEZOMETER INSTALLATION
- SLOPE INDICATOR INSTALLATION
- CONE PENETROMETER TEST
- SOUNDING ROD
- TEST BORING WITH CORE
- SPT N-VALUE

RECOMMENDATION SYMBOLS

- UNDERCUT
- SHALLOW UNDERCUT
- UNCLASSIFIED EXCAVATION - UNSUITABLE WASTE
- UNCLASSIFIED EXCAVATION - ACCEPTABLE DEGRADABLE ROCK
- UNCLASSIFIED EXCAVATION - ACCEPTABLE, BUT NOT TO BE USED IN THE TOP 3 FEET OF EMBANKMENT OR BACKFILL

ABBREVIATIONS

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
WEA. - WEATHERED
γ - UNIT WEIGHT
γ_d - DRY UNIT WEIGHT

SAMPLE ABBREVIATIONS

S - BULK
SS - SPLIT SPOON
ST - SHELBY TUBE
RS - ROCK
RT - RECOMPACTED TRIAXIAL
CBR - CALIFORNIA BEARING RATIO

EQUIPMENT USED ON SUBJECT PROJECT

DRILL UNITS:
- [X] CME-45C
- [ ] CME-55
- [ ] CME-550
- [ ] VANE SHEAR TEST
- [ ] PORTABLE HOIST
- [ ] _____
- [ ] _____

ADVANCING TOOLS:
- [ ] CLAY BITS
- [ ] 6" CONTINUOUS FLIGHT AUGER
- [ ] 8" HOLLOW AUGERS
- [ ] HARD FACED FINGER BITS
- [ ] TUNG.-CARBIDE INSERTS
- [ ] CASING [ ] W/ ADVANCER
- [ ] TRICONE _____" STEEL TEETH
- [ ] TRICONE _____" TUNG.-CARB.
- [ ] CORE BIT
- [X] MUD ROTARY

HAMMER TYPE:
- [X] AUTOMATIC [ ] MANUAL

CORE SIZE:
- [ ] -B _____ [ ] -H _____
- [ ] -N _____

HAND TOOLS:
- [ ] POST HOLE DIGGER
- [ ] HAND AUGER
- [ ] SOUNDING ROD
- [ ] VANE SHEAR TEST
- [ ] _____

PROJECT REFERENCE NO.	SHEET NO.
BP11.R010	2A

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

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

ROCK DESCRIPTION

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:

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 YEILD 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 SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED, SOME JOINTS MAY SHOW THIN CLAY COATINGS IF OPEN, CRYSTALS ON A BROKEN SPECIMEN FACE SHINE BRIGHTLY. ROCK RINGS UNDER HAMMER BLOWS IF OF A CRYSTALLINE NATURE.
SLIGHT (SLI.)	ROCK GENERALLY FRESH, JOINTS STAINED AND DISCOLORATION EXTENDS INTO ROCK UP TO 1 INCH. OPEN JOINTS MAY CONTAIN CLAY. IN GRANITOID ROCKS SOME OCCASIONAL FELDSPAR CRYSTALS ARE DULL AND DISCOLORED. CRYSTALLINE ROCKS RING UNDER HAMMER BLOWS.
MODERATE (MOD.)	SIGNIFICANT PORTIONS OF ROCK SHOW DISCOLORATION AND WEATHERING EFFECTS. IN GRANITOID ROCKS, MOST FELDSPARS ARE DULL AND DISCOLORED, SOME SHOW CLAY. ROCK HAS DULL SOUND UNDER HAMMER BLOWS AND SHOWS SIGNIFICANT LOSS OF STRENGTH AS COMPARED WITH FRESH ROCK.
MODERATELY SEVERE (MOD. SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. IN GRANITOID ROCKS, ALL FELDSPARS DULL AND DISCOLORED AND A MAJORITY SHOW KAOLINIZATION. ROCK SHOWS SEVERE LOSS OF STRENGTH AND CAN BE EXCAVATED WITH A GEOLOGIST'S PICK. ROCK GIVES "CLUNK" SOUND WHEN STRUCK. *IF TESTED, WOULD YIELD SPT REFUSAL*
SEVERE (SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC CLEAR AND EVIDENT BUT REDUCED IN STRENGTH TO STRONG SOIL. IN GRANITOID ROCKS ALL FELDSPARS ARE KAOLINIZED TO SOME EXTENT. SOME FRAGMENTS OF STRONG ROCK USUALLY REMAIN. *IF TESTED, WOULD YIELD SPT N VALUES > 100 BPF*
VERY SEVERE (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. *IF TESTED, WOULD YIELD SPT N VALUES < 100 BPF*
COMPLETE	ROCK REDUCED TO SOIL. ROCK FABRIC NOT DISCERNIBLE, OR DISCERNIBLE ONLY IN SMALL AND SCATTERED CONCENTRATIONS. QUARTZ MAY BE PRESENT AS DIKES OR STRINGERS. SAPROLITE IS ALSO AN EXAMPLE.

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 PEICES 1 INCH MAXIMUM SIZE BY HARD BLOWS OF THE POINT OF A GEOLOGIST'S PICK.
SOFT	CAN BE GROVED 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

TERM	SPACING
VERY WIDE	MORE THAN 10 FEET
WIDE	3 TO 10 FEET
MODERATELY CLOSE	1 TO 3 FEET
CLOSE	0.16 TO 1 FOOT
VERY CLOSE	LESS THAN 0.16 FEET

BEDDING

TERM	THICKNESS
VERY THICKLY BEDDED	4 FEET
THICKLY BEDDED	1.5 - 4 FEET
THINLY BEDDED	0.16 - 1.5 FEET
VERY THINLY BEDDED	0.03 - 0.16 FEET
THICKLY LAMINATED	0.008 - 0.03 FEET
THINLY LAMINATED	< 0.008 FEET

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.

TERMS AND DEFINITIONS

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 (RQD) - 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 (SRQD) - 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.

BENCH MARK:

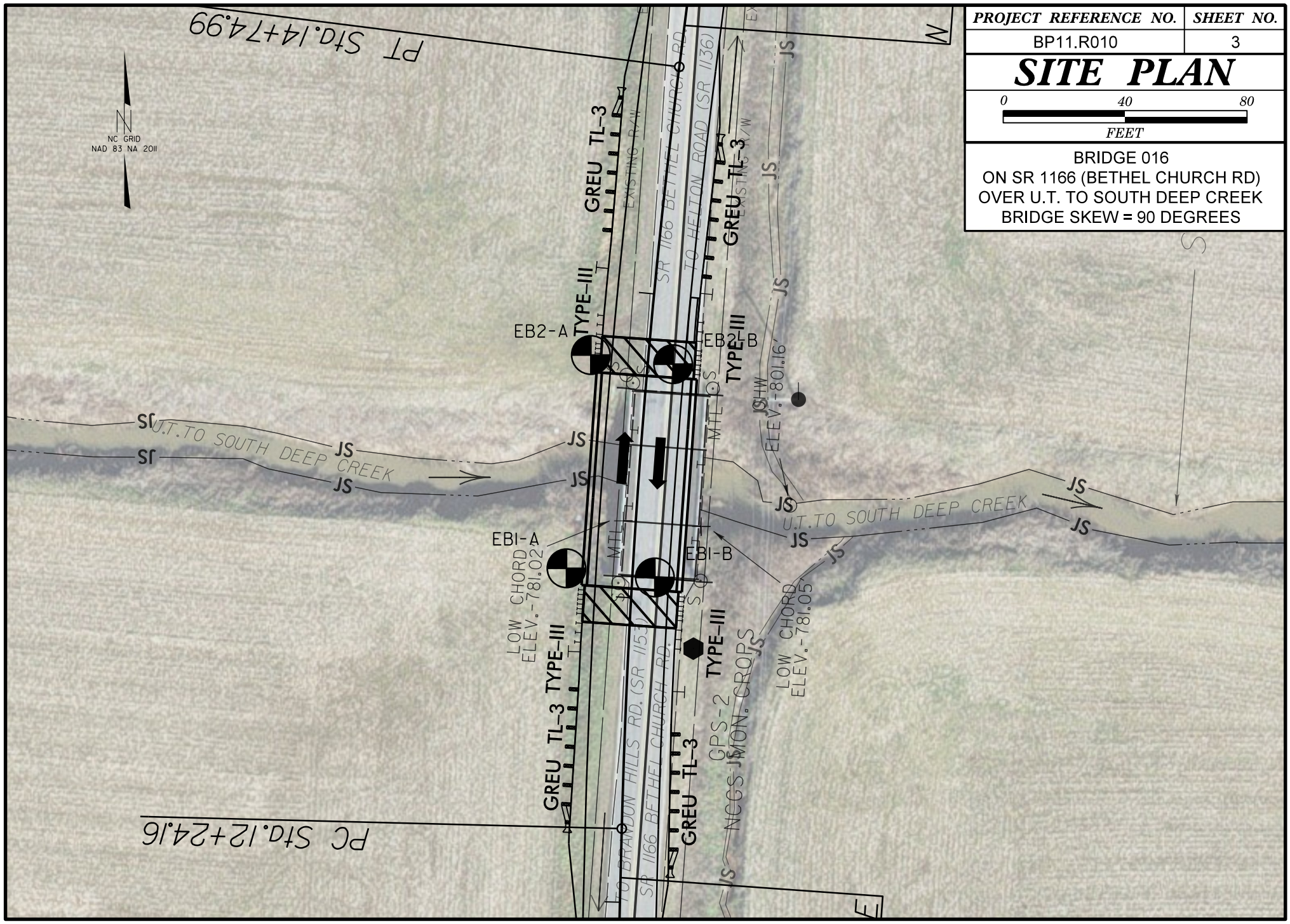
ELEVATION: FEET

NOTES:

NORTHING AND EASTINGS OBTAINED USING A TRIMBLE GEO7X BORING

FIAD = FILLED IN AFTER DRILLING

DATE: 8-15-14



GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	**TIP** NA	**COUNTY** YADKIN	**GEOLOGIST** B. Rogers
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek			**GROUND WTR (ft)**
BORING NO. EB1-A	**STATION** 13+08	**OFFSET** 22 ft LT	**ALIGNMENT** -L-	**0 HR.** N/A
COLLAR ELEV. 776.9 ft	**TOTAL DEPTH** 39.4 ft	**NORTHING** 858,246	**EASTING** 1,495,794	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic	
DRILLER Z. Burt	**START DATE** 05/16/22	**COMP. DATE** 05/16/22	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
780											
	776.9	0.0								776.9 GROUND SURFACE	0.0
775			2	2	2	4		M		Medium Stiff, Red-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica	
	773.4	3.5								773.9	3.0
			1	1	2	3		W		Soft, Orange-Red-Brown. Silty Fine to Coarse SAND (A-2-4), with trace mica	
	770.9	6.0								771.9	5.0
770			1	2	2	4		M		Medium Stif, Brown-Black, Clayey SILT (A-5), with trace mica	
	768.4	8.5									
			1	3	3	6		M			
765										764.9	12.0
	763.4	13.5								**ALLUVIAL** Very Loose to Loose, Black-Gray, Silty Fine to Coarse SAND (A-2-4), with trace mica	
			3	2	1	3		Sat.			
760											
	758.4	18.5									
			WOH	2	2	4		W			
755										754.9	22.0
	753.4	23.5								**RESIDUAL** Medium Dense, White-Tan-Orange, Silty Fine to Coarse SAND (A-2-4), with some mica	
			4	6	8	14		M			
750											
	748.4	28.5								747.9	29.0
			21	60	40/0.2	100/0.7				**WEATHERED ROCK** Tan-Black-White (GRANTIC ROCK)	
745											
	743.4	33.5									
			49	51/0.4		100/0.9					
740											
	738.4	38.5								737.5	39.4
			58	42/0.4		100/0.9				Boring Terminated at Elevation 737.5 ft In Weathered Rock (GRANTIC ROCK)	
										Surficial Organic Soil: 0.0 - 0.3 feet	

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	**TIP** NA	**COUNTY** YADKIN	**GEOLOGIST** B. Rogers
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek			**GROUND WTR (ft)**
BORING NO. EB1-B	**STATION** 13+07	**OFFSET** 7 ft RT	**ALIGNMENT** -L-	**0 HR.** N/A
COLLAR ELEV. 782.3 ft	**TOTAL DEPTH** 38.8 ft	**NORTHING** 858,243	**EASTING** 1,495,823	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Z. Burt	**START DATE** 05/16/22	**COMP. DATE** 05/16/22	**SURFACE WATER DEPTH** N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV. (ft) DEPTH (ft)
785										
	782.3	0.0								782.3 GROUND SURFACE 0.0
780			2	2	2	4		M		**ROADWAY EMBANKMENT** Soft to Medium Stiff, Orange-Brown, Silty CLAY (A-7-5), with trace rock fragments
	778.8	3.5	2	2	1	3		W		
	776.3	6.0								776.8 5.5
775			1	2	1	3		M		Soft, Orange-Brown. Fine to Coarse Sandy SILT (A-4), with trace mica
	773.8	8.5	WOH	1	1	2		W		
770										770.3 12.0
	768.8	13.5	2	1	2	3		W		**ALLUVIAL** Very Loose, Gray, Silty Fine to Coarse SAND (A-2-4)
765										
	763.8	18.5	1	1	2	3		Sat.		
760										760.3 22.0
	758.8	23.5	5	8	12	20		M		**RESIDUAL** Medium Dense, White-Brown-Gray, Silty Fine to Coarse SAND (A-2-4), with trace mica
755										
	753.8	28.5	51	49/0.2		100/0.7				753.8 28.5 **WEATHERED ROCK** White-Brown-Gray (GRANTIC ROCK)
750										
	748.8	33.5	34	60	40/0.2	100/0.7				
745										
	743.8	38.5	100/0.3			100/0.3				743.5 38.8 Boring Terminated at Elevation 743.5 ft In Weathered Rock (GRANTIC ROCK)

Note:
Borings were drilled in the roadway; however, pavement depths were not recorded.

NCDOT BORE SINGLE BRIDGE NO. 16.GPJ NC_DOT.GDT 8/7/23

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	**TIP** NA	**COUNTY** YADKIN	**GEOLOGIST** B. Rogers	
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek				**GROUND WTR (ft)**
BORING NO. EB2-A	**STATION** 13+78	**OFFSET** 19 ft LT	**ALIGNMENT** -L-	**0 HR.** N/A
COLLAR ELEV. 779.5 ft	**TOTAL DEPTH** 38.8 ft	**NORTHING** 858,316	**EASTING** 1,495,802	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic	
DRILLER Z. Burt	**START DATE** 05/16/22	**COMP. DATE** 05/16/22	**SURFACE WATER DEPTH** N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
780											
	779.5	0.0	3	2	3	5		M		779.5 GROUND SURFACE	0.0
										ROADWAY EMBANKMENT Soft to Medium Stiff, Brown-Orange. Fine to coarse Sandy SILT (A-4), with trace mica	
775	776.0	3.5	2	2	2	4		W			
	773.5	6.0	WOH	1	1	2		W		771.5	8.0
770	771.0	8.5	1	2	4	6		M		Medium Stiff, Brown, Silty CLAY (A-7-5)	
										767.5	12.0
765	766.0	13.5	2	2	2	4		Sat.		**ALLUVIAL** Loose, White-Gray, Coarse SAND (A-1-b)	
										762.5	17.0
760	761.0	18.5	WOH	1	5	6		W		Medium Stiff, Gray, Clayey SILT (A-5), with some mica	
										757.5	22.0
755	756.0	23.5	5	10	11	21		W		**RESIDUAL** Medium Dense, White-Gray, Silty Fine to Coarse SAND (A-2-4)	
750	751.0	28.5	28	49	51/0.3	100/0.8				750.5	29.0
										WEATHERED ROCK Brown-White (GRANTIC ROCK)	
745	746.0	33.5	26	46	54/0.4	100/0.9					
	741.0	38.5	100/0.3			100/0.3				740.7	38.8
										Boring Terminated at Elevation 740.7 ft In Weathered Rock (GRANTIC ROCK)	
										Surficial Organic Soil: 0.0 - 0.2 feet	

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	**TIP** NA	**COUNTY** YADKIN	**GEOLOGIST** B. Rogers
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek			**GROUND WTR (ft)**
BORING NO. EB2-B	**STATION** 13+78	**OFFSET** 8 ft RT	**ALIGNMENT** -L-	**0 HR.** N/A
COLLAR ELEV. 782.5 ft	**TOTAL DEPTH** 39.2 ft	**NORTHING** 858,313	**EASTING** 1,495,829	**24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Z. Burt	**START DATE** 05/16/22	**COMP. DATE** 05/16/22	**SURFACE WATER DEPTH** N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION ELEV. (ft)	DEPTH (ft)
785											
	782.5	0.0								782.5 GROUND SURFACE	0.0
780			2	4	3	7		M		**ROADWAY EMBANKMENT** Medium Stiff, Red-Orange-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica and rock fragments	
	779.0	3.5	1	2	3	5		W		777.0	5.5
	776.5	6.0								Soft, Brown, Clayey SILT (A-5), with trace mica	
775			2	1	2	3		W		774.5	8.0
	774.0	8.5	1	2	2	4		W		Medium Stiff, Brown-Orange, Silty CLAY (A-7-5), with trace mica	
770										770.5	12.0
	769.0	13.5	2	2	3	5		Sat.		**ALLUVIAL** Loose to Medium Dense, Gray-Brown, Silty Fine to Coarse SAND (A-2-4), with trace mica	
765											
	764.0	18.5	3	6	6	12		Sat.			
760										760.5	22.0
	759.0	23.5	5	6	6	12		W		**RESIDUAL** Medium Dense, White-Brown-Gray, Silty Fine to Coarse SAND (A-2-4), with some mica	
755											
	754.0	28.5	37	51	49/0.4	100/0.9				753.5	29.0
750										**WEATHERED ROCK** White-Brown-Gray (GRANTIC ROCK)	
	749.0	33.5	24	35	65	100/1.0					
745											
	744.0	38.5	34	66/0.2		100/0.7				743.3	39.2
										Boring Terminated at Elevation 743.3 ft In Weathered Rock (GRANTIC ROCK)	

Note:
Borings were drilled in the roadway; however, pavement depths were not recorded.

REPLACE BRIDGE No. 016 ON SR 1166 (BETHEL CHURCH ROAD) OVER UT TO SOUTH DEEP CREEK

SUPPORTING DOCUMENTATION

BRIDGE SURVEY & HYDRAULIC DESIGN REPORT

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

State Proj. Reference No. SF-980016 WBS Project No. BP11.R010 Proj. Station 13+38

County YADKIN Bridge Over UT TO SOUTH DEEP CREEK Bridge Inv. No. 016

On Highway SR 1166 (BETHEL CHURCH ROAD) Between SR 1136 (HELTON ROAD) and (SR 1153) BRANDON HILLS ROAD

Recommended Structure 1 @ 70' 24" CORED SLAB BRIDGE W/4' CAPS; OREGON RAIL

Recommended Width of Roadway 29'-7" CLEAR ROADWAY Skew 90°

Recommended Location is (Up, At, Down) Stream from Existing Crossing. AT EXISTING

Longitude 36.09627 Latitude -80.70657

Statewide Tier ☐ Regional Tier ☐ Sub-Regional Tier ☒

Bench Mark is BM #1: NAIL IN TRIPLE MAPLE; -L- 10+45.21,38.83 LT.

Northing 857984 Easting 1495770 Elev. 781.27 ft. Datum: NAVD88

Temporary Crossing STAGED CONSTRUCTION

Designed by: BRADLEY S. RIDNOUR, PE

Assisted by: ARTHUR WILLIAMS

Date 6/6/2023 | 1:54:49 PM EDT

NORTH CAROLINA PROFESSIONAL SEAL 033023 ENGINEER BRADLEY S. RIDNOUR

DocuSigned by: Bradley S Ridnour, PE 6/6/2023 | 1:54:49 PM EDT

QA Review by: Date

Vaughn & Melton Consulting Engineers

Drainage Area 9.6 SQ MI Source LONE HICKORY QUADRANGLE

River Basin YADKIN PEE-DEE Character RURAL

Stream Classification (Such as Trout, High Quality Water, etc.) WS-III

Data on Existing Structure 1@18'-5",1@25'-0",1@18'-5"; OAL 62' TIMBER FLOOR ON TIMBER JOISTS; E.BTS:TIM.CAPS/TIM.POST&CONC.SILLS;CRUTCH BT:ALL TIM.P&S Total Waterway Opening 402 s.f.

Debris Potential: Low Moderate X High Waterway Opening Below 100yr. WS EL. 402 s.f.

Data on Structures Up and Down Stream

DOWNSTREAM: CONFLUENCE WITH SOUTH DEEP CREEK

UPSTREAM: 2 @ 66" RCP ON MERRY ACRES LANE

Design Control Elev. 783.48 ft. (100-YEAR CORRECTED EFFECTIVE @ RS 4574)

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:

Date 2020 Elev. 780.3 ft. Est. Freq. 10 yr. Source Gary Robbins, NCDOT Bridge Maintenance Supervisor Period of Knowledge 30 yrs.

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Date Elev. ft. Est. Freq. yr. Source Period of Knowledge yrs.

Historical Scour Info: General ft. Contraction ft. Local ft.

Channel Slope N/A ft/ft Source N/A Normal Water Surface Elev. 770.3 ft.

Manning's n: Left O.B. 0.070-0.130 Channel 0.050 Right O.B. 0.070-0.130 Source FIS

Flood Study /Status LIMITED DETAIL (FIS EFFECTIVE 05/18/2009)

Flood Study 100yr. Discharge 5776 c.f.s. WS Elev.: With Non-Encroachment 783.65 ft. Without Non-Encroachment 783.17 ft. @ River Station 4574

DESIGN DATA

Hydrological Method Scientific Investigations Report 2009-5158

Hydraulic Design Method HEC-RAS ver. 6.3.0 (SF-908016 UT DEEP SOUTH CRK SR 1166)

@ River Station 4574	Floods Evaluated: Freq. (yr.)	Q (c.f.s)	Elev. (ft.)	Backwater (ft.)	Bridge Opening Velocity (f.p.s.)
	100 (FEMA)	5776	783.79	1.8	9.0
	10	1600	780.0	0.9	4.5
	25 (DESIGN)	2100	781.4	1.8	5.5
	50	2600	781.6	1.6	6.8
	100 (OT)	3000	781.6	1.3	7.9
	500	4000	783.2	2.2	7.6

Waterway Opening Provided Below: Design W.S. Elev. 377 s.f., 100yr W.S. Elev. 381 s.f., Total 381 s.f.,

Average Channel Velocity (Design) 9.2 f.p.s. Average Overbank Velocity (Design) 4.8 f.p.s.

Computed Scour : General — ft. Contraction Ys=2.3 ft. Local — ft.

State Floodway Compliance Type SFC A (0.29 FT INCREASE @ RS 4574)

INFORMATION TO BE SHOWN ON PLANS

HYDRAULIC DATA	
DESIGN DISCHARGE	= 2100 C.F.S.
FREQUENCY OF DESIGN FLOOD	= 25 YRS.
DESIGN HIGH WATER ELEVATION	= 781.4
DRAINAGE AREA	= 9.6 SQ. MI.
BASIC DISCHARGE (Q100)	= 3000 C.F.S.
BASIC HIGH WATER ELEVATION	= 781.6
OVERTOPPING FLOOD DATA	
OVERTOPPING DISCHARGE	= 3000 C.F.S.
FREQUENCY OF OVERTOPPING FLOOD	= 100 YRS.
OVERTOPPING FLOOD ELEVATION	= 781.6*

*AT SAG PT NEAR STATION 15+25

WS EL. Taken @ River Station 4574

ADDITIONAL INFORMATION AND COMPUTATIONS

HYDROLOGIC REGION =1; DRAINAGE AREA = 9.6 SQ MI

RURAL RIDGE and VALLEY-PIEDMONT
SIR 2009-5158

Q_{10} = 398 (DA)$^{0.617}$ = 1610 => 1600

Q_{25} = 537 (DA)$^{0.606}$ = 2120 => 2100

Q_{50} = 661 (DA)$^{0.600}$ = 2570 => 2600

Q_{100} = 776 (DA)$^{0.594}$ = 2980 => 3000

Q_{500} = 1,072 (DA)$^{0.583}$ = 4010 => 4000

FEMA DISCHARGES

Q_{100} = 5576

NOTE: REGRESSION EQUATIONS USED FOR NCDOT DESIGN. FIS DISCHARGES USED FOR FEMA COMPLIANCE.

