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Foundation Recommendation and Subsurface Investigation Report
April 29, 2013

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FOUNDATION RECOMMENDATION AND SUBSURFACE INVESTIGATION REPORT
NCRR/NS BRIDGE OVER MALLARD CREEK CHURCH ROAD
WBS NO. 50000.1.STR11T1B
TIP NO. P-5208G
F.A. NO. N/A
PITT COUNTY, NORTH CAROLINA
KLEINFELDER PROJECT NO. 127855

Prepared for:
AECOM
701 Corporate Center Drive, Suite 475
Raleigh, North Carolina 27607

Prepared By:
Kleinfelder Southeast, Inc.
313 Gallimore Dairy Road
Greensboro, North Carolina 27409

April 29, 2013

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KLEINFELDER
Bright People. Right Solutions.

April 29, 2013
File: 127855 | GSO13R0