SCOUR ANALYSIS

100-YEAR CONTRACTION SCOUR (PRESSURE EQN.)

Y2 = Y1[(Q2/Q1)^(6/7)*(W1/W2)^(K1)]-Yo

Y2 = 11.92[(2158.01/803.32)^(6/7)*(17.8/66.75)^(0.69)]

Y2 = 11.17

t = 0.5*[(Hb-Ht)/hu^2]^0.2*[1-(Hw/Ht)]^0.1*Hb

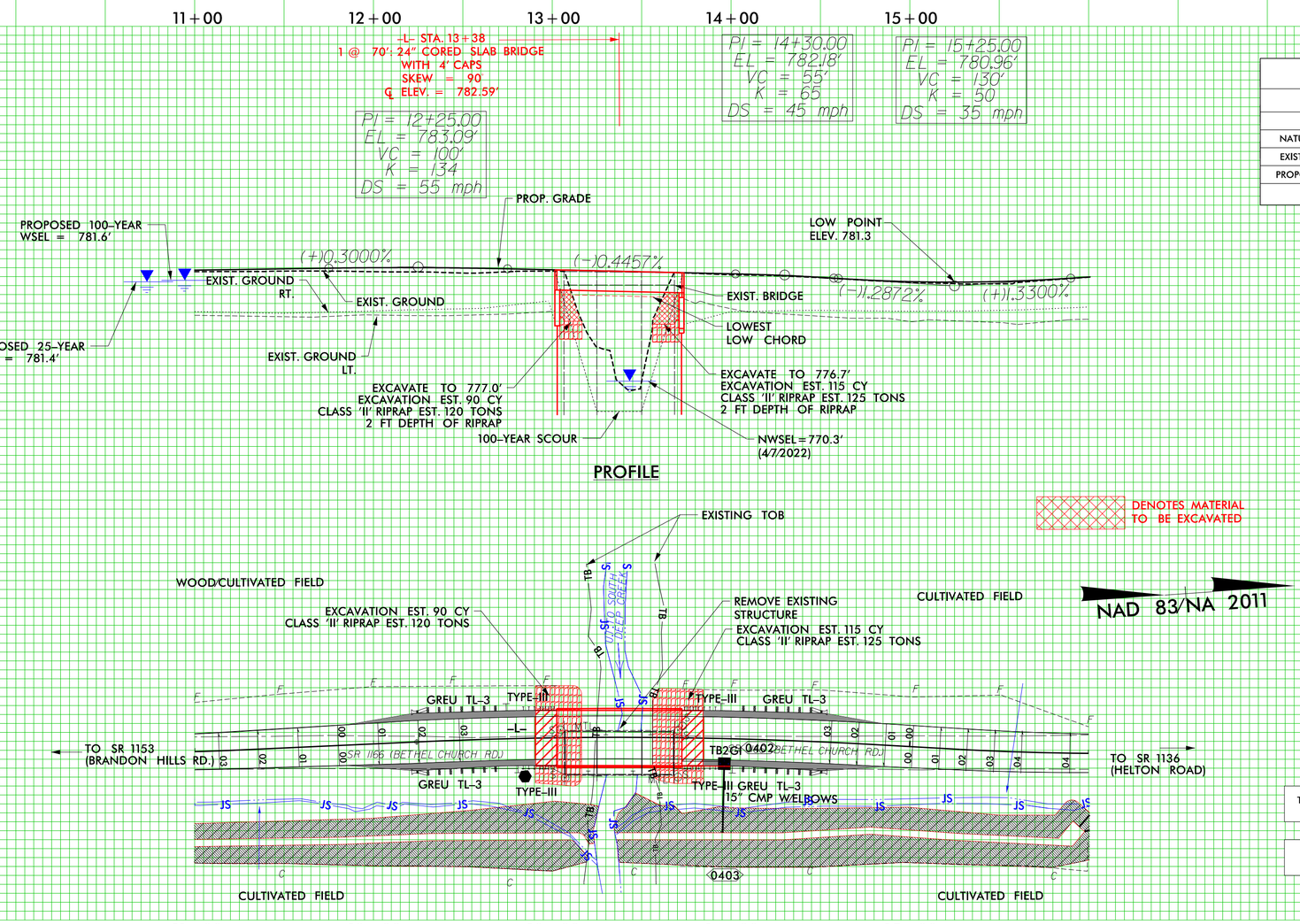
t = 0.5*[(12.02-2)/11.92^2]^0.2*[1-(0/2)]^0.1*11.92

t = 3.14

Ys = Y2+t-Hb

Ys = 11.17+3.14-12.02

Ys = 2.29



NCDOT PERFORMANCE TABLE

	FREQUENCY				
	10yr.	25yr.	50yr.	100yr.	500yr.
NATURAL	779.1	779.6	780.0	780.4	781.0
EXISTING	780.3	781.5	781.7	782.0	782.6
PROPOSED	780.0	781.4	781.6	781.6	783.2

@SECTION 4574
65.5 FT. FROM US FACE OF BRIDGE

FEMA PERFORMANCE TABLE

	100yr.
DUPLICATE EFFECTIVE	783.17
CORRECTED EFFECTIVE	783.48
REVISED	783.79

@SECTION 4574
65.5 FT. FROM US FACE OF BRIDGE

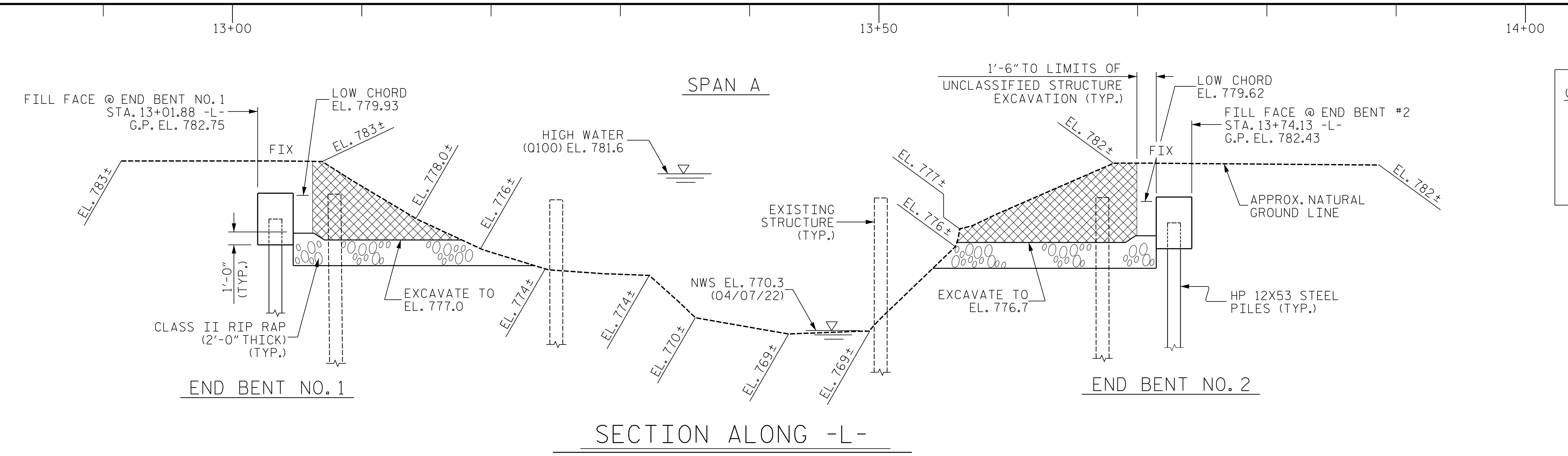
SPREAD ANALYSIS

@ STA. 13+95 RT
DA= 0.05
I= 4.0
C= 0.9
Q= 0.19
LONGITUDINAL SLOPE= 0.0045 ft/ft
CROSS SLOPE= 0.03 ft/ft
SHOULDER WIDTH= 3.4 FT.
SPREAD= 3.4 FT.

NO DECK DRAINS REQUIRED

THIS PROJECT COMPLIES WITH LOCAL FLOODPLAIN MANAGEMENT REGULATIONS.

NO STRUCTURES WILL BE ADVERSELY AFFECTED BY THIS PROJECT



SECTION ALONG -L-

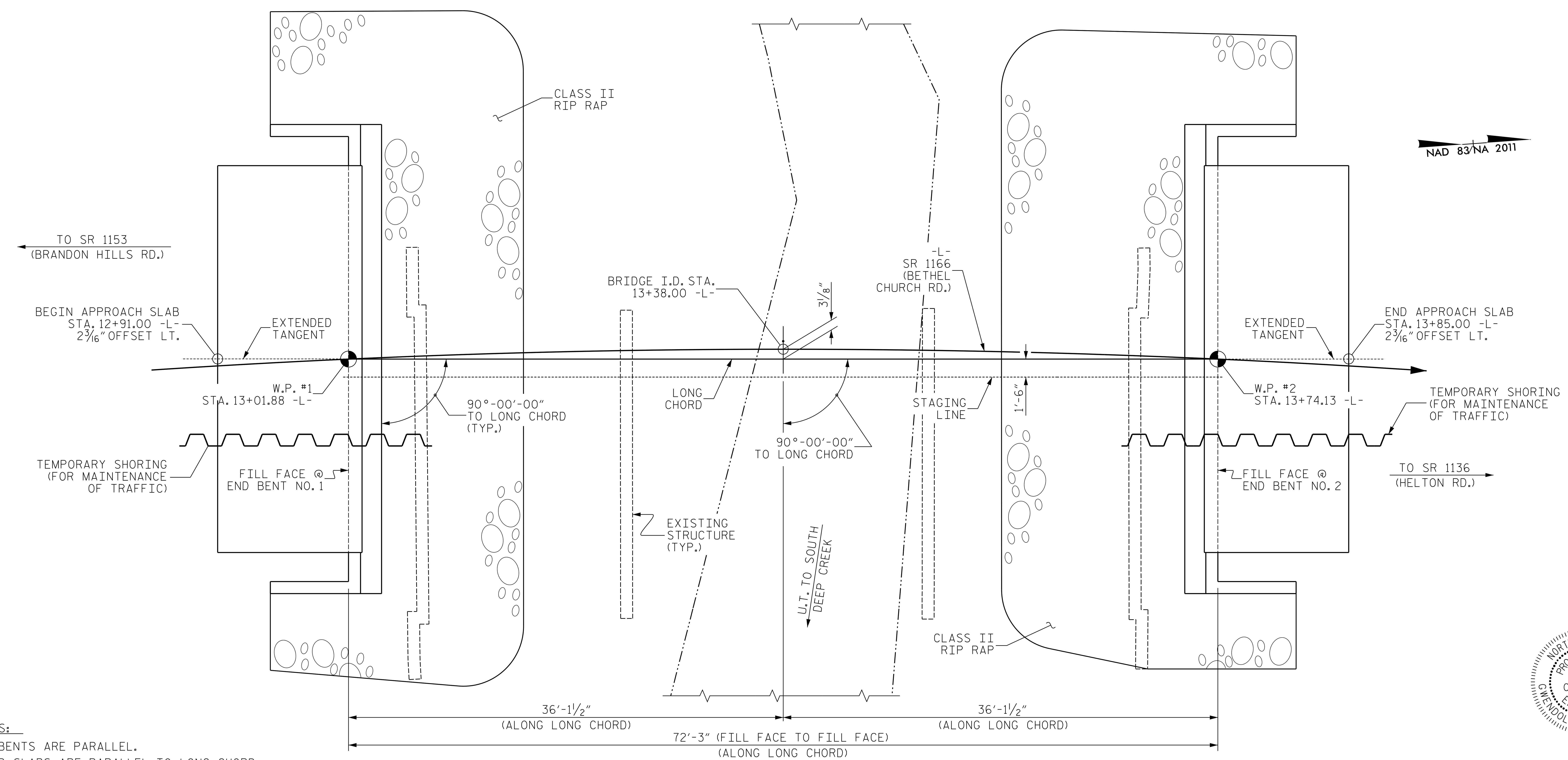
(+) 0.3000%	(-) 0.4457%	(-) 1.2872%
PI = 12+25.00 -L- EL = 783.09' VC = 100'		PI = 14+30.00 -L- EL = 782.18' VC = 55'

GRADE DATA -L-

UNCLASSIFIED STRUCTURE EXCAVATION

PI STA. 13+49.68
△ = 5°-44'-54.4" (RT)
D = 2°-17'-30.6"
L = 250.82'
T = 125.52'
R = 2500.00'

HORIZ. CURVE DATA -L-



PLAN

NOTES:

END BENTS ARE PARALLEL.
CORED SLABS ARE PARALLEL TO LONG CHORD.
HP PILES NOT SHOWN IN PLAN FOR CLARITY.

I HEREBY CERTIFY THAT THESE PLANS ARE THE AS-BUILT PLANS.

PROJECT NO. BP11.R010
YADKIN COUNTY
STATION: 13+38.00 -L-

SHEET 1 OF 2 REPLACES BRIDGE #980016

NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 045282 GWENDOLEN F. WILSON

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

GENERAL DRAWING

FOR BRIDGE OVER
U.T. TO SOUTH DEEP CREEK ON
SR 1166 (BETHEL CHURCH RD.)
BETWEEN SR 1153 AND SR 1136

DOCUMENT NOT CONSIDERED FINAL UNLESS ALL SIGNATURES COMPLETED

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License No: C-3097

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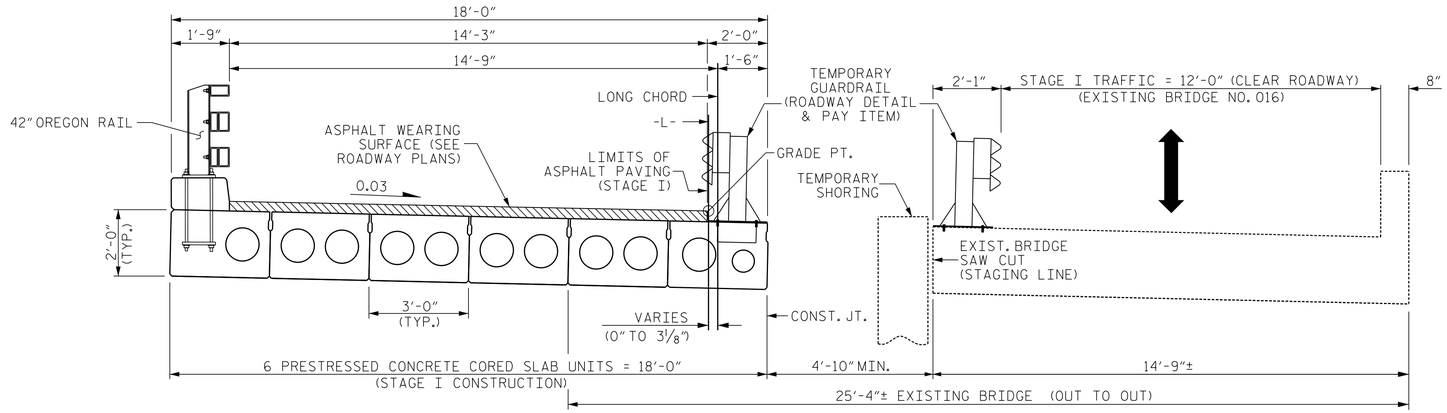
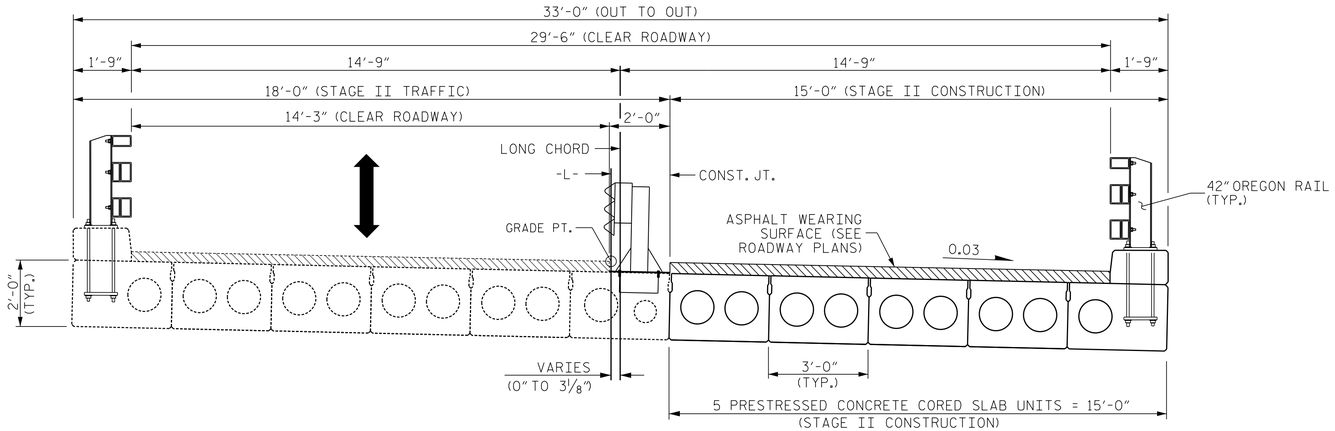
NO.	BY:	DATE:		NO.	BY:	DATE:		S-1
1				3				TOTAL SHEETS
2				4				24

DWN. BY: GWP	DATE: 07/2023
CHKD. BY: WDC	DATE: 07/2023
DES. EGR. OF RECORD: GWP	DATE: 07/2023

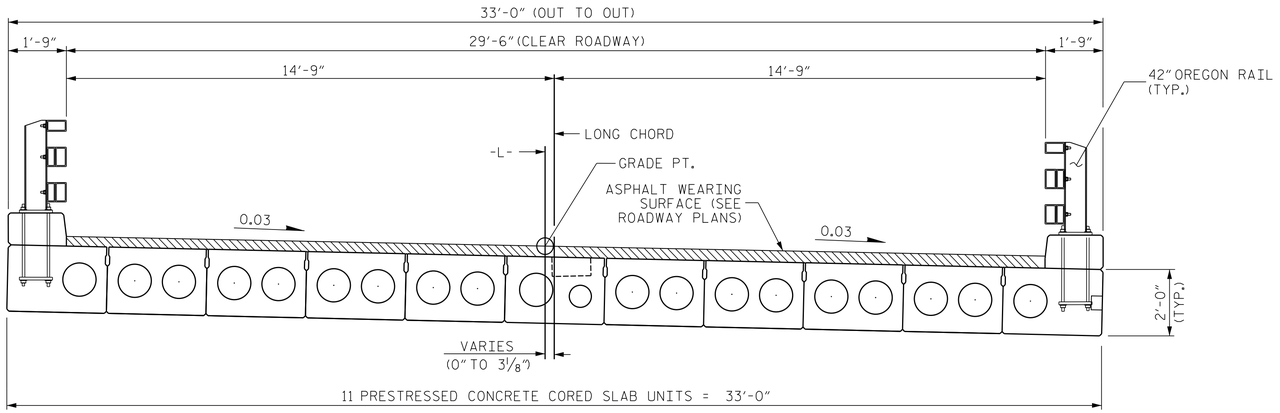
gwdowell
pw:\\jmt-pw.bentley.com:jmt-pw-01\Documents\Projects\2022\22-03163-001\03224-02\Structures\STR000\Plans\40_001_BP11_R010_SMU_S001_001.dgn
02:09 PM on Monday, September 11, 2023



STAGE I CONSTRUCTION



STAGE II CONSTRUCTION



FINAL TYPICAL SECTION

NOTES

FOR PHASING OF TRAFFIC AND OTHER DETAILS, SEE TRAFFIC MANAGEMENT PLANS.

STAGING SEQUENCE

1) SHIFT TRAFFIC TO THE RIGHT SIDE OF EXISTING BRIDGE.
2) SAW CUT AND REMOVE LEFT SIDE OF EXISTING BRIDGE, IN CONJUNCTION WITH PLACING TEMPORARY SHORING.
3) CONSTRUCT STAGE I OF PROPOSED BRIDGE.
4) SHIFT TRAFFIC TO STAGE I OF PROPOSED BRIDGE.
5) REMOVE REMAINING PORTION OF EXISTING BRIDGE, AND TEMPORARY SHORING.
6) CONSTRUCT STAGE II OF PROPOSED BRIDGE.
7) OPEN PROPOSED BRIDGE TO FULL TRAFFIC.

PROJECT NO. BP11.R010
YADKIN COUNTY
STATION: 13+38.00 -L-

NORTH CAROLINA PROFESSIONAL SEAL 045282 ENGINEER GWENDOLEN F. WILSON

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

CONSTRUCTION SEQUENCE

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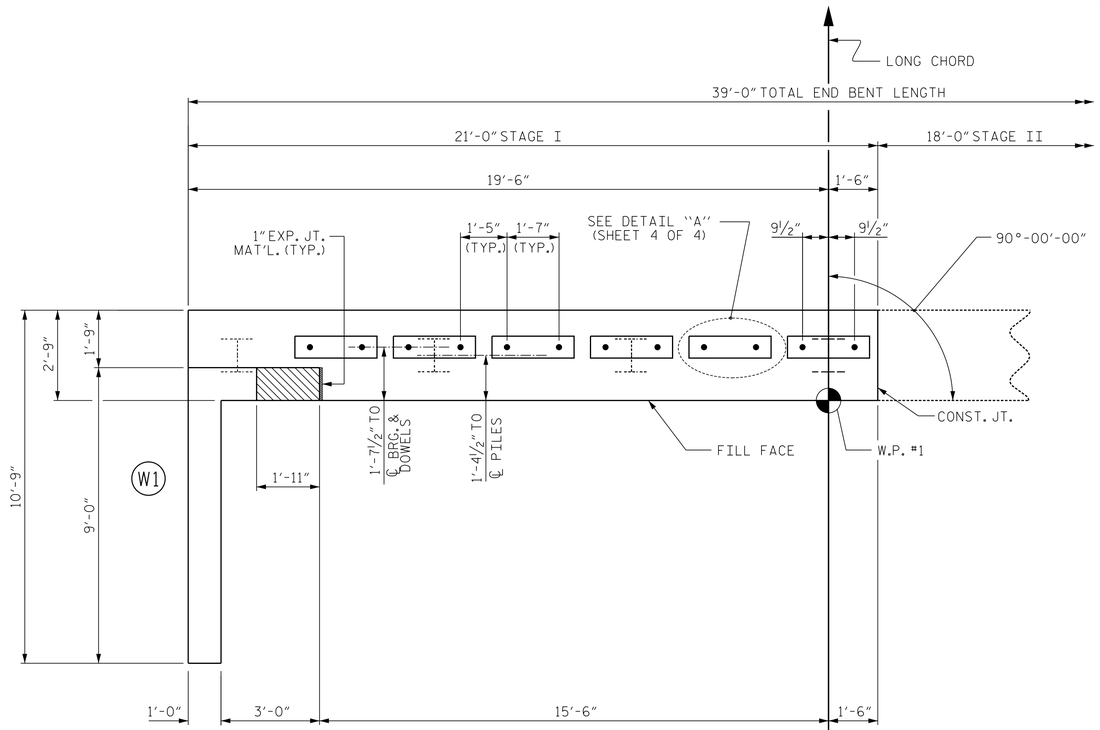
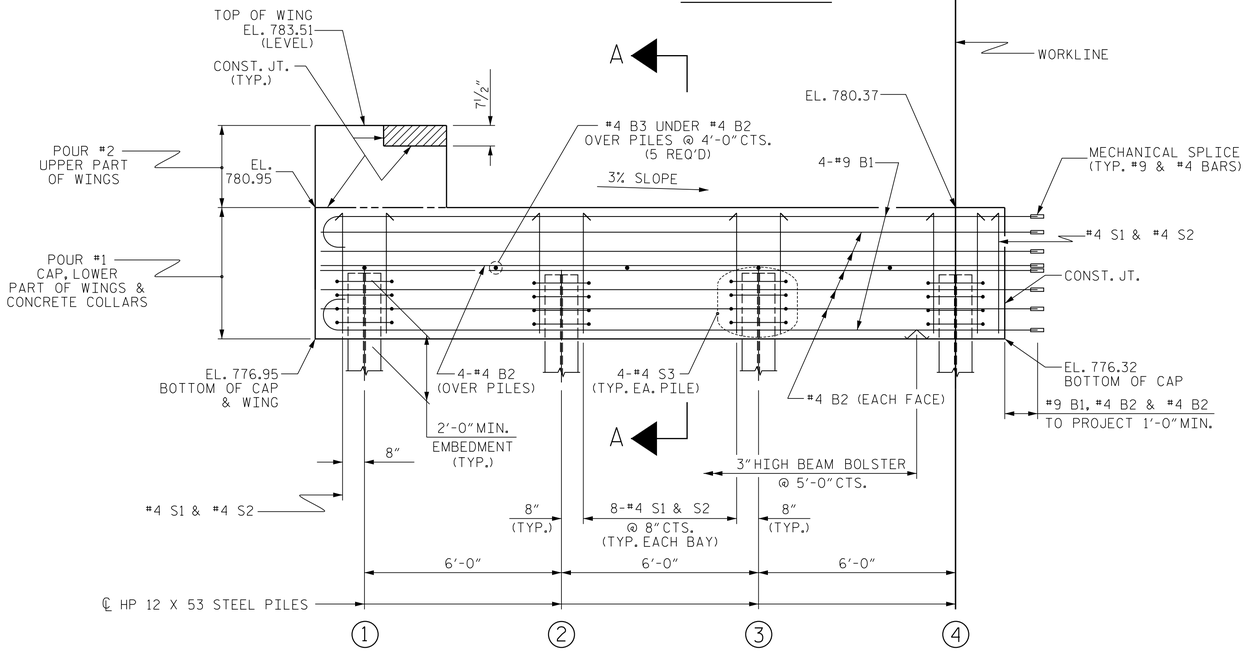
1			3			TOTAL SHEETS
2			4			24

DWN. BY: GWP DATE: 07/2023
CHKD. BY: WDC DATE: 07/2023
DES. EGR. OF RECORD: GWP DATE: 07/2023



PLAN



ELEVATION

WINGS NOT SHOWN FOR CLARITY.
FOR SECTION A-A, SEE SHEET 4 OF 4.
CONCRETE COLLARS FOR STEEL PILES NOT SHOWN IN PLAN AND ELEVATION VIEWS FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL", SHEET 4 OF 4.

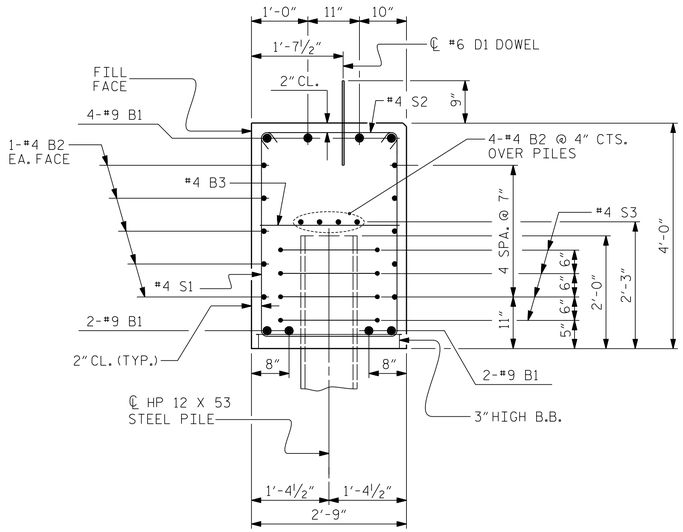
NOTES

STIRRUPS IN CAP MAY BE SHIFTED AS NECESSARY TO CLEAR DOWELS.

THE CONCRETE IN THE SHADED AREA OF THE WING SHALL BE POURED AFTER THE OREGON RAIL CONCRETE CURB IS CAST IF SLIP FORMING IS USED.

FOR PILE SPLICE DETAILS, SEE SHEET 4 OF 4.

FOR WING DETAILS, SEE SHEET 3 OF 4.



SECTION A-A

(CONCRETE COLLAR NOT SHOWN FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL.")

TOP OF PILE ELEVATIONS	
①	778.91
②	778.73
③	778.55
④	778.37

PROJECT NO. BP11.R010
YADKIN COUNTY
STATION: 13+38.00 -L-

SHEET 1 OF 4

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

SUBSTRUCTURE

END BENT No. 1
(STAGE I)

NORTH CAROLINA PROFESSIONAL SEAL 045282 ENGINEER GWENDOLEN F. WILSON

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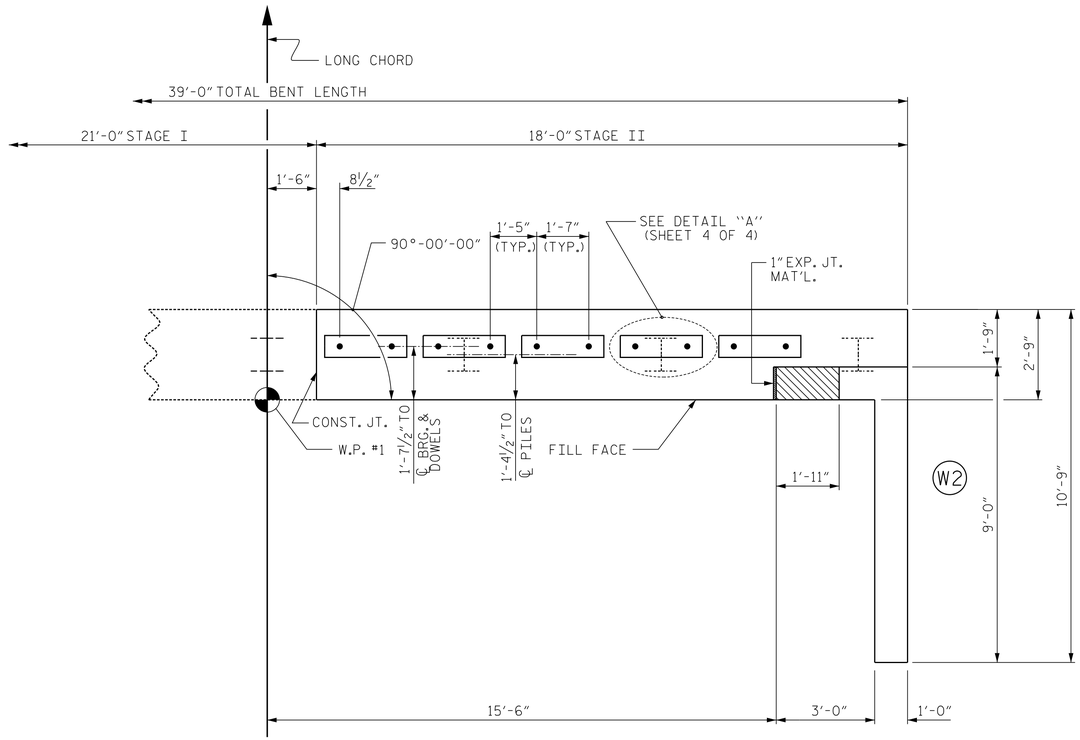
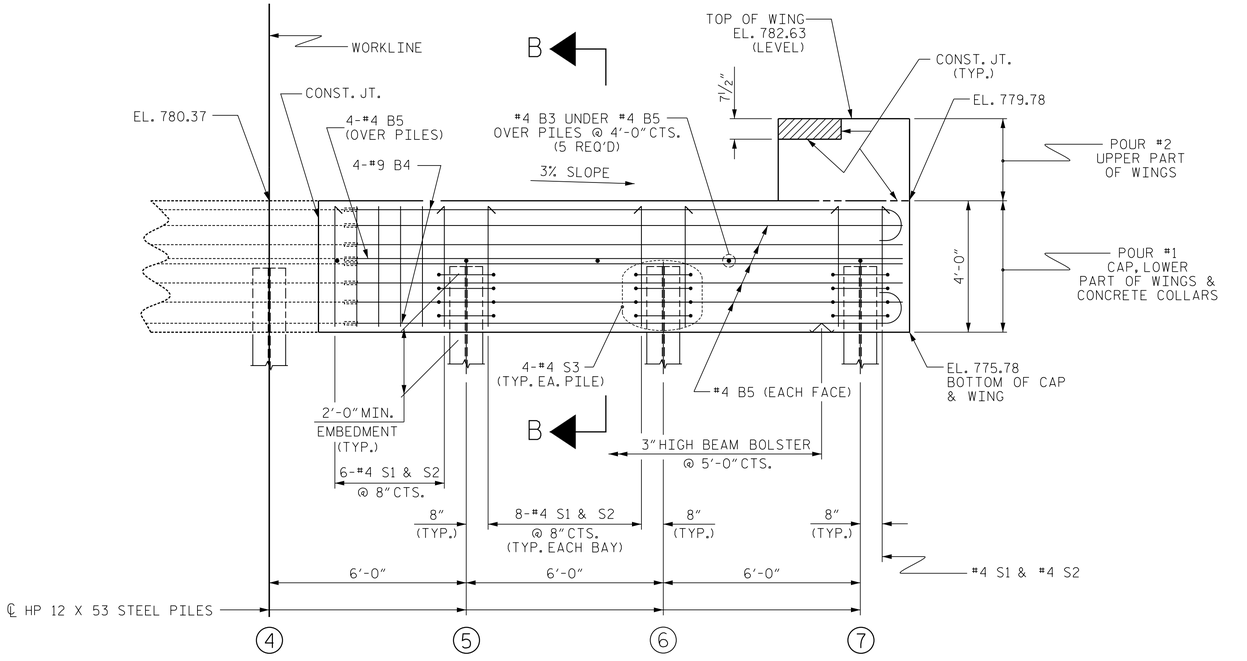
1			3			TOTAL SHEETS
2			4			24

DWN. BY: GWP	DATE: 07/2023	DRAWN BY : WJH 12/11	REV. 4/15 MAA/TMG	
CHKD. BY: WDC	DATE: 07/2023	CHECKED BY : AAC 12/11		
DES. EGR. OF RECORD: GWP	DATE: 07/2023			

STD. NO. EB_33_90S4

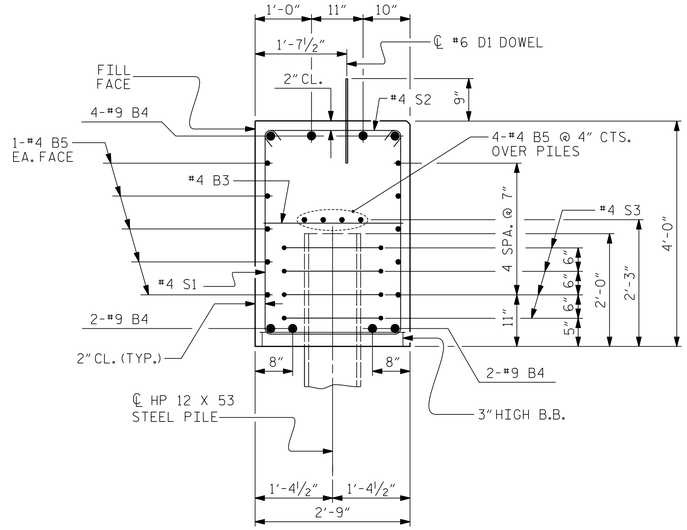


PLAN



ELEVATION

WINGS NOT SHOWN FOR CLARITY.
FOR SECTION A-A, SEE SHEET 4 OF 4.
CONCRETE COLLARS FOR STEEL PILES NOT SHOWN IN PLAN AND ELEVATION VIEWS FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL", SHEET 4 OF 4.



SECTION B-B

(CONCRETE COLLAR NOT SHOWN FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL.")

NOTES

STIRRUPS IN CAP MAY BE SHIFTED AS NECESSARY TO CLEAR DOWELS.

THE CONCRETE IN THE SHADED AREA OF THE WING SHALL BE POURED AFTER THE OREGON RAIL CONCRETE CURB IS CAST IF SLIP FORMING IS USED.

FOR PILE SPLICE DETAILS, SEE SHEET 4 OF 4.

FOR WING DETAILS, SEE SHEET 3 OF 4.

TOP OF PILE ELEVATIONS	
⑤	778.19
⑥	780.01
⑦	777.83

PROJECT NO. BP11.R010
YADKIN COUNTY
STATION: 13+38.00 -L-

SHEET 2 OF 4

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

SUBSTRUCTURE

END BENT No. 1
(STAGE II)

NORTH CAROLINA PROFESSIONAL SEAL 045282 ENGINEER GWENDOLEN F. WILSON

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NO.	BY:	DATE:	NO.	BY:	DATE:	S-16
1			3			TOTAL SHEETS
2			4			24

DWN. BY: GWP	DATE: 07/2023	DRAWN BY : WJH 12/11	REV. 4/15 MAA/TMG
CHKD. BY: WDC	DATE: 07/2023	CHECKED BY : AAC 12/11	
DES. EGR. OF RECORD: GWP	DATE: 07/2023		

gwpowell
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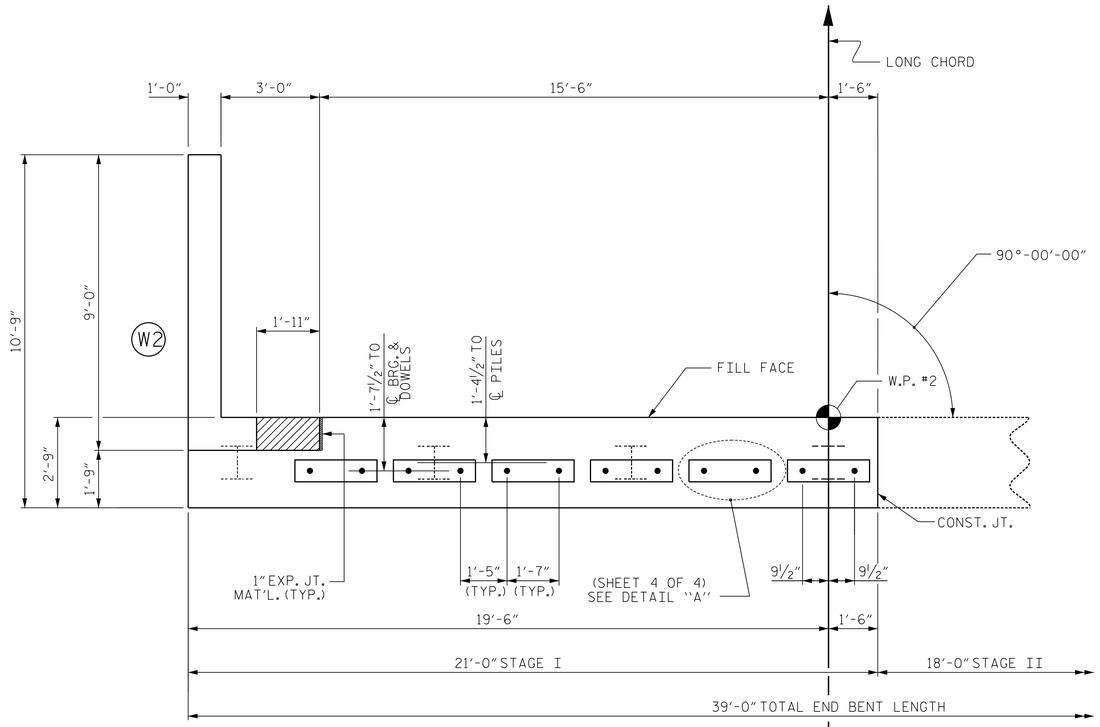
TIME: 02:50 PM on Monday, September 11, 2023

STD. NO. EB_33_90S4



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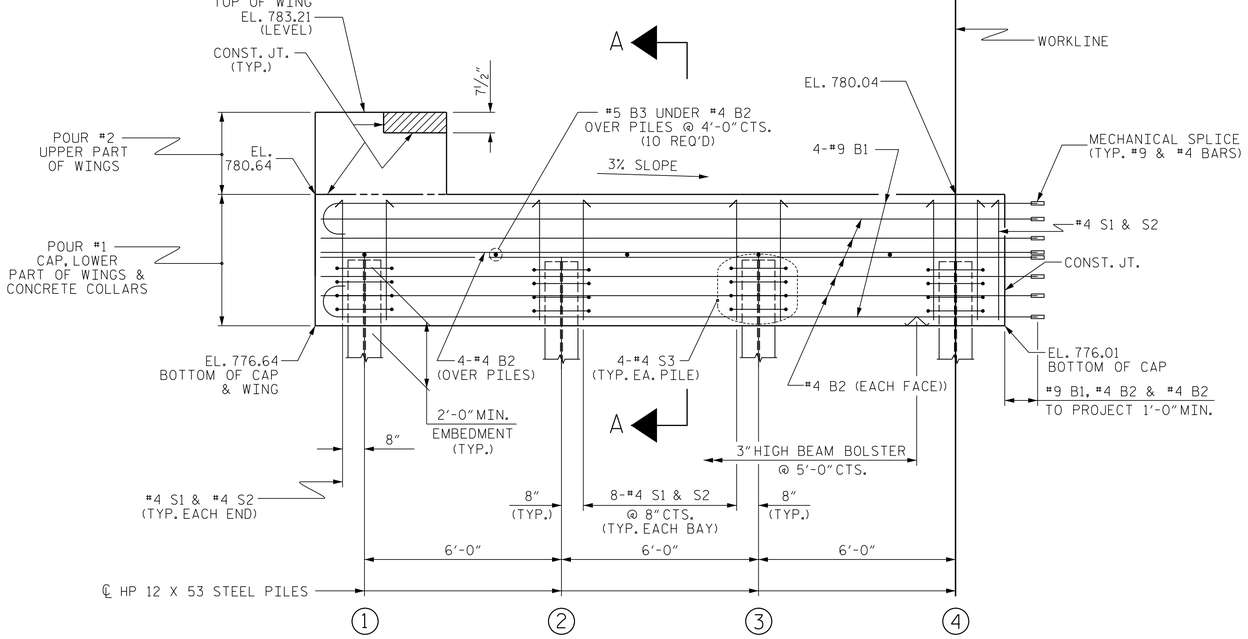


ELEVATION

WINGS NOT SHOWN FOR CLARITY.
FOR SECTION A-A, SEE SHEET 4 OF 4.
CONCRETE COLLARS FOR STEEL PILES NOT SHOWN IN PLAN AND ELEVATION VIEWS FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL", SHEET 4 OF 4.

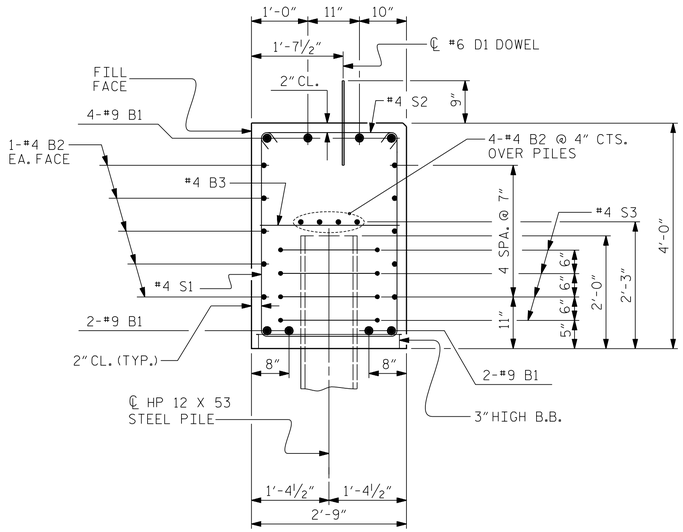
NOTES

STIRRUPS IN CAP MAY BE SHIFTED AS NECESSARY TO CLEAR DOWELS.

THE CONCRETE IN THE SHADED AREA OF THE WING SHALL BE POURED AFTER THE OREGON RAIL CONCRETE CURB IS CAST IF SLIP FORMING IS USED.

FOR PILE SPLICE DETAILS, SEE SHEET 4 OF 4.

FOR WING DETAILS, SEE SHEET 3 OF 4.



SECTION A-A

(CONCRETE COLLAR NOT SHOWN FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL.")

TOP OF PILE ELEVATIONS	
①	778.60
②	778.42
③	778.24
④	778.06

PROJECT NO. BP11.R010
YADKIN COUNTY
STATION: 13+38.00 -L-

SHEET 1 OF 4

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

SUBSTRUCTURE

END BENT No. 2
(STAGE I)

NORTH CAROLINA PROFESSIONAL SEAL 045282 ENGINEER GWENDOLEN F. WILSON

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1			3			TOTAL SHEETS
2			4			24

DWN. BY: GWP	DATE: 07/2023	DRAWN BY : WJH 12/11	REV. 4/15 MAA/TMG
CHKD. BY: WDC	DATE: 07/2023	CHECKED BY : AAC 12/11	
DES. EGR. OF RECORD: GWP	DATE: 07/2023		

DGN: bwx\\jmt-pw.bentley.com:jmt-pw-01\Documents Pro Iects\2022\22-03613-000\32241-02\Structures\STR000\Plans\R01_L05T_BP11R010_SMU_EB21_093.dgn
TIME: 08:50 PM on Monday, September 11, 2023

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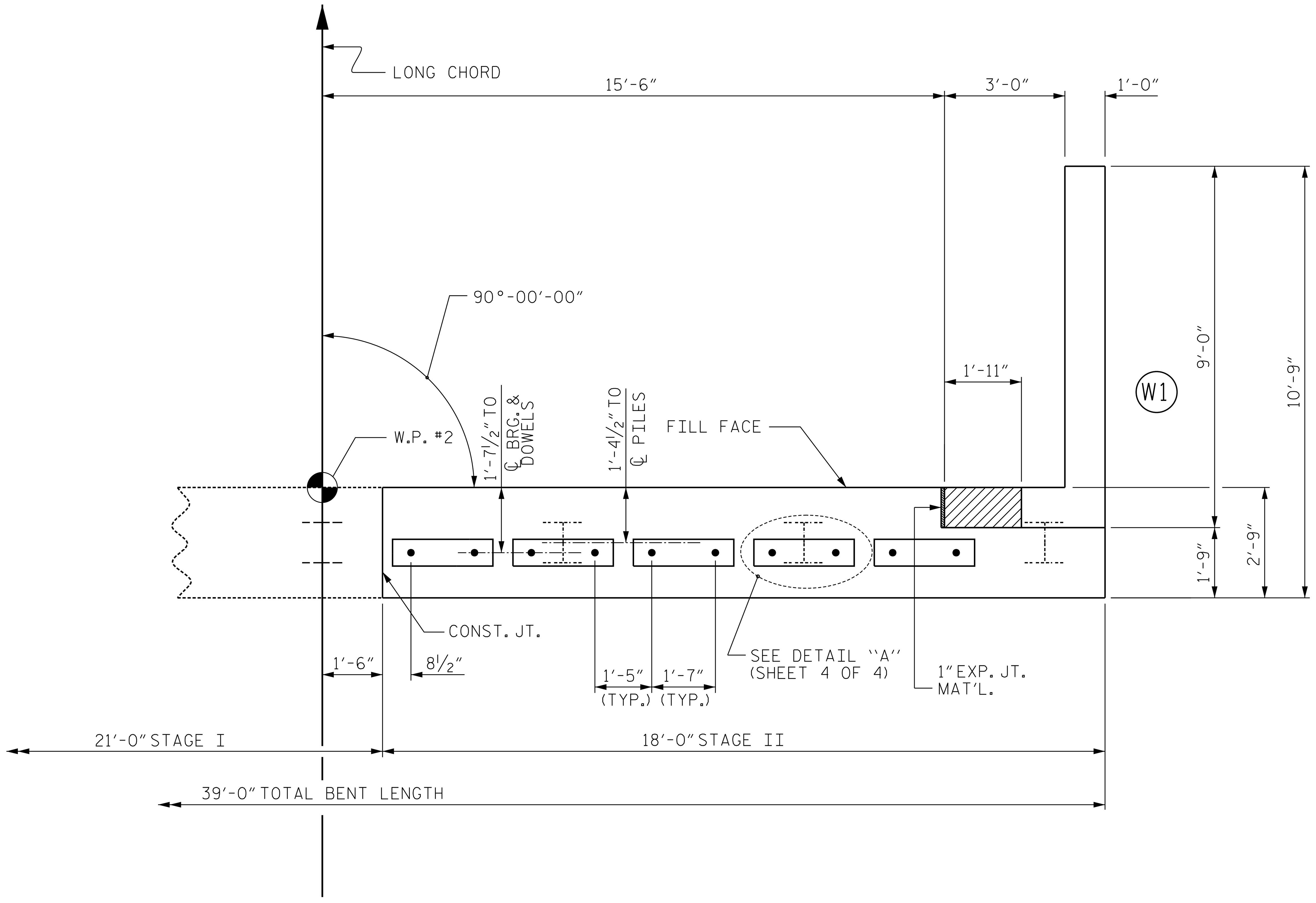
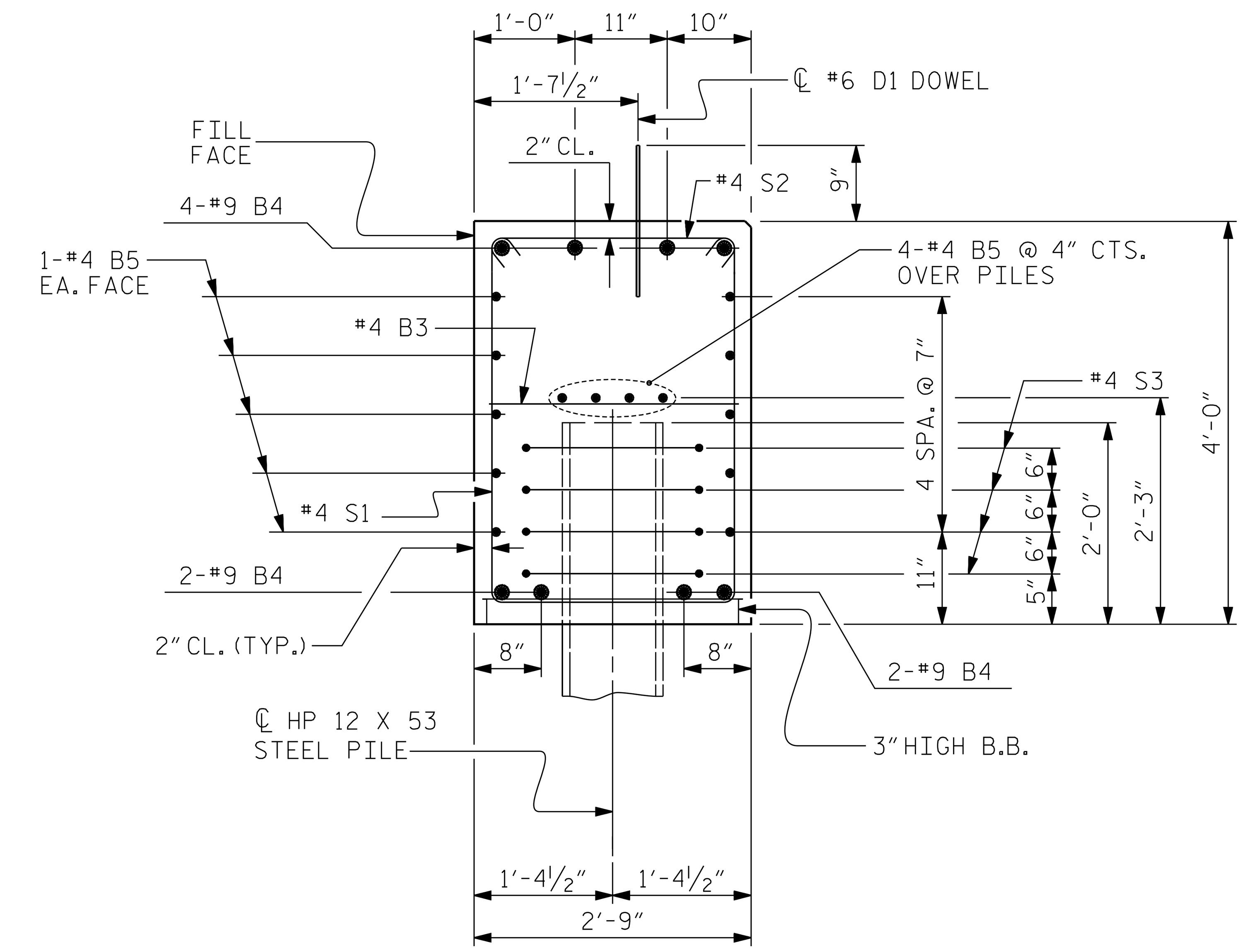


PLAN



SECTION B-B

(CONCRETE COLLAR NOT SHOWN FOR CLARITY. SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL.")

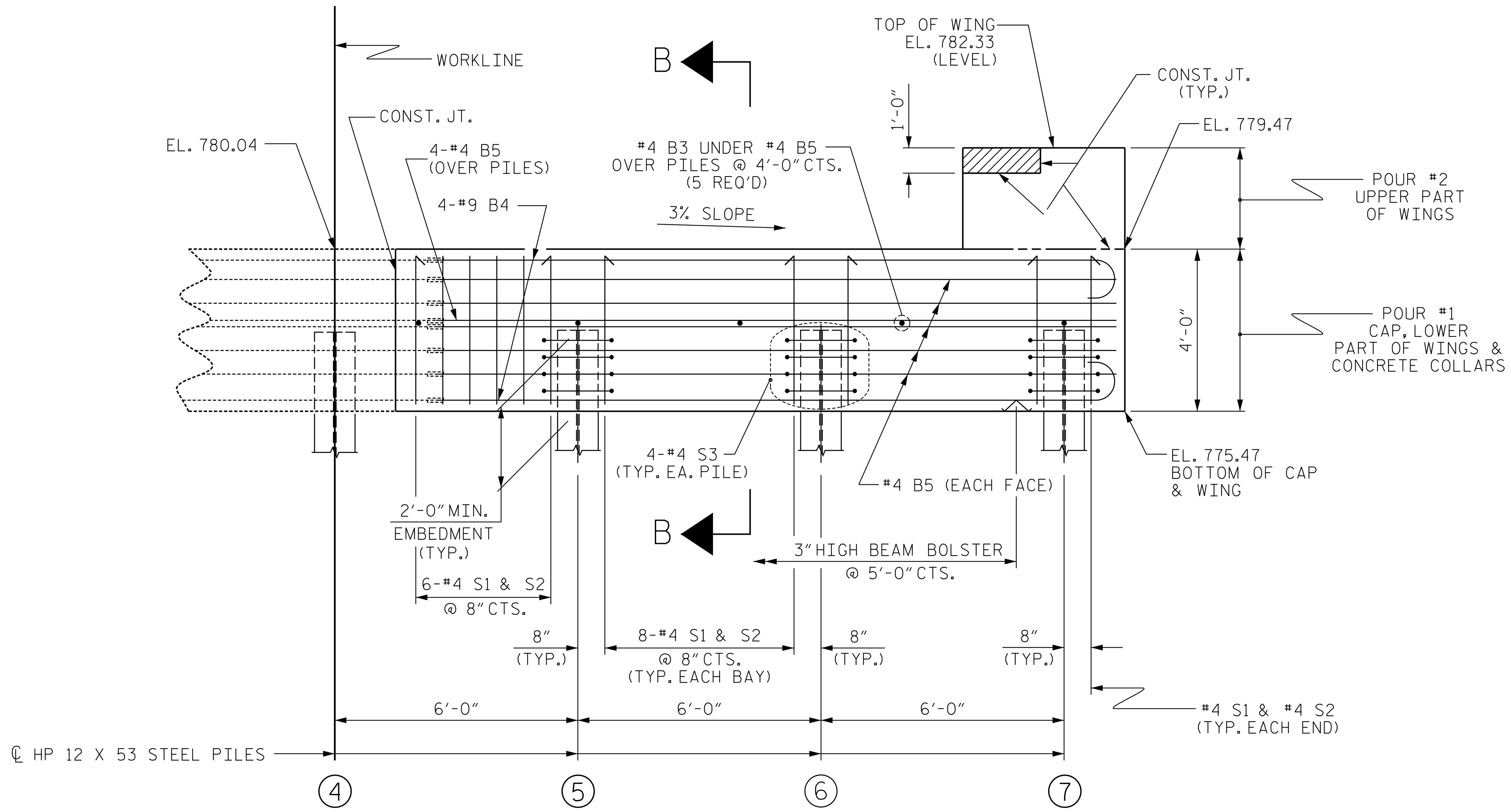
NOTES

STIRRUPS IN CAP MAY BE SHIFTED AS NECESSARY TO CLEAR DOWELS.

THE CONCRETE IN THE SHADED AREA OF THE WING SHALL BE POURED AFTER THE OREGON RAIL CONCRETE CURB IS CAST IF SLIP FORMING IS USED.

FOR PILE SPLICE DETAILS, SEE SHEET 4 OF 4.

FOR WING DETAILS, SEE SHEET 3 OF 4.



ELEVATION

WINGS NOT SHOWN FOR CLARITY.
FOR SECTION A-A, SEE SHEET 4 OF 4.
CONCRETE COLLARS FOR STEEL PILES NOT SHOWN IN PLAN AND ELEVATION VIEWS FOR CLARITY.
SEE "CORROSION PROTECTION FOR STEEL PILES DETAIL", SHEET 4 OF 4.

TOP OF PILE ELEVATIONS	
5	777.88
6	777.70
7	777.52

PROJECT NO. BP11.R010
YADKIN COUNTY
STATION: 13+38.00 -L-

SHEET 2 OF 4

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

SUBSTRUCTURE

END BENT No. 2 (STAGE II)

NORTH CAROLINA PROFESSIONAL SEAL 045282 ENGINEER GWENDOLEN F. WILSON

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1			3				TOTAL SHEETS
2			4				24

DWN. BY: GWP	DATE: 07/2023
CHKD. BY: WDC	DATE: 07/2023
DES. EGR. OF RECORD: GWP	DATE: 07/2023

DRAWN BY : WJH 12/11
CHECKED BY : AAC 12/11
REV. 4/15 MAA/TMG

STD. NO. EB_33_90S4

YADKIN 016

End Bent Geometry and Loads (Cored Slabs)

Bridge Width	CS Unit Length	Factored Pile Reaction (kips)	Factored Pile Reaction (tons)
27'	25'-0"	106	53
	30'-0"	118	59
	35'-0"	126	63
	40'-0"	132	66
	45'-0"	140	70
	50'-0"	154	77
	55'-0"	162	81
	60'-0"	170	85
	65'-0"	178	89
	70'-0"	184	92
30'	25'-0"	110	55
	30'-0"	122	61
	35'-0"	132	66
	40'-0"	140	70
	45'-0"	148	74
	50'-0"	162	81
	55'-0"	170	85
	60'-0"	180	90
	65'-0"	188	94
	70'-0"	194	97
33'	25'-0"	92	46
	30'-0"	102	51
	35'-0"	110	55
	40'-0"	118	59
	45'-0"	122	61
	50'-0"	134	67
	55'-0"	142	71
	60'-0"	148	74
	65'-0"	156	78
	70'-0"	162	81
36'	25'-0"	96	48
	30'-0"	108	54
	35'-0"	116	58
	40'-0"	122	61
	45'-0"	130	65
	50'-0"	142	71
	55'-0"	148	74
	60'-0"	156	78
	65'-0"	164	82
	70'-0"	170	85
39'	25'-0"	100	50
	30'-0"	112	56
	35'-0"	120	60
	40'-0"	126	63
	45'-0"	136	68
	50'-0"	146	73
	55'-0"	154	77
	60'-0"	162	81
	65'-0"	170	85
	70'-0"	176	88

USE Factored Load of 85 tons/pile at EB-1 And EB-2.

Bridge Width	Skew	Cap Length	No. of Vertical Piles	Pile Spacing
27'	60/120	38'-2"	5	8'-6"
	75/105	34'-3"	5	7'-6"
	90	33'-0"	5	7'-6"
30'	60/120	41'-8"	5	9'-6"
	75/105	37'-4"	5	8'-3"
	90	36'-0"	5	8'-3"
33'	60/120	45'-2"	7	7'-0"
	75/105	40'-6"	7	6'-0"
	90	39'-0"	7	6'-0"
36'	60/120	48'-7"	7	7'-6"
	75/105	43'-7"	7	6'-6"
	90	42'-0"	7	6'-6"
39'	60/120	52'-0"	7	8'-0"
	75/105	46'-8"	7	7'-0"
	90	45'-0"	7	7'-0"

7 Vertical Piles @ 6'-0" Spacing

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	TIP NA	COUNTY YADKIN	GEOLOGIST B. Rogers	
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek				GROUND WTR (ft)
BORING NO. EB1-A	STATION 13+08	OFFSET 22 ft LT	ALIGNMENT -L-	0 HR. N/A
COLLAR ELEV. 776.9 ft	TOTAL DEPTH 39.4 ft	NORTHING 858,246	EASTING 1,495,794	24 HR. FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		DRILL METHOD Mud Rotary		HAMMER TYPE Automatic
DRILLER Z. Burt	START DATE 05/16/22	COMP. DATE 05/16/22		SURFACE WATER DEPTH N/A

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV (ft)	DEPTH (ft)
780												
	776.9	0.0	2	2	2	4		M		GROUND SURFACE Medium Stiff, Red-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica	776.9	0.0
775	773.4	3.5	1	1	2	3		W			773.9	3.0
	770.9	6.0	1	2	2	4		M		Soft, Orange-Red-Brown, Silty Fine to Coarse SAND (A-2-4), with trace mica Medium Stiff, Brown-Black, Clayey SILT (A-5), with trace mica	771.9	5.0
770	768.4	8.5	1	3	3	6		M				
765	763.4	13.5	3	2	1	3		Sat.			764.9	12.0
760	758.4	18.5	WOH	2	2	4		W		ALLUVIAL Very Loose to Loose, Black-Gray, Silty Fine to Coarse SAND (A-2-4), with trace mica		
755	753.4	23.5	4	6	8	14		M			754.9	22.0
750	748.4	28.5	21	60	40/0.2					RESIDUAL Medium Dense, White-Tan-Orange, Silty Fine to Coarse SAND (A-2-4), with some mica	747.9	29.0
745	743.4	33.5	49	51/0.4		100/0.7				WEATHERED ROCK Tan-Black-White (GRANTIC ROCK)		
740	738.4	38.5	58	42/0.4		100/0.9					737.5	39.4
						100/0.9				Boring Terminated at Elevation 737.5 ft In Weathered Rock (GRANTIC ROCK) Surficial Organic Soil: 0.0 - 0.3 feet		

Boc = 776.4

Ave Boc = 776.4

Assume pile will refuse ≈1' into WR for a tip elevation of 746.9 Ft

L = Boc - Tip EL + 2.0 Embed

= 776.4 - 746.9 + 2.0 = 31.5'

Ave Pile Length = 35 Ft

NCDOT BORE SINGLE BRIDGE NO 16.GPJ NC_DOT.GDT 8/2/23

GEOTECHNICAL BORING REPORT
BORE LOG

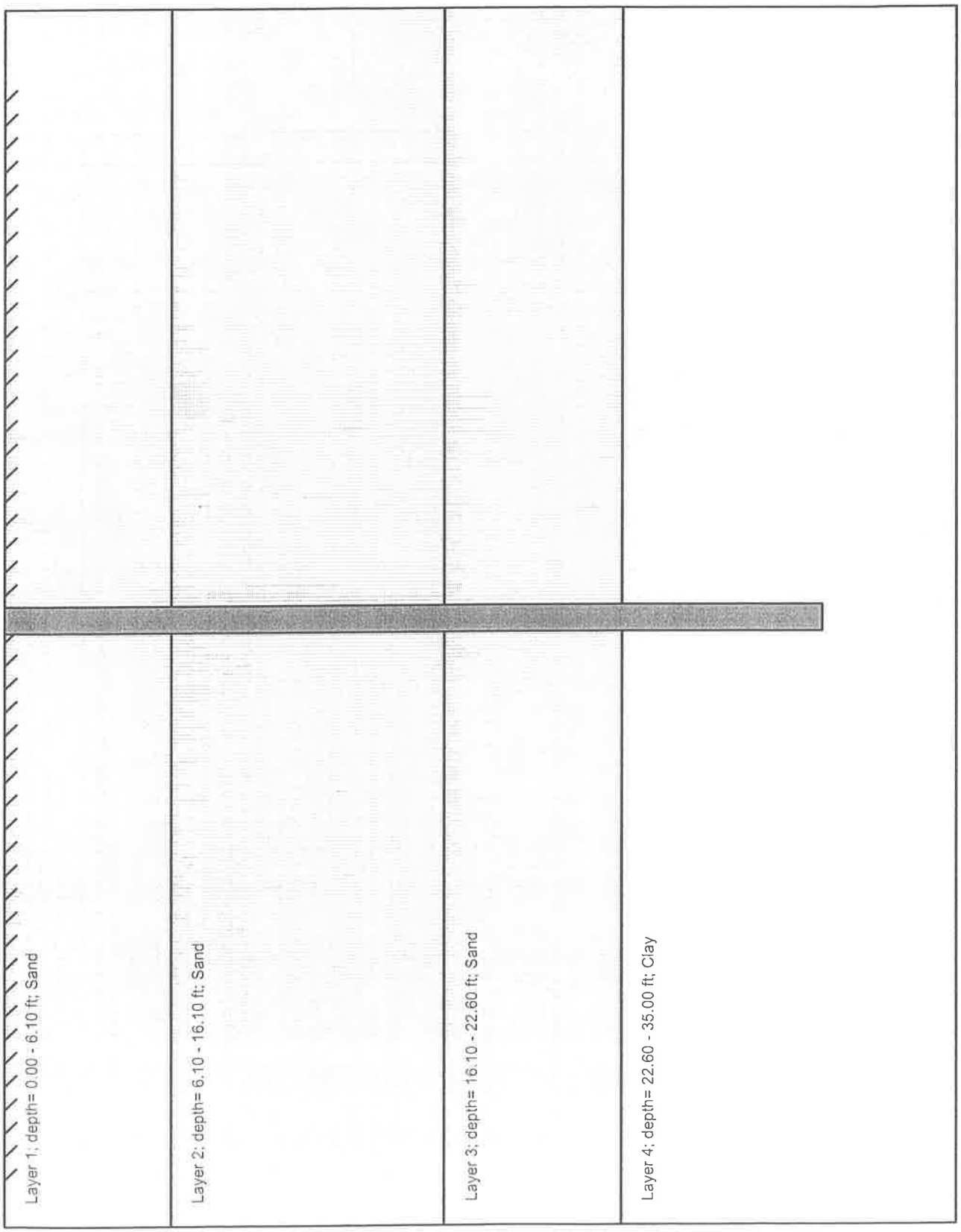
WBS BP11.R010	TIP NA	COUNTY YADKIN	GEOLOGIST B. Rogers	
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek				GROUND WTR (ft)
BORING NO. EB1-B	STATION 13+07	OFFSET 7 ft RT	ALIGNMENT -L-	0 HR. N/A
COLLAR ELEV. 782.3 ft	TOTAL DEPTH 38.8 ft	NORTHING 858,243	EASTING 1,495,823	24 HR. FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		DRILL METHOD Mud Rotary		HAMMER TYPE Automatic
DRILLER Z. Burt	START DATE 05/16/22	COMP. DATE 05/16/22	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION	ELEV. (ft)	DEPTH (ft)
785												
	782.3	0.0								GROUND SURFACE	782.3	0.0
780			2	2	2	4		M		ROADWAY EMBANKMENT Soft to Medium Stiff, Orange-Brown, Silty CLAY (A-7-5), with trace rock fragments		
	778.8	3.5	2	2	1	3 BOC= 776.4	0	W			776.8	5.5
	776.3	6.0	1	2	1	3 (4) N60=4 γ=105		M		Soft, Orange-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica		
775	773.8	8.5	WOH	1	1	2 (3) φ=28	6.1	W			770.3	12.0
770	768.8	13.5	2	1	2	3 (4) N60=4 γ=42.6 φ=28		W		ALLUVIAL Very Loose, Gray, Silty Fine to Coarse SAND (A-2-4)		
765	763.8	18.5	1	1	2	(4)	16.1	Sat.			760.3	22.0
760	758.8	23.5	5	8	12	20 (29) N60=29 γ=57.6 φ=34		M		RESIDUAL Medium Dense, White-Brown-Gray, Silty Fine to Coarse SAND (A-2-4), with trace mica		
755	753.8	28.5	51	49/0.2		γ=100 (wR) 100/0.7	22.6			WEATHERED ROCK White-Brown-Gray (GRANTIC ROCK)	753.8	28.5
750	748.8	33.5	34	60	40/0.2	100/0.7						
745	743.8	38.5	100/0.3			100/0.3					743.5	38.8
										Boring Terminated at Elevation 743.5 ft In Weathered Rock (GRANTIC ROCK)		

AVE BOC = 776.4

USE EB1-B for Analysis

Bridge 016
EB1-B



```
=============================================================================

                  APILE for Windows, Version 2019.9.12

                   Serial Number :  562476398

                   A Program for Analyzing the Axial Capacity
                   and Short-term Settlement of Driven Piles
                             under Axial Loading.
                 (c) Copyright ENSOFT, Inc., 1987-2019
                       All Rights Reserved

=============================================================================

     This program is licensed to :

     ECS Carolinas, LLP
     Charlotte, NC, USA

     Path to file locations      : C:\Users\MWalko\OneDrive - ECS Corporate Services\Home Dir\Working
Files to Move\Greensboro Projects\09-29600 Yadkin 016\Axial Capacity\
     Name of input data file     : Yadkin 016 - End Bent 1.ap9d
     Name of output file         : Yadkin 016 - End Bent 1.ap9o
     Name of plot output file    : Yadkin 016 - End Bent 1.ap9p

     -------------------------------------------------------------------------
                         Time and Date of Analysis
     -------------------------------------------------------------------------

               Date:  August 02, 2023     Time:  10:20:07


1
          **********************
          * INPUT INFORMATION *
          **********************


          Yadkin Bridge 016 - End Bent 1

          DESIGNER   : ECS Southeast

          JOB NUMBER : 09-29600


          METHOD FOR UNIT LOAD TRANSFERS :

          - FHWA (Federal Highway Administration)
            Unfactored Unit Side Friction and Unit Side Resistance are used.


          COMPUTATION METHOD(S) FOR PILE CAPACITY :

          - FHWA (Federal Highway Administration)


          TYPE OF LOADING :
```

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 15.50 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 30.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 47.65 IN.
- TIP AREA OF PILE = 15.50 IN2
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	Nq FACTOR FHWA
0.00	SAND	0.80*	105.00	28.00	22.80**
6.10	SAND	0.80*	105.00	28.00	22.80**
6.10	SAND	0.80*	42.60	28.00	22.80**
16.10	SAND	0.80*	42.60	28.00	22.80**
16.10	SAND	0.80*	57.60	34.00	55.60**
22.60	SAND	0.80*	57.60	34.00	55.60**
22.60	CLAY	0.80*	100.00	0.00	4.80**
35.00	CLAY	0.80*	100.00	0.00	4.80**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	8.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	8.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
6.10	1.000	1.000
6.10	1.000	1.000
16.10	1.000	1.000
16.10	1.000	1.000
22.60	1.000	1.000
22.60	1.000	1.000
35.00	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.152 *	0.00
6.10	0.152 *	0.00
6.10	0.152 *	0.00
16.10	0.152 *	0.00
16.10	0.152 *	0.00
22.60	0.152 *	0.00
22.60	0.152 *	0.90 **
35.00	0.152 *	0.90 **

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

1

****
* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	0.1	0.1
1.00	0.1	0.1	0.2
2.00	0.2	0.3	0.5
3.00	0.5	0.4	0.9
4.00	0.9	0.6	1.4
5.00	1.4	0.7	2.1
6.00	2.0	0.8	2.8
7.00	2.7	0.9	3.6

BOC
776.4

8.00	3.5	1.0	4.5
9.00	4.3	1.1	5.4
10.00	5.2	1.1	6.3
11.00	6.1	1.2	7.3
12.00	7.1	1.2	8.3
13.00	8.1	1.3	9.4
14.00	9.1	1.4	10.5
15.00	10.2	1.4	11.6
16.00	11.4	2.2	13.5
17.00	12.5	3.1	15.7
18.00	14.2	4.1	18.3
19.00	16.2	5.1	21.3
20.00	18.4	5.3	23.7
21.00	20.7	5.5	26.2
22.00	23.0	6.1	29.2
23.00	25.5	6.8	32.2
24.00	42.6	7.3	49.9
25.00	74.4	7.7	82.1
26.00	106.1	7.7	113.9
27.00	137.9	7.7	145.7
28.00	169.7	7.7	177.4
29.00	201.4	7.7	209.2
30.00	233.2	7.7	241.0

Top of wR 753.8

Factored Load = 85 ton

By inspection, pile should refuse ≈1' into wR for a tip elevation of 752.8'

L = Boc - Tip EL + 2.0 Embed into cap

= 776.4 - 752.8 + 2.0 = 25.6'

Ave Pile Length = 30'

DRIVE PILES to $\frac{85 \text{ ton}}{0.6}$ = 141.7 ton

RDR = 145 ton (290^K)

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

For WEAP: $\frac{26^K}{290^K}$ = 9% Skin

```
************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.2387E-02	0.2427E-01
			0.3979E-02	0.4702E-01
			0.5969E-02	0.8645E-01
			0.7162E-02	0.1213E+00
			0.7958E-02	0.1517E+00
			0.7958E-02	0.3033E+00
			0.7958E-02	0.4550E+00
			0.7958E-02	0.7584E+00
			0.7958E-02	0.3033E+01
2	10	0.3050E+01		
			0.0000E+00	0.0000E+00
			0.1748E+00	0.2427E-01
			0.2913E+00	0.4702E-01
			0.4369E+00	0.8645E-01
			0.5243E+00	0.1213E+00
			0.5825E+00	0.1517E+00
			0.5825E+00	0.3033E+00
			0.5825E+00	0.4550E+00

			0.5825E+00	0.7584E+00
			0.5825E+00	0.3033E+01
3	10	0.6058E+01		
			0.0000E+00	0.0000E+00
			0.3471E+00	0.2427E-01
			0.5786E+00	0.4702E-01
			0.8679E+00	0.8645E-01
			0.1041E+01	0.1213E+00
			0.1157E+01	0.1517E+00
			0.1157E+01	0.3033E+00
			0.1157E+01	0.4550E+00
			0.1157E+01	0.7584E+00
			0.1157E+01	0.3033E+01
4	10	0.6142E+01		
			0.0000E+00	0.0000E+00
			0.3519E+00	0.2427E-01
			0.5865E+00	0.4702E-01
			0.8798E+00	0.8645E-01
			0.1056E+01	0.1213E+00
			0.1173E+01	0.1517E+00
			0.1173E+01	0.3033E+00
			0.1173E+01	0.4550E+00
			0.1173E+01	0.7584E+00
			0.1173E+01	0.3033E+01
5	10	0.1110E+02		
			0.0000E+00	0.0000E+00
			0.4964E+00	0.2427E-01
			0.8274E+00	0.4702E-01
			0.1241E+01	0.8645E-01
			0.1489E+01	0.1213E+00
			0.1655E+01	0.1517E+00
			0.1655E+01	0.3033E+00
			0.1655E+01	0.4550E+00
			0.1655E+01	0.7584E+00
			0.1655E+01	0.3033E+01
6	10	0.1606E+02		
			0.0000E+00	0.0000E+00
			0.6117E+00	0.2427E-01
			0.1019E+01	0.4702E-01
			0.1529E+01	0.8645E-01
			0.1835E+01	0.1213E+00
			0.2039E+01	0.1517E+00
			0.2039E+01	0.3033E+00
			0.2039E+01	0.4550E+00
			0.2039E+01	0.7584E+00
			0.2039E+01	0.3033E+01
7	10	0.1614E+02		
			0.0000E+00	0.0000E+00
			0.6136E+00	0.2427E-01
			0.1023E+01	0.4702E-01
			0.1534E+01	0.8645E-01
			0.1841E+01	0.1213E+00
			0.2045E+01	0.1517E+00
			0.2045E+01	0.3033E+00
			0.2045E+01	0.4550E+00
			0.2045E+01	0.7584E+00
			0.2045E+01	0.3033E+01
8	10	0.1935E+02		
			0.0000E+00	0.0000E+00
			0.1130E+01	0.2427E-01
			0.1884E+01	0.4702E-01

			0.2826E+01	0.8645E-01
			0.3391E+01	0.1213E+00
			0.3768E+01	0.1517E+00
			0.3768E+01	0.3033E+00
			0.3768E+01	0.4550E+00
			0.3768E+01	0.7584E+00
			0.3768E+01	0.3033E+01
9	10	0.2256E+02		
			0.0000E+00	0.0000E+00
			0.1292E+01	0.2427E-01
			0.2153E+01	0.4702E-01
			0.3229E+01	0.8645E-01
			0.3875E+01	0.1213E+00
			0.4305E+01	0.1517E+00
			0.4305E+01	0.3033E+00
			0.4305E+01	0.4550E+00
			0.4305E+01	0.7584E+00
			0.4305E+01	0.3033E+01
10	10	0.2264E+02		
			0.0000E+00	0.0000E+00
			0.1296E+01	0.2427E-01
			0.2160E+01	0.4702E-01
			0.3239E+01	0.8645E-01
			0.3887E+01	0.1213E+00
			0.4319E+01	0.1517E+00
			0.3887E+01	0.3033E+00
			0.3887E+01	0.4550E+00
			0.3887E+01	0.7584E+00
			0.3887E+01	0.3033E+01
11	10	0.2880E+02		
			0.0000E+00	0.0000E+00
			0.1667E+02	0.2427E-01
			0.2778E+02	0.4702E-01
			0.4167E+02	0.8645E-01
			0.5000E+02	0.1213E+00
			0.5556E+02	0.1517E+00
			0.5000E+02	0.3033E+00
			0.5000E+02	0.4550E+00
			0.5000E+02	0.7584E+00
			0.5000E+02	0.3033E+01
12	10	0.3496E+02		
			0.0000E+00	0.0000E+00
			0.1667E+02	0.2427E-01
			0.2778E+02	0.4702E-01
			0.4167E+02	0.8645E-01
			0.5000E+02	0.1213E+00
			0.5556E+02	0.1517E+00
			0.5000E+02	0.3033E+00
			0.5000E+02	0.4550E+00
			0.5000E+02	0.7584E+00
			0.5000E+02	0.3033E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4844E+00	0.7584E-02
0.9687E+00	0.1517E-01
0.1937E+01	0.3033E-01

0.3875E+01	0.1972E+00
0.5812E+01	0.6370E+00
0.6975E+01	0.1107E+01
0.7750E+01	0.1517E+01
0.7750E+01	0.2275E+01
0.7750E+01	0.3033E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.3375E+00	0.3210E-03	0.6387E-02	0.1000E-03
0.3375E+01	0.3210E-02	0.6387E-01	0.1000E-02
0.1709E+02	0.1617E-01	0.3194E+00	0.5000E-02
0.3427E+02	0.3243E-01	0.6387E+00	0.1000E-01
0.6736E+02	0.6452E-01	0.1277E+01	0.2000E-01
0.1328E+03	0.1388E+00	0.2166E+01	0.5000E-01
0.1783E+03	0.2000E+00	0.2514E+01	0.8000E-01
0.1997E+03	0.2350E+00	0.2747E+01	0.1000E+00
0.2294E+03	0.3564E+00	0.3887E+01	0.2000E+00
0.2173E+03	0.6479E+00	0.5209E+01	0.5000E+00
0.2183E+03	0.9487E+00	0.6215E+01	0.8000E+00
0.2188E+03	0.1149E+01	0.6710E+01	0.1000E+01
0.2199E+03	0.2150E+01	0.7750E+01	0.2000E+01

WEAP Parameter Calculation

Bent #: EB-1

		Toe Quake	Shaft Quake
Pile Type:	HP 12X53	**0.10**	**0.10**

Subsurface Conditions: Loose/Soft or Submerged

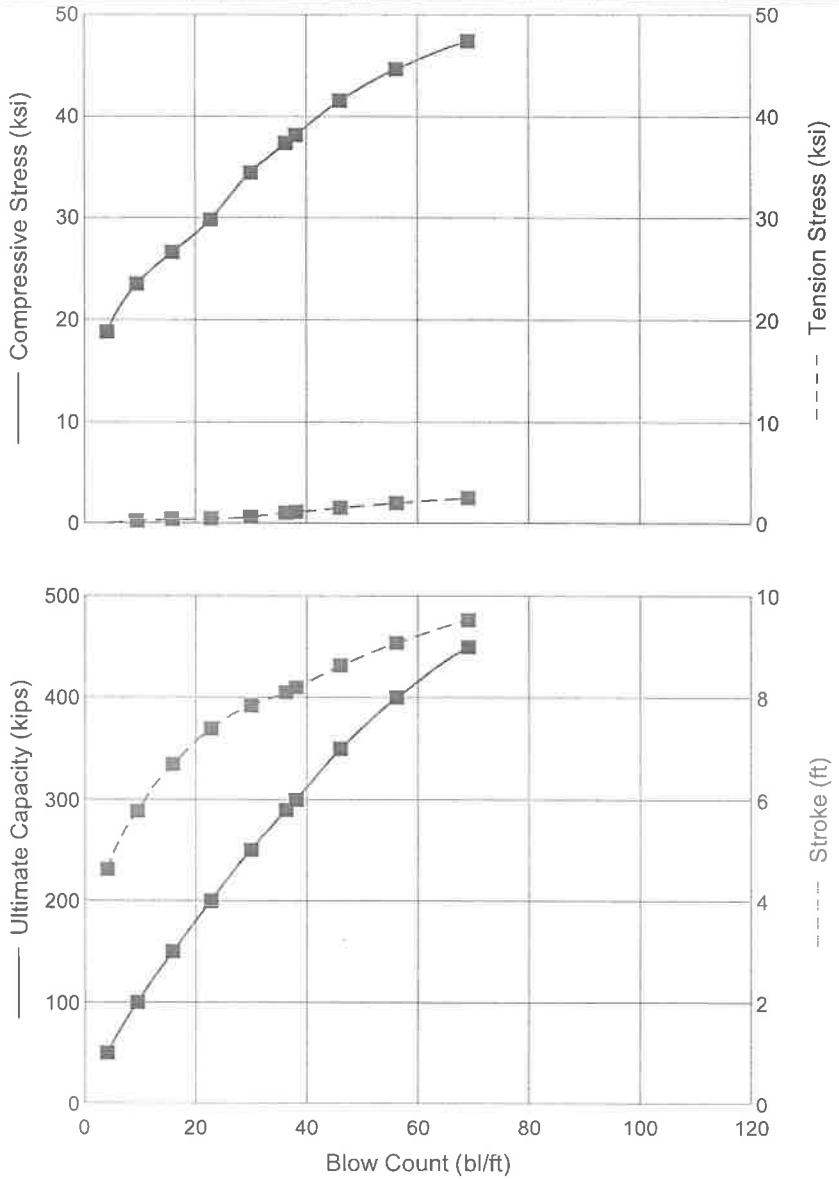
Layer #	Top	Bottom	Navg	Soil Type	Shaft Damping
1	776.4	770.3	4	Sand	0.20
2	770.3	760.3	4	Sand	0.20
3	760.3	753.8	29	Sand	0.15
4	753.8	752.8	100	WR	0.10
5					
6					
7					
8					
9					
10					
11					
12					
13					

Length of Pile 23.6

	Toe Damping
0.18	**0.10**

ECS Carolinas LLP
Yadkin Bridge 016 - End Bent 1

13-Sep-2023
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1580 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.180	s/ft
Toe Damping	0.100	s/ft
Pile Length	30.00	ft
Pile Penetration	23.60	ft
Pile Top Area	15.50	in2

Pile Model

Skin Friction Distribution

Res. Shaft = 9 %
(Proportional)

ECS Carolinas LLP
Yadkin Bridge 016 - End Bent 1

13-Sep-2023
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
50.0	18.81	0.00	4.1	4.61	23.01
100.0	23.53	0.22	9.5	5.77	19.87
150.0	26.64	0.39	15.9	6.70	18.68
200.0	29.81	0.45	22.8	7.39	18.24
250.0	34.43	0.64	30.0	7.84	18.04
→ 290.0	37.40	1.04	36.3	8.10	18.14
300.0	38.15	1.13	38.1	8.19	18.14
350.0	41.58	1.55	46.1	8.63	18.90
400.0	44.69	2.03	56.2	9.08	19.60
450.0	47.43	2.52	69.1	9.53	20.28

A Delmag D19-32 is suitable to drive piles at EB-1.

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

```
 Input  File: C:\USERS\MWALKO\ONEDRIVE - ECS CORPORATE SERVICES\HOME DIR\WORKING
FILES TO MOVE\GREENSBORO PROJECTS\09-29600 YADKIN 016\WEAP ANALYSIS\END BENT 1
DELMAG D19-32.GWW
 Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
 Hammer File Version:  2003 (12/4/2018)

                      Input File Contents
    Yadkin Bridge 016 - End Bent 1
 OUT OSG HAM STR FUL PEL  N SPL N-U P-D %SK ISM  0 PHI RSA ITR H-D MXT     DEx
   6   0  40   0   1   0  0   0   0   0   9   1  0   0   0   0   0   0   0.000
    Pile g  Hammer g  Toe Area Pile Size           Pile Type
    32.170    32.170   141.890    12.040              H Pile
      W Cp       A Cp       E Cp       T Cp       CoR       ROut       StCp
     1.900    227.000      530.0      2.000     0.800      0.010        0.0
      A Cu       E Cu       T Cu        CoR       ROut       StCu
     0.000        0.0      0.000      0.000      0.000        0.0
      LPle       APle       EPle       WPle       Peri         CI        CoR       ROut
    30.000      15.50    30000.0    492.000      3.970          0      0.850      0.010
 FFatigue         F0  0-Bottom
        0      0.000      0.000
 Manufac  Hmr Name  HmrType No Seg-s
 DELMAG   D 19-32         1       5
    Ram Wt     Ram L    Ram Dia    MaxStrk    RtdStrk     Efficy
      4.00    129.10      12.60      11.76      10.61       0.80
    IB. Wt     IB. L     IB.Dia     IB CoR     IB RO
      0.75    25.30      12.60      0.900      0.010
 CompStrk A Chamber V Chamber   C Delay  C Duratn Exp Coeff VolCStart  Vol CEnd
     15.50    124.70    157.70     0.0020     0.0020      1.250       0.00       0.00
     P atm        P1        P2         P3         P4         P5
     14.70   1580.00   1420.00    1280.00    1150.00       0.00
    Stroke     Effic.  Pressure  R-Weight   T-Delay Exp-Coeff    Eps-Str  Total-AW
   10.6100    0.8000 1580.0000     0.0000     0.0000     0.0000     0.0100     0.0000
        Qs         Qt         Js         Jt         Qx         Jx       Rati       Dept
     0.100      0.100      0.180      0.100      0.000      0.000      0.000      0.000
 Research Soil Model: Atoe, Plug,  Gap, Q-fac
     0.000      0.000      0.000      0.000
 Research Soil Model: RD-skn: m, d, toe: m, d
     0.000      0.000      0.000      0.000
 Research Toe Plug: Res-int, Q-int, D-int, Res-plug, Q-plug, D-plug
     0.000      0.000      0.000      0.000      0.000
 Research Toe Plug: RD plug toe: m, d
     0.000      0.000
 Research Toe Plug: New Toe Plug Model is NOT applied
 Res. Distribution
    Dpth     Rskn       Dpth     Dpth
    0.00     0.00      23.60    23.60     0.00     0.00     0.00     0.00     0.00     0.000
    6.10     0.11       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
    6.10     0.11       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   16.10     0.17       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   16.10     0.25       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   22.60     0.37       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   22.60     1.61       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   23.60     1.61       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   23.60     1.61       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   27.60     1.61       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
   30.00     1.61       0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.000
 Rult
    50.0    100.0    150.0    200.0    250.0    290.0    300.0    350.0    400.0    450.0
```

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

Yadkin Bridge 016 - End Bent 1

Hammer Model: D 19-32 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.6	1.000	0.0000	
3	0.800	140046.6	1.000	0.0000	
4	0.800	140046.6	1.000	0.0000	
5	0.800	140046.6	1.000	0.0000	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		11625.0			

HAMMER OPTIONS:

Hammer File ID No.	40	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.76			
Rated Stroke	(ft)	10.61	Efficiency		0.800
Maximum Pressure	(psi)	1580.00	Actual Pressure	(psi)	1580.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

PILE PROFILE:

Toe Area	(in2)	141.890	Pile Type		H Pile
Pile Size	(inch)	12.040			

L b Top	Area	E-Mod	Spec Wt	Perim	C Index	Wave Sp	EA/c
ft	in2	ksi	lb/ft3	ft		ft/s	k/ft/s
0.0	15.50	30000.	492.0	4.0	0	16807.	27.7
30.0	15.50	30000.	492.0	4.0	0	16807.	27.7

Wave Travel Time 2L/c (ms) 3.570

Pile and Soil Model — Total Capacity Rut (kips) 50.0

No.	Weight	Stiffn	C-Slk	T-Slk	CoR	Soil-S	Soil-D	Quake	LbTop	Perim	Area
	kips	k/in	ft	ft		kips	s/ft	inch	ft	ft	in2
1	0.177	11625	0.010	0.000	0.85	0.0	0.180	0.100	3.33	4.0	15.5
2	0.177	11625	0.000	0.000	1.00	0.0	0.180	0.100	6.67	4.0	15.5
3	0.177	11625	0.000	0.000	1.00	0.1	0.180	0.100	10.00	4.0	15.5
4	0.177	11625	0.000	0.000	1.00	0.3	0.180	0.100	13.33	4.0	15.5
5	0.177	11625	0.000	0.000	1.00	0.3	0.180	0.100	16.67	4.0	15.5
6	0.177	11625	0.000	0.000	1.00	0.4	0.180	0.100	20.00	4.0	15.5
7	0.177	11625	0.000	0.000	1.00	0.5	0.180	0.100	23.33	4.0	15.5
8	0.177	11625	0.000	0.000	1.00	0.8	0.180	0.100	26.67	4.0	15.5
9	0.177	11625	0.000	0.000	1.00	2.0	0.180	0.100	30.00	4.0	15.5
Toe						45.5	0.100	0.100			

1.589 kips total unreduced pile weight (g= 32.17 ft/s2)
1.589 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	23.60	Pile Damping Fact.(k/ft/s)	0.553
% Shaft Resistance	9		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

Rut= 50.0, Rtoe = 45.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	288.3	0.00	18.60	11.36	3.081	23.01
2	0.0	289.0	0.00	18.65	12.05	3.078	23.05
3	0.0	289.8	0.00	18.70	12.65	3.075	23.07
4	0.0	291.0	0.00	18.78	12.68	3.072	23.01
5	0.0	291.5	0.00	18.81	12.46	3.068	22.87
6	0.0	290.2	0.00	18.72	12.77	3.065	22.68
7	0.0	279.3	0.00	18.02	13.77	3.061	22.45
8	0.0	246.3	0.00	15.89	14.79	3.057	22.07
9	0.0	182.4	0.00	11.77	15.51	3.054	21.83

(Eq) Strokes Analyzed and Last Return (ft):
10.61 3.88 4.86 4.49 4.61 4.57

Max. Combustion Pressure 1580.0 psi

Rut= 100.0, Rtoe= 91.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	359.0	0.00	23.16	11.83	1.430	19.87
2	-0.5	359.7	-0.04	23.21	11.79	1.423	19.87
3	-1.7	361.5	-0.11	23.32	11.77	1.415	19.84
4	-2.6	363.4	-0.17	23.45	11.75	1.407	19.74
5	-3.2	364.7	-0.20	23.53	11.74	1.399	19.58
6	-3.4	364.6	-0.22	23.52	11.86	1.391	19.38
7	-3.4	356.7	-0.22	23.01	13.22	1.383	19.14
8	-3.2	328.0	-0.20	21.16	14.66	1.375	18.78
9	-2.2	286.8	-0.14	18.51	15.72	1.367	18.54

(Eq) Strokes Analyzed and Last Return (ft):
10.61 5.07 5.98 5.77 5.81

Max. Combustion Pressure 1580.0 psi

Rut= 150.0, Rtoe= 136.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	405.7	0.00	26.18	13.40	0.953	18.68
2	-2.4	406.3	-0.15	26.21	13.35	0.942	18.63
3	-4.6	408.5	-0.29	26.36	13.33	0.930	18.56
4	-5.9	411.0	-0.38	26.52	13.29	0.918	18.41
5	-6.0	413.0	-0.39	26.64	13.26	0.906	18.20
6	-5.5	412.6	-0.36	26.62	13.32	0.894	17.96
7	-4.7	405.1	-0.30	26.14	14.08	0.882	17.67
8	-3.6	378.3	-0.23	24.41	14.56	0.869	17.28
9	-2.1	379.0	-0.13	24.45	14.76	0.857	17.02

(Eq) Strokes Analyzed and Last Return (ft):
10.61 6.30 6.78 6.70 6.72

Max. Combustion Pressure 1580.0 psi

Rut= 200.0, Rtoe = 182.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	436.7	0.00	28.17	14.45	0.754	18.24
2	-3.0	437.2	-0.20	28.21	14.40	0.739	18.13
3	-5.6	439.9	-0.36	28.38	14.37	0.723	17.99
4	-6.9	443.3	-0.45	28.60	14.33	0.707	17.78
5	-7.0	444.8	-0.45	28.70	14.25	0.691	17.50
6	-6.5	444.9	-0.42	28.70	14.26	0.675	17.19
7	-5.6	437.3	-0.36	28.21	14.80	0.659	16.84
8	-4.5	432.5	-0.29	27.90	14.86	0.642	16.39
9	-2.4	462.1	-0.15	29.81	13.28	0.626	16.07

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.14 7.39 7.37

Max. Combustion Pressure 1580.0 psi

Rut= 250.0, Rtoe= 227.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	456.4	0.00	29.44	15.11	0.664	18.04
2	-4.2	456.7	-0.27	29.46	15.05	0.643	17.83
3	-7.8	459.8	-0.50	29.66	15.01	0.623	17.60
4	-9.9	463.6	-0.64	29.91	14.95	0.602	17.29
5	-9.8	465.1	-0.63	30.00	14.85	0.582	16.92
6	-8.5	464.7	-0.55	29.98	14.81	0.561	16.51
7	-6.6	457.4	-0.43	29.51	15.15	0.540	16.07
8	-4.4	500.4	-0.28	32.29	14.81	0.520	15.54
9	-1.9	533.7	-0.12	34.43	11.72	0.500	15.16

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.72 7.84 7.85

Max. Combustion Pressure 1580.0 psi

Rut= 290.0, Rtoe= 263.9 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	467.2	0.00	30.14	15.48	0.631	18.14
2	-6.8	467.7	-0.44	30.18	15.41	0.605	17.82
3	-12.6	470.9	-0.82	30.38	15.37	0.579	17.46
4	-16.0	475.1	-1.03	30.65	15.28	0.554	17.02
5	-16.1	476.3	-1.04	30.73	15.17	0.528	16.51
6	-14.1	475.9	-0.91	30.70	15.10	0.503	15.99
7	-11.0	483.5	-0.71	31.19	15.32	0.478	15.46
8	-7.4	546.0	-0.48	35.23	14.71	0.454	14.85
9	-3.4	579.7	-0.22	37.40	11.20	0.431	14.40

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.10 8.17

Max. Combustion Pressure 1580.0 psi

Rut= 300.0, Rtoe = 273.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	479.9	0.00	30.96	15.60	0.625	18.14
2	-6.9	471.2	-0.45	30.40	15.53	0.597	17.78
3	-13.3	474.5	-0.86	30.61	15.49	0.571	17.40
4	-17.1	478.8	-1.10	30.89	15.39	0.544	16.93
5	-17.4	479.9	-1.12	30.96	15.28	0.517	16.39
6	-15.4	479.4	-0.99	30.93	15.20	0.490	15.82
7	-12.0	494.0	-0.77	31.87	15.39	0.464	15.25
8	-8.0	557.8	-0.51	35.99	14.72	0.439	14.63
9	-3.7	591.3	-0.24	38.15	11.10	0.415	14.15

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.19 8.26

Max. Combustion Pressure 1580.0 psi

Rut= 350.0, Rtoe= 318.5 kips, Time Inc. =0.074 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	561.4	0.00	36.22	16.21	0.615	18.90
2	-7.3	535.1	-0.47	34.52	16.11	0.582	18.38
3	-14.0	530.9	-0.90	34.25	16.06	0.549	17.81
4	-19.6	528.0	-1.27	34.06	15.97	0.517	17.16
5	-23.3	521.6	-1.50	33.65	15.82	0.485	16.44
6	-24.0	518.0	-1.55	33.42	15.69	0.452	15.67
7	-21.4	546.5	-1.38	35.26	15.72	0.420	14.89
8	-16.0	612.1	-1.03	39.49	14.72	0.389	14.11
9	-8.8	644.5	-0.57	41.58	10.59	0.360	13.51

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.63 8.66

Max. Combustion Pressure 1580.0 psi

Rut= 400.0, Rtoe= 364.0 kips, Time Inc. =0.068 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	630.1	0.00	40.65	16.81	0.610	19.60
2	-8.4	595.1	-0.54	38.39	16.70	0.572	18.91
3	-16.8	590.3	-1.08	38.08	16.65	0.535	18.17
4	-23.8	582.8	-1.53	37.60	16.52	0.497	17.31
5	-28.8	575.8	-1.86	37.15	16.35	0.460	16.39
6	-31.5	573.5	-2.03	37.00	16.18	0.422	15.43
7	-30.6	591.5	-1.97	38.16	16.07	0.384	14.42
8	-25.3	659.9	-1.63	42.57	14.78	0.347	13.43
9	-15.2	692.7	-0.98	44.69	10.18	0.313	12.69

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.08 9.08

Max. Combustion Pressure 1580.0 psi

Yadkin Bridge 016 - End Bent 1 09/13/2023
ECS Carolinas LLP GRLWEAP Version 2010

Rut= 450.0, Rtoe = 409.5 kips, Time Inc. =0.063 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	689.1	0.00	44.46	17.40	0.608	20.28
2	-12.6	648.7	-0.81	41.85	17.27	0.566	19.42
3	-21.6	641.6	-1.40	41.39	17.21	0.524	18.51
4	-28.9	629.5	-1.86	40.61	17.08	0.481	17.44
5	-35.3	622.9	-2.28	40.18	16.88	0.440	16.31
6	-39.0	621.9	-2.52	40.12	16.65	0.398	15.16
7	-38.6	632.4	-2.49	40.80	16.41	0.355	13.94
8	-33.3	703.5	-2.15	45.38	14.85	0.312	12.68
9	-21.8	735.2	-1.41	47.43	9.79	0.274	11.78

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.53 9.51

Max. Combustion Pressure 1580.0 psi

Yadkin Bridge 016 - End Bent 1 09/13/2023
ECS Carolinas LLP GRLWEAP Version 2010

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
50.0	4.1	4.61	4.57	0.00	1	0	18.81	5	3	23.0	55.2
100.0	9.5	5.77	5.81	-0.22	6	38	23.53	5	3	19.9	49.0
150.0	15.9	6.70	6.72	-0.39	5	50	26.64	5	3	18.7	45.5
200.0	22.8	7.39	7.37	-0.45	5	46	29.81	9	3	18.2	43.5
250.0	30.0	7.84	7.85	-0.64	4	38	34.43	9	3	18.0	42.2
290.0	36.3	8.10	8.17	-1.04	5	35	37.40	9	4	18.1	41.5
300.0	38.1	8.19	8.26	-1.12	5	34	38.15	9	3	18.1	41.2
350.0	46.1	8.63	8.66	-1.55	6	33	41.58	9	4	18.9	40.2
400.0	56.2	9.08	9.08	-2.03	6	32	44.69	9	4	19.6	39.3
450.0	69.1	9.53	9.51	-2.52	6	31	47.43	9	4	20.3	38.4

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	TIP NA	COUNTY YADKIN	GEOLOGIST B. Rogers	
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek				GROUND WTR (ft)
BORING NO. EB2-A	STATION 13+78	OFFSET 19 ft LT	ALIGNMENT -L-	0 HR. N/A
COLLAR ELEV. 779.5 ft	TOTAL DEPTH 38.8 ft	NORTHING 858,316	EASTING 1,495,802	24 HR. FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		DRILL METHOD Mud Rotary		HAMMER TYPE Automatic
DRILLER Z. Burt	START DATE 05/16/22	COMP. DATE 05/16/22	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
780										ELEV (ft) 779.5 GROUND SURFACE DEPTH (ft) 0.0
	779.5	0.0	3	2	3	(5) BOC = 776.1	0	M		ROADWAY EMBANKMENT Soft to Medium Stiff, Brown-Orange. Fine to coarse Sandy SILT (A-4), with trace mica
	776.0	3.5								
775			2	2	2	(6)		W		
	773.5	6.0	WOH	1	1	(3) N60 = 5 γ = 110 Φ = 28	4.6	W		771.5 8.0
770	771.0	8.5	1	2	4	(9) N60 = 9 γ = 120 c = 750	8.6	M		Medium Stiff, Brown, Silty CLAY (A-7-5) 767.5 ▽ 12.0
	766.0	13.5								ALLUVIAL
765			2	2	2	(6) γ = 57.6		Sat		Loose, White-Gray, Coarse SAND (A-1-b)
						N60 = 8 Φ = 30				762.5 17.0
760	761.0	18.5	WOH	1	5	(9)	18.6	W		Medium Stiff, Gray, Clayey SILT (A-5), with some mica 757.5 22.0
	756.0	23.5								RESIDUAL
755			5	10	11	(30) N60 = 30 γ = 57.6 Φ = 34		W		Medium Dense, White-Gray, Silty Fine to Coarse SAND (A-2-4)
750	751.0	28.5	28	49	51/0.3		25.6			750.5 29.0
						100/0.8				WEATHERED ROCK Brown-White (GRANTIC ROCK)
745	746.0	33.5	26	46	54/0.4	100/0.9				
	741.0	38.5	100/0.3			100/0.3				740.7 38.8
										Boring Terminated at Elevation 740.7 ft In Weathered Rock (GRANTIC ROCK)
										Surficial Organic Soil: 0.0 - 0.2 feet

AVE BOC = 776.1

USE EB2-A for analysis

GEOTECHNICAL BORING REPORT
BORE LOG

WBS BP11.R010	TIP NA	COUNTY YADKIN	GEOLOGIST B. Rogers	
SITE DESCRIPTION Bridge No.16 on SR 1166 (Bethel Church Road) over UT to South Deep Creek				GROUND WTR (ft)
BORING NO. EB2-B	STATION 13+78	OFFSET 8 ft RT	ALIGNMENT -L-	0 HR. N/A
COLLAR ELEV. 782.5 ft	TOTAL DEPTH 39.2 ft	NORTHING 858,313	EASTING 1,495,829	24 HR. FIAD
DRILL RIG/HAMMER EFF./DATE BRI5184 CME-45C 87% 03/30/2022		DRILL METHOD Mud Rotary		HAMMER TYPE Automatic
DRILLER Z. Burt	START DATE 05/16/22	COMP. DATE 05/16/22	SURFACE WATER DEPTH N/A	

ELEV (ft)	DRIVE ELEV (ft)	DEPTH (ft)	BLOW COUNT 0.5ft	0.5ft	0.5ft	BLOWS PER FOOT 0 25 50 75 100	SAMP. NO.	MOI	LOG	SOIL AND ROCK DESCRIPTION
										ELEV (ft) DEPTH (ft)
785										
	782.5	0.0								782.5 GROUND SURFACE 0.0
			2	4	3	7		M		ROADWAY EMBANKMENT Medium Stiff, Red-Orange-Brown, Fine to Coarse Sandy SILT (A-4), with trace mica and rock fragments
780	779.0	3.5	1	2	3	5 Boc= 776.1		W		777.0 5.5
	776.5	6.0	2	1	2	3		W		Soft, Brown, Clayey SILT (A-5), with trace mica
775	774.0	8.5								774.5 8.0
			1	2	2	4		W		Medium Stiff, Brown-Orange, Silty CLAY (A-7-5), with trace mica
770	769.0	13.5								770.5 12.0
			2	2	3	5		Sat.		ALLUVIAL Loose to Medium Dense, Gray-Brown, Silty Fine to Coarse SAND (A-2-4), with trace mica
765	764.0	18.5								
			3	6	6	12		Sat.		
760	759.0	23.5								760.5 22.0
			5	6	6	12		W		RESIDUAL Medium Dense, White-Brown-Gray, Silty Fine to Coarse SAND (A-2-4), with some mica
755	754.0	28.5								753.5 29.0
			37	51	49/0.4	100/0.9				WEATHERED ROCK White-Brown-Gray (GRANTIC ROCK)
750	749.0	33.5								
			24	35	65	100/1.0				
745	744.0	38.5								
			34	66/0.2		100/0.7				743.3 39.2 Boring Terminated at Elevation 743.3 ft In Weathered Rock (GRANTIC ROCK)

Ave Boc= 776.1

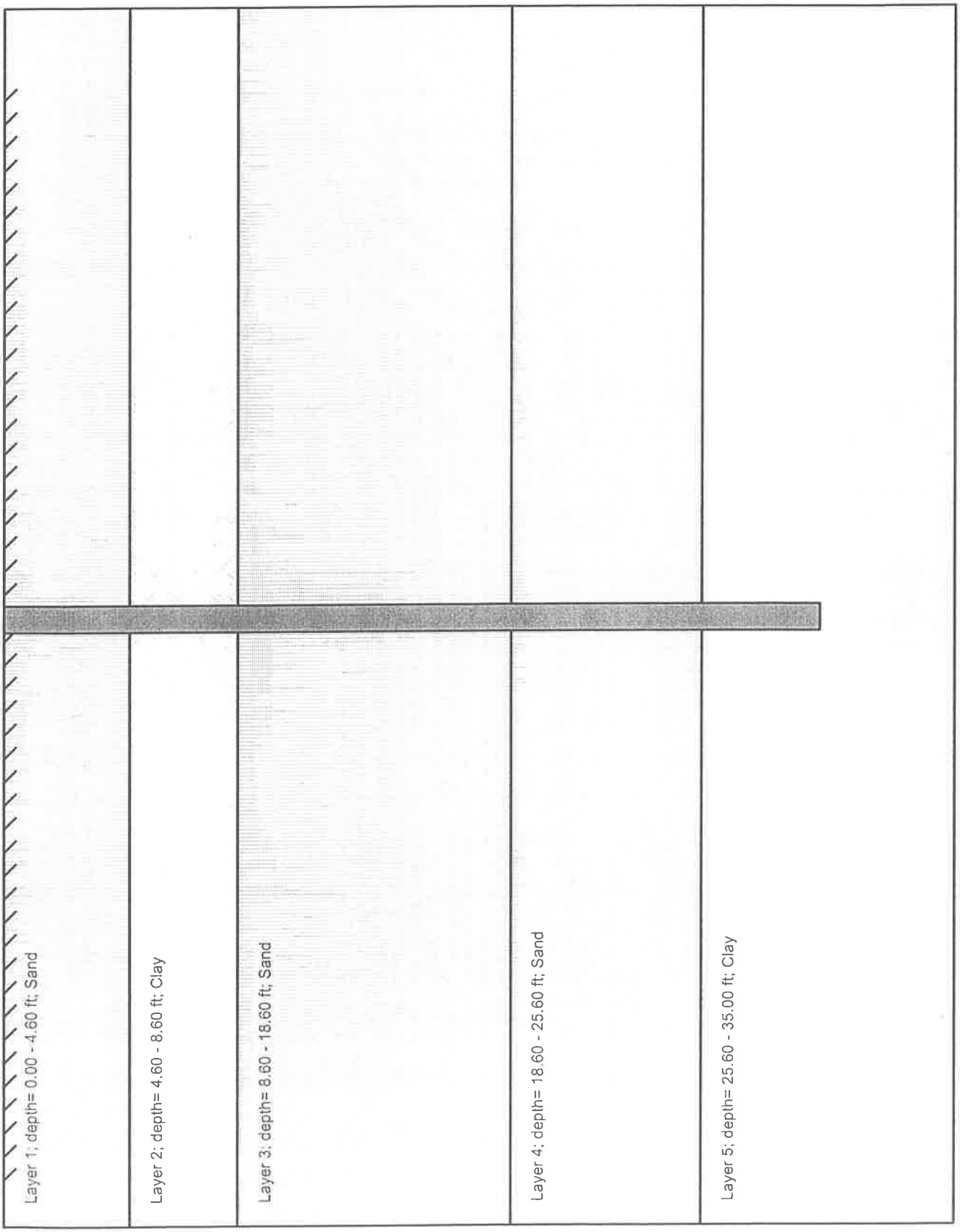
Assume Pile will refuse ≈1' into WR for a tip elevation of 752.5 ft.

L= Boc - Tip EL + 2.0 embed

= 776.1 - 752.5 + 2 = 25.6

Ave Pile Length = 30 Ft

Bridge 016
EB2-A



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=============================================================================

                  APILE for Windows, Version 2019.9.12

                   Serial Number :  562476398

                   A Program for Analyzing the Axial Capacity
                   and Short-term Settlement of Driven Piles
                             under Axial Loading.
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=============================================================================

     This program is licensed to :

     ECS Carolinas, LLP
     Charlotte, NC, USA

     Path to file locations      : C:\Users\MWalko\OneDrive - ECS Corporate Services\Home Dir\Working
Files to Move\Greensboro Projects\09-29600 Yadkin 016\Axial Capacity\
     Name of input data file     : Yadkin 016 - End Bent 2.ap9d
     Name of output file         : Yadkin 016 - End Bent 2.ap9o
     Name of plot output file    : Yadkin 016 - End Bent 2.ap9p

     -----------------------------------------------------------------------------
                         Time and Date of Analysis
     -----------------------------------------------------------------------------

               Date:  August 02, 2023     Time:  11:37:50


1
          **********************
          * INPUT INFORMATION *
          **********************



          Yadkin Bridge 016 - End Bent 2

          DESIGNER   : ECS Southeast

          JOB NUMBER : 09-29600


          METHOD FOR UNIT LOAD TRANSFERS :

          - FHWA (Federal Highway Administration)
            Unfactored Unit Side Friction and Unit Side Resistance are used.



          COMPUTATION METHOD(S) FOR PILE CAPACITY :

          - FHWA (Federal Highway Administration)


          TYPE OF LOADING :
```

- COMPRESSION

PILE TYPE :

H-Pile/Steel Pile

DATA FOR AXIAL STIFFNESS :

- MODULUS OF ELASTICITY = 0.290E+08 PSI
- CROSS SECTION AREA = 15.50 IN2

NONCIRCULAR PILE PROPERTIES :

- TOTAL PILE LENGTH, TL = 30.00 FT.
- BATTER ANGLE = 0.00 DEG
- PILE STICKUP LENGTH, PSL = 0.00 FT.
- ZERO FRICTION LENGTH, ZFL = 0.00 FT.
- PERIMETER OF PILE = 47.65 IN.
- TIP AREA OF PILE = 15.50 IN2
- INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/FT^3	FRICTION ANGLE DEGREES	Nq FACTOR FHWA
0.00	SAND	0.80*	110.00	28.00	22.80**
4.60	SAND	0.80*	110.00	28.00	22.80**
4.60	CLAY	0.80*	120.00	0.00	4.80**
8.60	CLAY	0.80*	120.00	0.00	4.80**
8.60	SAND	0.80*	57.60	30.00	30.00**
18.60	SAND	0.80*	57.60	30.00	30.00**
18.60	SAND	0.80*	57.60	34.00	55.60**
25.60	SAND	0.80*	57.60	34.00	55.60**
25.60	CLAY	0.80*	100.00	0.00	4.80**
35.00	CLAY	0.80*	100.00	0.00	4.80**

* VALUE ASSUMED BY THE PROGRAM
** VALUE ESTIMATED BY THE PROGRAM BASED ON FRICTION ANGLE

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.75	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00

0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	0.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	8.00	0.00	0.00	0.00	0.00
0.10E+08*	0.10E+08*	8.00	0.00	0.00	0.00	0.00

* MAXIMUM UNIT FRICTION AND/OR MAXIMUM UNIT BEARING
WERE SET TO BE 0.10E+08 BECAUSE THE USER DOES NOT
PLAN TO LIMIT THE COMPUTED DATA.

DEPTH FT.	LRFD FACTOR ON UNIT FRICTION	LRFD FACTOR ON UNIT BEARING
0.00	1.000	1.000
4.60	1.000	1.000
4.60	1.000	1.000
8.60	1.000	1.000
8.60	1.000	1.000
18.60	1.000	1.000
18.60	1.000	1.000
25.60	1.000	1.000
25.60	1.000	1.000
35.00	1.000	1.000

DEPTH FT.	Z PEAK IN.	T RESIDUAL
0.00	0.152 *	0.00
4.60	0.152 *	0.00
4.60	0.152 *	0.90 **
8.60	0.152 *	0.90 **
8.60	0.152 *	0.00
18.60	0.152 *	0.00
18.60	0.152 *	0.00
25.60	0.152 *	0.00
25.60	0.152 *	0.90 **
35.00	0.152 *	0.90 **

* DEFAULT VALUE = 0.01 D
** DEFAULT VALUE = 0.9

1

****
* COMPUTATION RESULT *
****

****
* FED. HWY. METHOD *
****

PILE PENETRATION FT.	SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP

BOC
776.1

0.00	0.0	0.1	0.1
1.00	0.1	0.1	0.2
2.00	0.2	0.3	0.5
3.00	0.5	0.4	0.9
4.00	0.9	0.6	1.5
5.00	1.4	0.7	2.1
6.00	3.2	0.7	3.9
7.00	6.2	0.7	6.9
8.00	9.2	0.9	10.1
9.00	12.1	1.1	13.2
10.00	14.3	1.3	15.5
11.00	15.6	1.4	17.0
12.00	17.0	1.4	18.4
13.00	18.5	1.4	19.9
14.00	20.0	1.4	21.4
15.00	21.6	1.4	23.0
16.00	23.2	1.4	24.7
17.00	25.0	1.4	26.4
18.00	26.8	2.6	29.4
19.00	28.6	4.0	32.7
20.00	31.0	5.5	36.4
21.00	33.8	6.8	40.6
22.00	36.7	7.1	43.8
23.00	39.7	7.3	47.0
24.00	42.8	7.5	50.3
25.00	46.0	7.7	53.7
26.00	49.3	7.7	57.0
27.00	66.9	7.8	74.6
28.00	98.6	7.7	106.4
29.00	130.4	7.7	138.1
30.00	162.1	7.7	169.9

Top of WR
750.5

Factored load = 85 tons
By inspection, pile should refuse ≈ 1' into WR for a tip elevation of 749.5'
L = BOC - Tip EL + 2.0 Embed into CAP
= 776.1 - 749.5 + 2.0 = 28.6'
Ave Pile Length = 30'

DRIVE Piles to: $\frac{85\ \text{ton}}{0.6} = 141.7\ \text{ton}$

RDR = 145 tons (290^K)

For WEAP: $\frac{50^K}{290^K} = 17\%$ SKIN

NOTES:
- AN ASTERISK IS PLACED IN THE END-BEARING COLUMN
  IF THE TIP RESISTANCE IS CONTROLLED BY THE FRICTION
  OF SOIL PLUG INSIDE AN OPEN-ENDED PIPE PILE.

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************************************************
* COMPUTE LOAD-DISTRIBUTION AND LOAD-SETTLEMENT *
* CURVES FOR AXIAL LOADING                      *
************************************************
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T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.4167E-01		
			0.0000E+00	0.0000E+00
			0.2501E-02	0.2427E-01
			0.4169E-02	0.4702E-01
			0.6253E-02	0.8645E-01
			0.7504E-02	0.1213E+00
			0.8337E-02	0.1517E+00
			0.8337E-02	0.3033E+00
			0.8337E-02	0.4550E+00
			0.8337E-02	0.7584E+00
			0.8337E-02	0.3033E+01
2	10	0.2300E+01		

			0.0000E+00	0.0000E+00
			0.1381E+00	0.2427E-01
			0.2301E+00	0.4702E-01
			0.3452E+00	0.8645E-01
			0.4142E+00	0.1213E+00
			0.4602E+00	0.1517E+00
			0.4602E+00	0.3033E+00
			0.4602E+00	0.4550E+00
			0.4602E+00	0.7584E+00
			0.4602E+00	0.3033E+01
3	10	0.4558E+01		
			0.0000E+00	0.0000E+00
			0.2736E+00	0.2427E-01
			0.4560E+00	0.4702E-01
			0.6841E+00	0.8645E-01
			0.8209E+00	0.1213E+00
			0.9121E+00	0.1517E+00
			0.9121E+00	0.3033E+00
			0.9121E+00	0.4550E+00
			0.9121E+00	0.7584E+00
			0.9121E+00	0.3033E+01
4	10	0.4642E+01		
			0.0000E+00	0.0000E+00
			0.2786E+00	0.2427E-01
			0.4644E+00	0.4702E-01
			0.6966E+00	0.8645E-01
			0.8359E+00	0.1213E+00
			0.9288E+00	0.1517E+00
			0.8359E+00	0.3033E+00
			0.8359E+00	0.4550E+00
			0.8359E+00	0.7584E+00
			0.8359E+00	0.3033E+01
5	10	0.6600E+01		
			0.0000E+00	0.0000E+00
			0.1563E+01	0.2427E-01
			0.2604E+01	0.4702E-01
			0.3906E+01	0.8645E-01
			0.4687E+01	0.1213E+00
			0.5208E+01	0.1517E+00
			0.4687E+01	0.3033E+00
			0.4687E+01	0.4550E+00
			0.4687E+01	0.7584E+00
			0.4687E+01	0.3033E+01
6	10	0.8558E+01		
			0.0000E+00	0.0000E+00
			0.1563E+01	0.2427E-01
			0.2604E+01	0.4702E-01
			0.3906E+01	0.8645E-01
			0.4687E+01	0.1213E+00
			0.5208E+01	0.1517E+00
			0.4687E+01	0.3033E+00
			0.4687E+01	0.4550E+00
			0.4687E+01	0.7584E+00
			0.4687E+01	0.3033E+01
7	10	0.8642E+01		
			0.0000E+00	0.0000E+00
			0.1563E+01	0.2427E-01
			0.2604E+01	0.4702E-01
			0.3906E+01	0.8645E-01
			0.4687E+01	0.1213E+00
			0.5208E+01	0.1517E+00

			0.5208E+01	0.3033E+00
			0.5208E+01	0.4550E+00
			0.5208E+01	0.7584E+00
			0.5208E+01	0.3033E+01
8	10	0.1360E+02		
			0.0000E+00	0.0000E+00
			0.8058E+00	0.2427E-01
			0.1343E+01	0.4702E-01
			0.2014E+01	0.8645E-01
			0.2417E+01	0.1213E+00
			0.2686E+01	0.1517E+00
			0.2686E+01	0.3033E+00
			0.2686E+01	0.4550E+00
			0.2686E+01	0.7584E+00
			0.2686E+01	0.3033E+01
9	10	0.1856E+02		
			0.0000E+00	0.0000E+00
			0.9835E+00	0.2427E-01
			0.1639E+01	0.4702E-01
			0.2459E+01	0.8645E-01
			0.2950E+01	0.1213E+00
			0.3278E+01	0.1517E+00
			0.3278E+01	0.3033E+00
			0.3278E+01	0.4550E+00
			0.3278E+01	0.7584E+00
			0.3278E+01	0.3033E+01
10	10	0.1864E+02		
			0.0000E+00	0.0000E+00
			0.9865E+00	0.2427E-01
			0.1644E+01	0.4702E-01
			0.2466E+01	0.8645E-01
			0.2959E+01	0.1213E+00
			0.3288E+01	0.1517E+00
			0.3288E+01	0.3033E+00
			0.3288E+01	0.4550E+00
			0.3288E+01	0.7584E+00
			0.3288E+01	0.3033E+01
11	10	0.2210E+02		
			0.0000E+00	0.0000E+00
			0.1556E+01	0.2427E-01
			0.2594E+01	0.4702E-01
			0.3890E+01	0.8645E-01
			0.4669E+01	0.1213E+00
			0.5187E+01	0.1517E+00
			0.5187E+01	0.3033E+00
			0.5187E+01	0.4550E+00
			0.5187E+01	0.7584E+00
			0.5187E+01	0.3033E+01
12	10	0.2556E+02		
			0.0000E+00	0.0000E+00
			0.1730E+01	0.2427E-01
			0.2883E+01	0.4702E-01
			0.4325E+01	0.8645E-01
			0.5190E+01	0.1213E+00
			0.5766E+01	0.1517E+00
			0.5766E+01	0.3033E+00
			0.5766E+01	0.4550E+00
			0.5766E+01	0.7584E+00
			0.5766E+01	0.3033E+01
13	10	0.2564E+02		
			0.0000E+00	0.0000E+00

			0.1734E+01	0.2427E-01
			0.2890E+01	0.4702E-01
			0.4335E+01	0.8645E-01
			0.5202E+01	0.1213E+00
			0.5780E+01	0.1517E+00
			0.5202E+01	0.3033E+00
			0.5202E+01	0.4550E+00
			0.5202E+01	0.7584E+00
			0.5202E+01	0.3033E+01
14	10	0.3030E+02		
			0.0000E+00	0.0000E+00
			0.1667E+02	0.2427E-01
			0.2778E+02	0.4702E-01
			0.4167E+02	0.8645E-01
			0.5000E+02	0.1213E+00
			0.5556E+02	0.1517E+00
			0.5000E+02	0.3033E+00
			0.5000E+02	0.4550E+00
			0.5000E+02	0.7584E+00
			0.5000E+02	0.3033E+01
15	10	0.3496E+02		
			0.0000E+00	0.0000E+00
			0.1667E+02	0.2427E-01
			0.2778E+02	0.4702E-01
			0.4167E+02	0.8645E-01
			0.5000E+02	0.1213E+00
			0.5556E+02	0.1517E+00
			0.5000E+02	0.3033E+00
			0.5000E+02	0.4550E+00
			0.5000E+02	0.7584E+00
			0.5000E+02	0.3033E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4844E+00	0.7584E-02
0.9687E+00	0.1517E-01
0.1937E+01	0.3033E-01
0.3875E+01	0.1972E+00
0.5812E+01	0.6370E+00
0.6975E+01	0.1107E+01
0.7750E+01	0.1517E+01
0.7750E+01	0.2275E+01
0.7750E+01	0.3033E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2424E+00	0.2479E-03	0.6387E-02	0.1000E-03
0.2424E+01	0.2479E-02	0.6387E-01	0.1000E-02
0.1219E+02	0.1242E-01	0.3194E+00	0.5000E-02
0.2450E+02	0.2492E-01	0.6387E+00	0.1000E-01

0.4772E+02	0.4953E-01	0.1277E+01	0.2000E-01
0.9412E+02	0.1094E+00	0.2166E+01	0.5000E-01
0.1255E+03	0.1601E+00	0.2514E+01	0.8000E-01
0.1406E+03	0.1903E+00	0.2747E+01	0.1000E+00
0.1613E+03	0.3059E+00	0.3887E+01	0.2000E+00
0.1549E+03	0.6012E+00	0.5209E+01	0.5000E+00
0.1559E+03	0.9020E+00	0.6215E+01	0.8000E+00
0.1564E+03	0.1102E+01	0.6710E+01	0.1000E+01
0.1574E+03	0.2103E+01	0.7750E+01	0.2000E+01

WEAP Parameter Calculation

Bent #: EB-2

		Toe Quake	Shaft Quake
Pile Type:	HP 12X53	**0.10**	**0.10**

Subsurface Conditions: Loose/Soft or Submerged

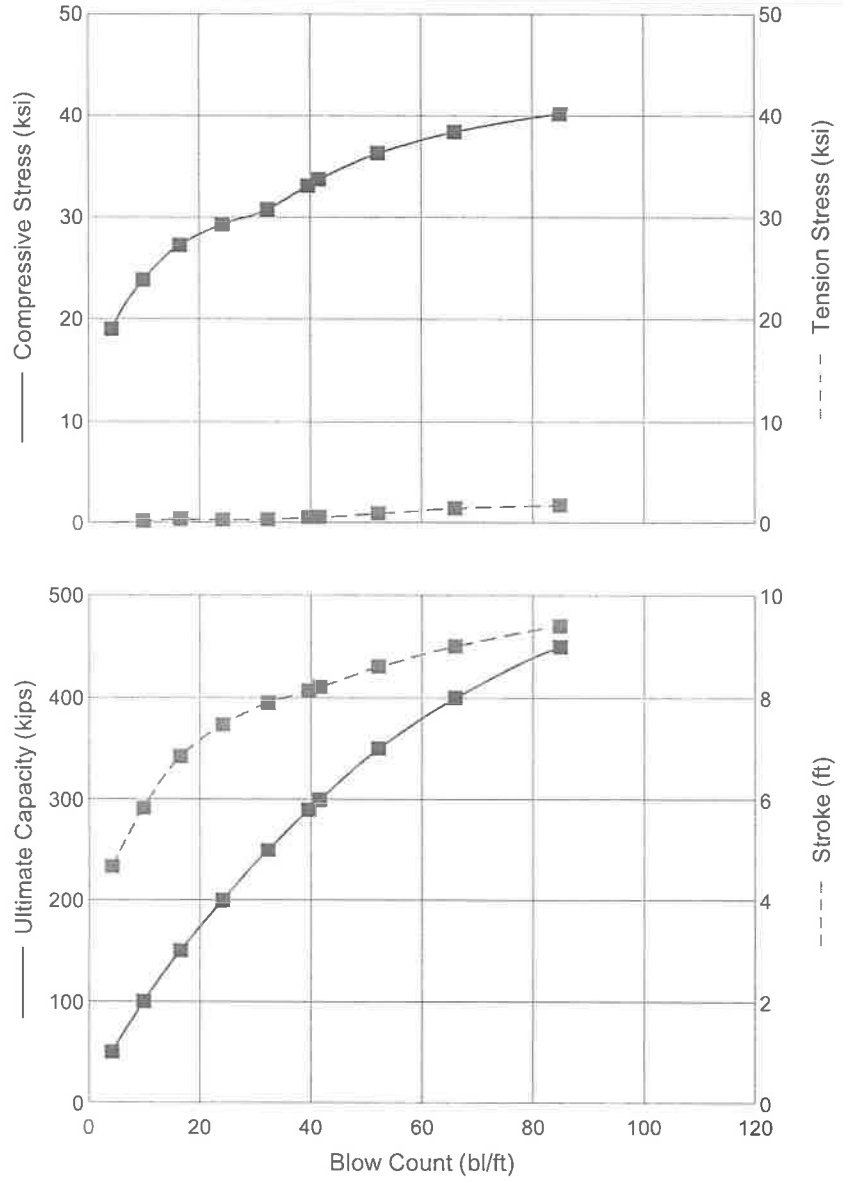
Layer #	Top	Bottom	Navg	Soil Type	Shaft Damping
1	776.1	771.5	5	Sand	0.20
2	771.5	767.5	9	Clay	0.25
3	767.5	757.5	8	Sand	0.20
4	757.5	750.5	30	Sand	0.15
5	750.5	749.5	100	WR	0.10
6					
7					
8					
9					
10					
11					
12					
13					
					0.19

Length of Pile 26.6

Toe Damping
0.10

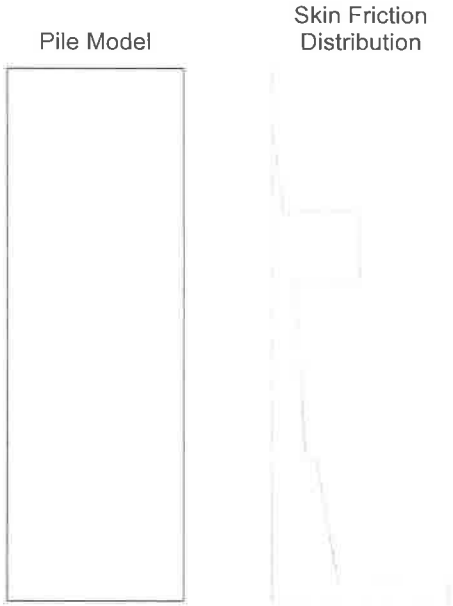
ECS Carolinas LLP
Yadkin Bridge 016 - End Bent 2

13-Sep-2023
GRLWEAP Version 2010



DELMAG D 19-32

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1580 (100%)	psi
Helmet Weight	1.90	kips
Hammer Cushion	60155	kips/in
COR of H.C.	0.800	
Skin Quake	0.100	in
Toe Quake	0.100	in
Skin Damping	0.190	s/ft
Toe Damping	0.100	s/ft
Pile Length	30.00	ft
Pile Penetration	26.60	ft
Pile Top Area	15.50	in2



Res. Shaft = 17 %
(Proportional)

ECS Carolinas LLP
Yadkin Bridge 016 - End Bent 2

13-Sep-2023
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
50.0	19.03	0.00	4.2	4.67	22.83
100.0	23.87	0.15	9.9	5.83	19.69
150.0	27.29	0.35	16.5	6.84	18.69
200.0	29.34	0.29	24.2	7.47	18.00
250.0	30.80	0.35	32.3	7.91	17.78
→ 290.0	33.11	0.55	39.6	8.14	17.77
300.0	33.74	0.58	41.6	8.22	17.82
350.0	36.33	0.93	52.2	8.62	18.32
400.0	38.41	1.44	66.0	9.01	18.86
450.0	40.17	1.74	84.9	9.40	19.47

A Delmag D19-32 is suitable to drive piles at EB-2.

GRLWEAP - Version 2010
WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS

written by GRL Engineers, Inc. (formerly Goble Rausche Likins and Associates, Inc.) with cooperation from Pile Dynamics, Inc.

ABOUT THE WAVE EQUATION ANALYSIS RESULTS

The GRLWEAP program simulates the behavior of a preformed pile driven by either an impact hammer or a vibratory hammer. The program is based on mathematical models, which describe motion and forces of hammer, driving system, pile and soil under the hammer action. Under certain conditions, the models only crudely approximate, often complex, dynamic situations.

A wave equation analysis generally relies on input data, which represents normal situations. In particular, the hammer data file supplied with the program assumes that the hammer is in good working order. All of the input data selected by the user may be the best available information at the time when the analysis is performed. However, input data and therefore results may significantly differ from actual field conditions.

Therefore, the program authors recommend prudent use of the GRLWEAP results. Soil response and hammer performance should be verified by static and/or dynamic testing and measurements. Estimates of bending or other local stresses (e.g., helmet or clamp contact, uneven rock surfaces etc.), prestress effects and others must also be accounted for by the user.

The calculated capacity - blow count relationship, i.e. the bearing graph, should be used in conjunction with observed blow counts for the capacity assessment of a driven pile. Soil setup occurring after pile installation may produce bearing capacity values that differ substantially from those expected from a wave equation analysis due to soil setup or relaxation. This is particularly true for pile driven with vibratory hammers. The GRLWEAP user must estimate such effects and should also use proper care when applying blow counts from restrike because of the variability of hammer energy, soil resistance and blow count during early restriking.

Finally, the GRLWEAP capacities are ultimate values. They MUST be reduced by means of an appropriate factor of safety to yield a design or working load. The selection of a factor of safety should consider the quality of the construction control, the variability of the site conditions, uncertainties in the loads, the importance of building and other factors.

Input File: C:\USERS\MWALKO\ONEDRIVE - ECS CORPORATE SERVICES\HOME DIR\WORKING FILES TO MOVE\GREENSBORO PROJECTS\09-29600 YADKIN 016\WEAP ANALYSIS\END BENT 2 DELMAG D19-32.GWW
Hammer File: C:\ProgramData\PDI\GRLWEAP\2010\Resource\HAMMER2010.GW
Hammer File Version: 2003 (12/4/2018)

Input File Contents

Yadkin Bridge 016 - End Bent 2

OUT	OSG	HAM	STR	FUL	PEL	N	SPL	N-U	P-D	%SK	ISM	0	PHI	RSA	ITR	H-D	MXT	DEx
6	0	40	0	1	0	0	0	0	0	17	1	0	0	0	0	0	0	0.000

Pile g	Hammer g	Toe Area	Pile Size	Pile Type
32.170	32.170	141.890	12.040	H Pile

W Cp	A Cp	E Cp	T Cp	CoR	ROut	StCp
1.900	227.000	530.0	2.000	0.800	0.010	0.0

A Cu	E Cu	T Cu	CoR	ROut	StCu
0.000	0.0	0.000	0.000	0.000	0.0

LPle	APle	EPle	WPle	Peri	CI	CoR	ROut
30.000	15.50	30000.0	492.000	3.970	0	0.850	0.010

FFatigue	F0	0-Bottom
0	0.000	0.000

Manufac	Hmr Name	HmrType	No Seg-s
DELMAG	D 19-32	1	5

Ram Wt	Ram L	Ram Dia	MaxStrk	RtdStrk	Efficy
4.00	129.10	12.60	11.76	10.61	0.80

IB. Wt	IB. L	IB.Dia	IB CoR	IB RO
0.75	25.30	12.60	0.900	0.010

CompStrk	A Chamber	V Chamber	C Delay	C Duratn	Exp Coeff	VolCStart	Vol CEnd
15.50	124.70	157.70	0.0020	0.0020	1.250	0.00	0.00

P atm	P1	P2	P3	P4	P5
14.70	1580.00	1420.00	1280.00	1150.00	0.00

Stroke	Effic.	Pressure	R-Weight	T-Delay	Exp-Coeff	Eps-Str	Total-AW
10.6100	0.8000	1580.0000	0.0000	0.0000	0.0000	0.0100	0.0000

Qs	Qt	Js	Jt	Qx	Jx	Rati	Dept
0.100	0.100	0.190	0.100	0.000	0.000	0.000	0.000

Research Soil Model: Atoe, Plug, Gap, Q-fac

0.000	0.000	0.000	0.000

Research Soil Model: RD-skn: m, d, toe: m, d

0.000	0.000	0.000	0.000

Research Toe Plug: Res-int, Q-int, D-int, Res-plug, Q-plug, D-plug

0.000	0.000	0.000	0.000	0.000	0.000

Research Toe Plug: RD plug toe: m, d

0.000	0.000

Research Toe Plug: New Toe Plug Model is NOT applied

Res. Distribution

Dpth	Rskn	Dpth	Dpth						
0.00	0.00	26.60	26.60	0.00	0.00	0.00	0.00	0.00	0.000
4.60	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
4.60	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
8.60	0.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
8.60	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
18.60	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
18.60	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
25.60	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
25.60	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
26.60	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
26.60	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
30.00	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000

Rult

50.0	100.0	150.0	200.0	250.0	290.0	300.0	350.0	400.0	450.0

GRLWEAP: WAVE EQUATION ANALYSIS OF PILE FOUNDATIONS
Version 2010
English Units

Yadkin Bridge 016 - End Bent 2

Hammer Model: D 19-32 Made by: DELMAG

No.	Weight kips	Stiffn k/inch	CoR	C-Slk ft	Dampg k/ft/s
1	0.800				
2	0.800	140046.6	1.000	0.0000	
3	0.800	140046.6	1.000	0.0000	
4	0.800	140046.6	1.000	0.0000	
5	0.800	140046.6	1.000	0.0000	
Imp Block	0.753	70735.6	0.900	0.0100	
Helmet	1.900	60155.0	0.800	0.0100	5.8
Combined Pile Top		11625.0			

HAMMER OPTIONS:

Hammer File ID No.	40	Hammer Type	OE Diesel
Stroke Option	FxdP-VarS	Stroke Convergence Crit.	0.010
Fuel Pump Setting	Maximum		

HAMMER DATA:

Ram Weight	(kips)	4.00	Ram Length	(inch)	129.10
Maximum Stroke	(ft)	11.76			
Rated Stroke	(ft)	10.61	Efficiency		0.800
Maximum Pressure	(psi)	1580.00	Actual Pressure	(psi)	1580.00
Compression Exponent		1.350	Expansion Exponent		1.250
Ram Diameter	(inch)	12.60			
Combustion Delay	(s)	0.00200	Ignition Duration	(s)	0.00200

The Hammer Data Includes Estimated (NON-MEASURED) Quantities

HAMMER CUSHION			PILE CUSHION		
Cross Sect. Area	(in2)	227.00	Cross Sect. Area	(in2)	0.00
Elastic-Modulus	(ksi)	530.0	Elastic-Modulus	(ksi)	0.0
Thickness	(inch)	2.00	Thickness	(inch)	0.00
Coeff of Restitution		0.8	Coeff of Restitution		0.0
RoundOut	(ft)	0.0	RoundOut	(ft)	0.0
Stiffness	(kips/in)	60155.0	Stiffness	(kips/in)	0.0

PILE PROFILE:

Toe Area	(in2)	141.890	Pile Type	H Pile
Pile Size	(inch)	12.040		

L b Top ft	Area in2	E-Mod ksi	Spec Wt lb/ft3	Perim ft	C Index	Wave Sp ft/s	EA/c k/ft/s
0.0	15.50	30000.	492.0	4.0	0	16807.	27.7
30.0	15.50	30000.	492.0	4.0	0	16807.	27.7

Wave Travel Time 2L/c (ms) 3.570

Pile and Soil Model — Total Capacity Rut (kips) 50.0

No.	Weight kips	Stiffn k/in	C-Slk ft	T-Slk ft	CoR	Soil-S kips	Soil-D s/ft	Quake inch	LbTop ft	Perim ft	Area in2
1	0.177	11625	0.010	0.000	0.85	0.0	0.190	0.100	3.33	4.0	15.5
2	0.177	11625	0.000	0.000	1.00	0.1	0.190	0.100	6.67	4.0	15.5
3	0.177	11625	0.000	0.000	1.00	1.3	0.190	0.100	10.00	4.0	15.5
4	0.177	11625	0.000	0.000	1.00	1.4	0.190	0.100	13.33	4.0	15.5
5	0.177	11625	0.000	0.000	1.00	0.7	0.190	0.100	16.67	4.0	15.5
6	0.177	11625	0.000	0.000	1.00	0.7	0.190	0.100	20.00	4.0	15.5
7	0.177	11625	0.000	0.000	1.00	0.9	0.190	0.100	23.33	4.0	15.5
8	0.177	11625	0.000	0.000	1.00	1.2	0.190	0.100	26.67	4.0	15.5
9	0.177	11625	0.000	0.000	1.00	2.1	0.190	0.100	30.00	4.0	15.5
Toe						41.5	0.100	0.100			

1.589 kips total unreduced pile weight (g= 32.17 ft/s2)
1.589 kips total reduced pile weight (g= 32.17 ft/s2)

PILE, SOIL, ANALYSIS OPTIONS:

Uniform pile		Pile Segments: Automatic	
No. of Slacks/Splices	0	Pile Damping (%)	1
Pile Penetration (ft)	26.60	Pile Damping Fact.(k/ft/s)	0.553
% Shaft Resistance	17		
Soil Damping Option	Smith		
Max No Analysis Iterations	0	Time Increment/Critical	160
Output Time Interval	1	Analysis Time-Input (ms)	0
Output Level: Variable vs Time			
Gravity Mass, Pile, Hammer:	32.170	32.170 32.170	
Output Segment Generation: Automatic			

Rut= 50.0, Rtoe = 41.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	292.3	0.00	18.86	11.33	2.971	22.83
2	0.0	293.5	0.00	18.94	12.07	2.968	22.84
3	0.0	295.0	0.00	19.03	12.67	2.965	22.47
4	0.0	293.0	0.00	18.90	12.72	2.961	21.71
5	0.0	290.6	0.00	18.75	12.52	2.958	21.13
6	0.0	288.7	0.00	18.63	12.86	2.955	20.75
7	0.0	277.5	0.00	17.90	13.89	2.952	20.29
8	0.0	243.3	0.00	15.69	14.93	2.948	19.68
9	0.0	176.9	0.00	11.41	15.68	2.945	19.33

(Eq) Strokes Analyzed and Last Return (ft):
10.61 3.88 4.93 4.54 4.67 4.63

Max. Combustion Pressure 1580.0 psi

Rut= 100.0, Rtoe= 83.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	364.0	0.00	23.48	11.91	1.377	19.69
2	-1.3	366.6	-0.08	23.65	11.79	1.370	19.66
3	-2.3	369.9	-0.15	23.87	11.69	1.362	19.31
4	-1.8	365.8	-0.11	23.60	11.64	1.355	18.62
5	-1.1	360.3	-0.07	23.24	11.59	1.347	18.08
6	-1.3	358.8	-0.08	23.15	11.75	1.339	17.72
7	-1.3	348.9	-0.08	22.51	13.26	1.332	17.30
8	-1.2	316.2	-0.08	20.40	14.67	1.324	16.74
9	-0.9	268.8	-0.06	17.34	15.72	1.317	16.42

(Eq) Strokes Analyzed and Last Return (ft):
10.61 5.17 6.03 5.83 5.88

Max. Combustion Pressure 1580.0 psi

Rut= 150.0, Rtoe= 124.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	414.1	0.00	26.72	13.57	0.919	18.69
2	-3.0	417.5	-0.19	26.94	13.41	0.907	18.61
3	-5.4	423.0	-0.35	27.29	13.22	0.895	18.21
4	-4.3	416.4	-0.28	26.86	13.10	0.884	17.47
5	-2.8	406.6	-0.18	26.24	13.00	0.872	16.89
6	-2.6	404.1	-0.17	26.07	13.01	0.861	16.50
7	-2.1	393.4	-0.14	25.38	13.84	0.849	16.04
8	-1.4	360.9	-0.09	23.28	14.45	0.838	15.48
9	-0.6	348.8	-0.04	22.51	14.69	0.827	15.13

(Eq) Strokes Analyzed and Last Return (ft):
10.61 6.41 6.84 6.78

Max. Combustion Pressure 1580.0 psi

Rut= 200.0, Rtoe = 166.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	442.7	0.00	28.56	14.50	0.718	18.00
2	-2.6	447.3	-0.17	28.86	14.29	0.702	17.86
3	-4.5	454.7	-0.29	29.34	14.03	0.686	17.38
4	-1.6	445.1	-0.10	28.72	13.81	0.671	16.54
5	0.0	430.7	0.00	27.79	13.66	0.656	15.90
6	0.0	427.6	0.00	27.59	13.59	0.640	15.44
7	0.0	416.7	0.00	26.88	14.14	0.625	14.94
8	0.0	396.9	0.00	25.60	14.35	0.610	14.34
9	0.0	418.2	0.00	26.98	12.87	0.595	13.96

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.25 7.47 7.45

Max. Combustion Pressure 1580.0 psi

Rut= 250.0, Rtoe= 207.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	462.1	0.00	29.81	15.12	0.628	17.78
2	-3.1	467.8	-0.20	30.18	14.86	0.607	17.54
3	-5.4	477.3	-0.35	30.80	14.51	0.586	16.92
4	-1.1	464.5	-0.07	29.97	14.21	0.567	15.95
5	0.0	445.4	0.00	28.73	14.00	0.547	15.18
6	0.0	440.9	0.00	28.45	13.86	0.528	14.64
7	0.0	429.3	0.00	27.70	14.20	0.509	14.06
8	0.0	455.7	0.00	29.40	14.06	0.490	13.40
9	0.0	476.1	0.00	30.72	11.59	0.471	12.97

(Eq) Strokes Analyzed and Last Return (ft):
10.61 7.79 7.91 7.90

Max. Combustion Pressure 1580.0 psi

Rut= 290.0, Rtoe= 240.7 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	472.1	0.00	30.46	15.43	0.593	17.77
2	-4.8	479.4	-0.31	30.93	15.15	0.567	17.41
3	-8.6	490.2	-0.55	31.62	14.71	0.541	16.63
4	-4.4	474.4	-0.28	30.61	14.34	0.516	15.48
5	0.0	451.6	0.00	29.14	14.11	0.492	14.57
6	0.0	446.5	0.00	28.81	13.92	0.469	13.93
7	0.0	445.7	0.00	28.76	14.10	0.446	13.28
8	0.0	492.8	0.00	31.79	13.76	0.424	12.57
9	0.0	513.3	0.00	33.11	10.98	0.403	12.10

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.14 8.20

Max. Combustion Pressure 1580.0 psi

Rut= 300.0, Rtoe = 249.0 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	475.8	0.00	30.69	15.54	0.587	17.82
2	-4.9	483.0	-0.32	31.16	15.26	0.560	17.43
3	-9.0	494.2	-0.58	31.88	14.81	0.533	16.61
4	-4.6	478.0	-0.30	30.84	14.41	0.507	15.40
5	0.0	454.1	0.00	29.30	14.17	0.482	14.46
6	0.0	448.4	0.00	28.93	13.97	0.457	13.78
7	0.0	456.6	0.00	29.46	14.11	0.434	13.10
8	0.0	503.7	0.00	32.49	13.76	0.411	12.38
9	0.0	522.9	0.00	33.74	10.89	0.388	11.89

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.22 8.28

Max. Combustion Pressure 1580.0 psi

Rut= 350.0, Rtoe= 290.5 kips, Time Inc. =0.076 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	521.4	0.00	33.64	16.06	0.572	18.32
2	-8.3	501.2	-0.53	32.34	15.75	0.538	17.74
3	-14.5	513.7	-0.93	33.14	15.18	0.505	16.67
4	-9.7	507.5	-0.63	32.74	14.69	0.474	15.20
5	-3.7	483.6	-0.24	31.20	14.42	0.443	14.06
6	-3.9	473.9	-0.25	30.57	14.15	0.414	13.21
7	-3.8	499.2	-0.24	32.20	14.14	0.384	12.36
8	-3.0	544.3	-0.19	35.12	13.56	0.356	11.52
9	-1.2	563.1	-0.07	36.33	10.30	0.330	10.94

(Eq) Strokes Analyzed and Last Return (ft):
10.61 8.62 8.64

Max. Combustion Pressure 1580.0 psi

Rut= 400.0, Rtoe= 332.0 kips, Time Inc. =0.071 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	576.0	0.00	37.16	16.57	0.562	18.86
2	-12.4	551.1	-0.80	35.56	16.20	0.524	18.10
3	-22.4	546.4	-1.44	35.25	15.55	0.485	16.78
4	-18.5	551.6	-1.19	35.59	14.97	0.448	15.01
5	-12.5	527.0	-0.80	34.00	14.65	0.414	13.64
6	-12.6	513.3	-0.81	33.12	14.33	0.380	12.63
7	-10.2	536.1	-0.66	34.59	14.17	0.345	11.62
8	-6.4	580.0	-0.42	37.42	13.40	0.312	10.62
9	-2.4	595.4	-0.16	38.41	9.84	0.282	9.93

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.01 9.01

Max. Combustion Pressure 1580.0 psi

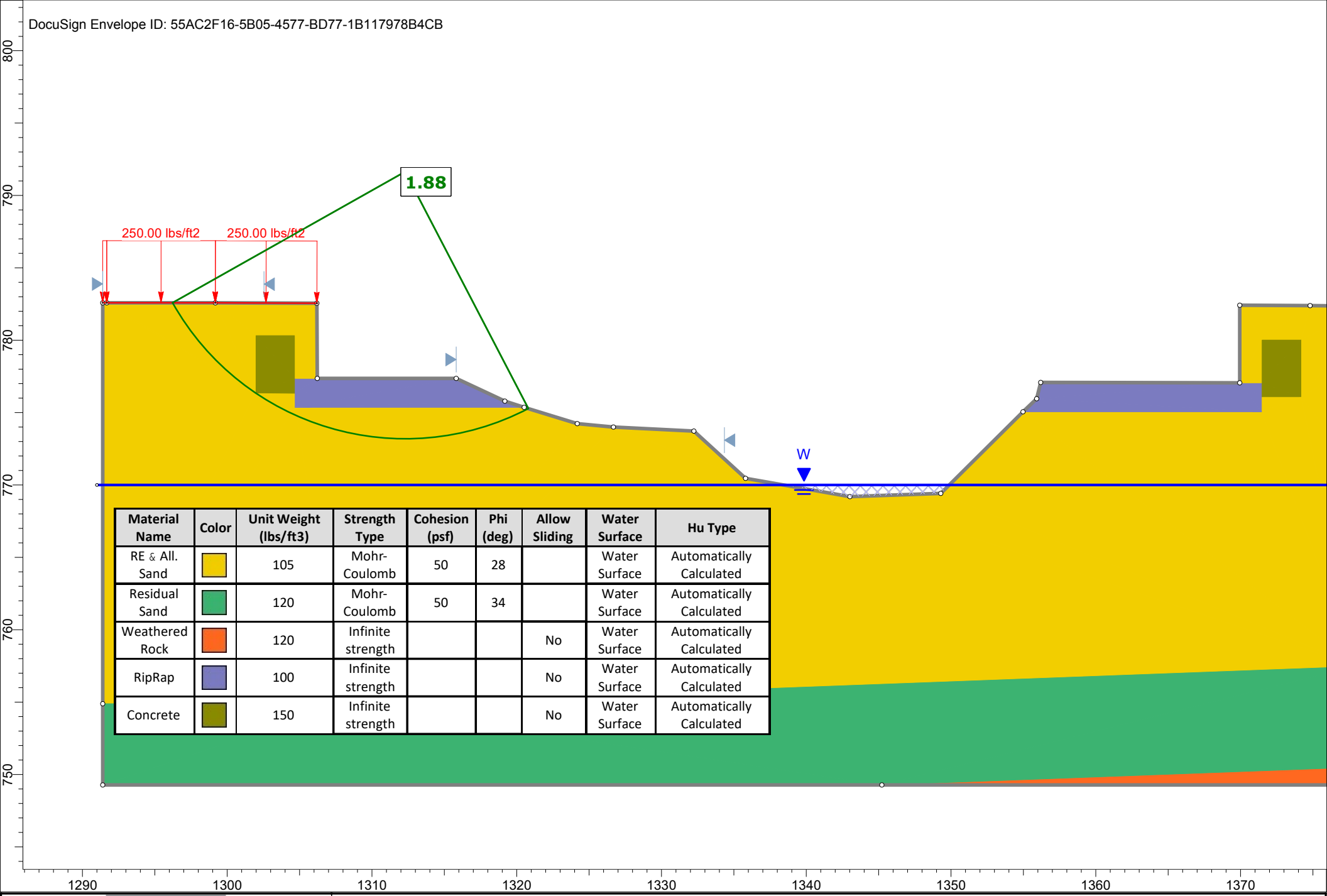
Rut= 450.0, Rtoe = 373.5 kips, Time Inc. =0.066 ms

No	mxTForce kips	mxCForce kips	mxTStrss ksi	mxCStrss ksi	max V ft/s	max D inch	max Et kip-ft
1	0.0	621.2	0.00	40.08	17.05	0.557	19.47
2	-14.9	594.8	-0.96	38.37	16.67	0.514	18.53
3	-27.0	588.4	-1.74	37.96	15.90	0.471	16.96
4	-23.3	589.7	-1.50	38.05	15.22	0.430	14.88
5	-16.7	566.0	-1.08	36.52	14.86	0.391	13.26
6	-16.7	546.8	-1.08	35.28	14.47	0.352	12.08
7	-14.0	566.8	-0.91	36.57	14.19	0.314	10.90
8	-8.9	607.8	-0.58	39.21	13.24	0.276	9.74
9	-3.9	622.7	-0.25	40.17	9.35	0.241	8.92

(Eq) Strokes Analyzed and Last Return (ft):
10.61 9.40 9.32

Max. Combustion Pressure 1580.0 psi

Rut kips	Bl Ct b/ft	Stroke (ft) down	up	Ten Str ksi	i	t	Comp Str ksi	i	t	ENTHRU kip-ft	Bl Rt b/min
50.0	4.2	4.67	4.63	0.00	1	0	19.03	3	2	22.8	54.9
100.0	9.9	5.83	5.88	-0.15	3	38	23.87	3	2	19.7	48.7
150.0	16.5	6.84	6.78	-0.35	3	49	27.29	3	2	18.7	45.2
200.0	24.2	7.47	7.45	-0.29	3	42	29.34	3	2	18.0	43.2
250.0	32.3	7.91	7.90	-0.35	3	37	30.80	3	2	17.8	42.1
290.0	39.6	8.14	8.20	-0.55	3	34	33.11	9	4	17.8	41.4
300.0	41.6	8.22	8.28	-0.58	3	33	33.74	9	4	17.8	41.2
350.0	52.2	8.62	8.64	-0.93	3	31	36.33	9	4	18.3	40.3
400.0	66.0	9.01	9.01	-1.44	3	30	38.41	9	4	18.9	39.4
450.0	84.9	9.40	9.32	-1.74	3	29	40.17	9	4	19.5	38.7



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Hu Type
RE & All. Sand		105	Mohr-Coulomb	50	28		Water Surface	Automatically Calculated
Residual Sand		120	Mohr-Coulomb	50	34		Water Surface	Automatically Calculated
Weathered Rock		120	Infinite strength			No	Water Surface	Automatically Calculated
RipRap		100	Infinite strength			No	Water Surface	Automatically Calculated
Concrete		150	Infinite strength			No	Water Surface	Automatically Calculated

SLIDEINTERPRET 9.023

Project	Bridge No. 16 on SR 1166 over UT to South Deep Creek		
Group	Group 1	Scenario	Master Scenario
Drawn By	KND	Company	ECS Southeast, LLP
Date	8/7/2023, 7:22:22 AM	File Name	Bridge No. 16.slmd

rocscience

Bridge No. 16
Bridge No. 16 on SR 1166 over UT to South Deep Creek
ECS Southeast, LLP
Date Created: 8/7/2023, 7:22:22 AM
Software Version: 9.023

Table of Contents

Slide2 Analysis Information

Bridge No. 16

Project Summary

File Name:	Bridge No. 16.slmd
Slide2 Modeler Version:	9.023
Compute Time:	00h:00m:00.826s
Project Title:	Bridge No. 16 on SR 1166 over UT to South Deep Creek
Analysis:	End Bent No. 1
Author:	KND
Company:	ECS Southeast, LLP
Date Created:	8/7/2023, 7:22:22 AM

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes
Eliminate vertical segments in non-circular search	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Loading

1 Distributed Load present

Distributed Load 1	
Distribution:	Constant
Magnitude [psf]:	250
Orientation:	Normal to boundary

Materials

RE & All. Sand	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	105
Cohesion [psf]	50
Friction Angle [deg]	28
Water Surface	Water Table
Hu Value	Automatically Calculated
Residual Sand	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	50
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	Automatically Calculated
Weathered Rock	
Color	
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	120
Allow Sliding Along Boundary	No
Water Surface	Water Table
Hu Value	Automatically Calculated
RipRap	
Color	
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	100
Allow Sliding Along Boundary	No
Water Surface	Water Table
Hu Value	Automatically Calculated
Concrete	
Color	
Strength Type	Infinite strength
Unit Weight [lbs/ft3]	150
Allow Sliding Along Boundary	No
Water Surface	Water Table
Hu Value	Automatically Calculated

Global Minimums

Method: spencer

FS	1.876740
Center:	1312.294, 791.641
Radius:	18.447
Left Slip Surface Endpoint:	1296.219, 782.593
Right Slip Surface Endpoint:	1320.810, 775.277
Resisting Moment:	158878 lb-ft
Driving Moment:	84656.3 lb-ft
Resisting Horizontal Force:	7589.99 lb
Driving Horizontal Force:	4044.24 lb
Total Slice Area:	99.5305 ft2
Surface Horizontal Width:	24.5912 ft
Surface Average Height:	4.0474 ft

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	3628
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.87674

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.491824	21.2502	-59.1375	RE & All. Sand	50	28	65.8143	123.516	138.264	0	138.264	248.395	248.395
2	0.491824	61.5222	-56.2726	RE & All. Sand	50	28	81.9149	153.733	195.094	0	195.094	317.793	317.793
3	0.491824	97.7744	-53.6093	RE & All. Sand	50	28	97.5084	182.998	250.133	0	250.133	382.435	382.435
4	0.491824	130.746	-51.1052	RE & All. Sand	50	28	112.62	211.359	303.472	0	303.472	443.07	443.07
5	0.491824	160.958	-48.7306	RE & All. Sand	50	28	127.277	238.865	355.204	0	355.204	500.236	500.236
6	0.491824	188.793	-46.4636	RE & All. Sand	50	28	141.502	265.562	405.413	0	405.413	554.336	554.336
7	0.491824	214.493	-44.2876	RE & All. Sand	50	28	155.352	291.555	454.3	0	454.3	605.836	605.836
8	0.491824	238.283	-42.1896	RE & All. Sand	50	28	168.736	316.674	501.541	0	501.541	654.486	654.486
9	0.491824	260.401	-40.1592	RE & All. Sand	50	28	181.746	341.09	547.46	0	547.46	700.826	700.826
10	0.491824	280.998	-38.1879	RE & All. Sand	50	28	194.397	364.833	592.115	0	592.115	745.024	745.024
11	0.491824	300.197	-36.2687	RE & All. Sand	50	28	206.705	387.931	635.555	0	635.555	787.221	787.221
12	0.491824	349.494	-34.3956	RE & All. Sand	50	28	232.514	436.369	726.655	0	726.655	885.835	885.835
13	0.491824	423.412	-32.5636	RE & All. Sand	50	28	270.173	507.045	859.578	0	859.578	1032.12	1032.12
14	0.491824	439.077	-30.7684	RE & All. Sand	50	28	282.34	529.879	902.521	0	902.521	1070.62	1070.62
15	0.491824	453.672	-29.006	RE & All. Sand	50	28	294.196	552.13	944.37	0	944.37	1107.49	1107.49
16	0.491824	467.254	-27.2733	RE & All. Sand	50	28	305.753	573.819	985.16	0	985.16	1142.79	1142.79
17	0.491824	479.87	-25.5671	RE & All. Sand	50	28	317.02	594.965	1024.93	0	1024.93	1176.6	1176.6
18	0.491824	419.788	-23.885	RE & All. Sand	50	28	292.693	549.309	939.064	0	939.064	1068.68	1068.68
19	0.491824	408.224	-22.2245	RE & All. Sand	50	28	291.62	547.295	935.277	0	935.277	1054.43	1054.43
20	0.491824	418.073	-20.5835	RE & All. Sand	50	28	301.238	565.346	969.224	0	969.224	1082.35	1082.35
21	0.491824	241.199	-18.9599	RE & All. Sand	50	28	169.128	317.409	502.923	0	502.923	561.026	561.026
22	0.491824	167.296	-17.352	RE & All. Sand	50	28	114.284	214.481	309.342	0	309.342	345.052	345.052
23	0.491824	174.848	-15.7581	RE & All. Sand	50	28	119.922	225.062	329.243	0	329.243	363.083	363.083
24	0.491824	181.639	-14.1766	RE & All. Sand	50	28	125.287	235.132	348.184	0	348.184	379.832	379.832
25	0.491824	187.687	-12.6061	RE & All. Sand	50	28	130.377	244.683	366.147	0	366.147	395.304	395.304
26	0.491824	193.006	-11.0452	RE & All. Sand	50	28	135.184	253.706	383.115	0	383.115	409.502	409.502
27	0.491824	197.608	-9.49247	RE & All. Sand	50	28	139.704	262.189	399.068	0	399.068	422.428	422.428
28	0.491824	201.504	-7.94681	RE & All. Sand	50	28	143.931	270.121	413.989	0	413.989	434.081	434.081
29	0.491824	204.703	-6.40694	RE & All. Sand	50	28	147.858	277.491	427.847	0	427.847	444.45	444.45
30	0.491824	207.212	-4.87172	RE & All. Sand	50	28	151.477	284.283	440.622	0	440.622	453.533	453.533

31	0.491824	209.035	-3.33999	RE & All. Sand	50	28	154.78	290.482	452.281	0	452.281	461.314	461.314
32	0.491824	210.178	-1.81065	RE & All. Sand	50	28	157.758	296.07	462.79	0	462.79	467.777	467.777
33	0.491824	210.642	-0.282608	RE & All. Sand	50	28	160.399	301.027	472.113	0	472.113	472.904	472.904
34	0.491824	210.428	1.24524	RE & All. Sand	50	28	162.693	305.333	480.211	0	480.211	476.675	476.675
35	0.491824	209.537	2.77397	RE & All. Sand	50	28	164.626	308.961	487.036	0	487.036	479.06	479.06
36	0.491824	207.966	4.30468	RE & All. Sand	50	28	166.185	311.886	492.536	0	492.536	480.026	480.026
37	0.491824	205.711	5.83848	RE & All. Sand	50	28	167.352	314.076	496.654	0	496.654	479.542	479.542
38	0.491824	202.769	7.3765	RE & All. Sand	50	28	168.109	315.497	499.326	0	499.326	477.563	477.563
39	0.491824	199.131	8.91988	RE & All. Sand	50	28	168.436	316.11	500.479	0	500.479	474.043	474.043
40	0.491824	194.648	10.4698	RE & All. Sand	50	28	168.207	315.68	499.671	0	499.671	468.588	468.588
41	0.491824	182.323	12.0276	RE & All. Sand	50	28	162.368	304.722	479.063	0	479.063	444.469	444.469
42	0.491824	165.308	13.5944	RE & All. Sand	50	28	152.898	286.949	445.637	0	445.637	408.663	408.663
43	0.491824	147.555	15.1716	RE & All. Sand	50	28	142.53	267.491	409.043	0	409.043	370.394	370.394
44	0.491824	129.048	16.7608	RE & All. Sand	50	28	131.191	246.211	369.02	0	369.02	329.509	329.509
45	0.491824	109.769	18.3633	RE & All. Sand	50	28	118.794	222.945	325.263	0	325.263	285.83	285.83
46	0.491824	89.6977	19.9809	RE & All. Sand	50	28	105.237	197.503	277.413	0	277.413	239.15	239.15
47	0.491824	68.9661	21.6152	RE & All. Sand	50	28	90.5293	169.9	225.5	0	225.5	189.629	189.629
48	0.491824	49.7515	23.2683	RE & All. Sand	50	28	76.3921	143.368	175.6	0	175.6	142.75	142.75
49	0.491824	30.457	24.9421	RE & All. Sand	50	28	61.4628	115.35	122.905	0	122.905	94.3198	94.3198
50	0.491824	10.2779	26.6391	RE & All. Sand	50	28	44.7299	83.9464	63.8438	0	63.8438	41.4066	41.4066

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.87674

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	1296.22	782.593	0	0	0
2	1296.71	781.77	81.3351	22.8511	15.6927
3	1297.2	781.033	184.664	51.8815	15.6928
4	1297.69	780.366	303.498	85.268	15.6927
5	1298.19	779.756	432.97	121.643	15.6927
6	1298.68	779.196	569.275	159.938	15.6927
7	1299.17	778.678	709.345	199.291	15.6927
8	1299.66	778.198	850.169	238.855	15.6927
9	1300.15	777.752	990.024	278.148	15.6927
10	1300.65	777.337	1127.09	316.656	15.6927
11	1301.14	776.95	1259.77	353.933	15.6927
12	1301.63	776.59	1386.67	389.585	15.6927
13	1302.12	776.253	1516.16	425.965	15.6927
14	1302.61	775.939	1652.4	464.241	15.6927
15	1303.1	775.646	1776.92	499.227	15.6927
16	1303.6	775.373	1888.85	530.672	15.6927
17	1304.09	775.12	1987.35	558.346	15.6927
18	1304.58	774.884	2071.66	582.033	15.6927
19	1305.07	774.667	2131.33	598.797	15.6927
20	1305.56	774.466	2174.95	611.053	15.6927
21	1306.06	774.281	2204.9	619.467	15.6927
22	1306.55	774.112	2206.33	619.868	15.6927
23	1307.04	773.958	2197.51	617.391	15.6927
24	1307.53	773.82	2184.07	613.615	15.6927
25	1308.02	773.695	2165.55	608.411	15.6927
26	1308.51	773.585	2141.53	601.663	15.6927
27	1309.01	773.489	2111.65	593.268	15.6927
28	1309.5	773.407	2075.58	583.134	15.6927
29	1309.99	773.338	2033.03	571.179	15.6927
30	1310.48	773.283	1983.74	557.333	15.6927
31	1310.97	773.241	1927.52	541.537	15.6927
32	1311.47	773.213	1864.18	523.741	15.6927
33	1311.96	773.197	1793.58	503.907	15.6927
34	1312.45	773.195	1715.63	482.007	15.6927
35	1312.94	773.205	1630.27	458.025	15.6927
36	1313.43	773.229	1537.49	431.957	15.6927
37	1313.92	773.266	1437.31	403.811	15.6927
38	1314.42	773.316	1329.8	373.609	15.6928
39	1314.91	773.38	1215.12	341.387	15.6927
40	1315.4	773.457	1093.42	307.198	15.6928
41	1315.89	773.548	965.067	271.136	15.6927
42	1316.38	773.653	834.802	234.538	15.6927
43	1316.88	773.772	706.406	198.465	15.6927
44	1317.37	773.905	581.571	163.393	15.6928
45	1317.86	774.053	462.219	129.861	15.6928
46	1318.35	774.217	350.539	98.4841	15.6927
47	1318.84	774.395	249.038	69.9672	15.6927
48	1319.33	774.59	160.452	45.079	15.6927
49	1319.83	774.802	85.6444	24.0618	15.6927
50	1320.32	775.031	27.2236	7.64847	15.6927
51	1320.81	775.277	0	0	0

Discharge Sections

Entity Information

Group 1

Shared Entities

Type	Coordinates (x,y)
External Boundary	1291.4, 749.282 1345.22, 749.282 1388.68, 749.282 1388.68, 750.5 1388.68, 757.5 1388.68, 782.281 1384.18, 782.318 1379.18, 782.358 1374.81, 782.393 1369.95, 782.427 1369.95, 777.06 1356.2, 777.084 1355.91, 775.962 1354.97, 775.06 1349.29, 769.418 1343.01, 769.2 1335.8, 770.459 1332.24, 773.733 1326.69, 774.006 1324.19, 774.241 1320.51, 775.37 1319.18, 775.804 1315.81, 777.37 1306.22, 777.37 1306.2, 782.563 1299.18, 782.593 1291.68, 782.593 1291.4, 782.593 1291.4, 754.9
Material Boundary	1306.22, 777.37 1304.7, 777.37 1304.7, 776.344 1304.7, 775.37 1320.51, 775.37
Material Boundary	1354.97, 775.06 1371.45, 775.06 1371.45, 776.06 1371.45, 777.06 1369.95, 777.06
Material Boundary	1291.4, 754.9 1308, 754.9 1378, 757.5 1388.68, 757.5

Material Boundary	1345.22, 749.282 1378, 750.5 1388.68, 750.5
Material Boundary	1301.95, 776.37 1304.7, 776.344
Material Boundary	1301.95, 776.37 1301.95, 780.37 1304.7, 780.37 1304.7, 777.37
Material Boundary	1371.45, 777.06 1371.45, 780.06
Material Boundary	1371.45, 776.06 1374.2, 776.06 1374.2, 780.06 1371.45, 780.06

Scenario-based Entities

Type	Coordinates (x,y)	Master Scenario
Water Table	1291, 770 1388.68, 770	Assigned to: RE & All. Sand Residual Sand Weathered Rock RipRap Concrete
Distributed Load	1306.2, 782.563 1299.18, 782.593 1291.68, 782.593 1291.4, 782.593	Constant DistributionOrientation: Normal to boundaryMagnitude: 250 lbs/ft2Creates Excess Pore Pressure: No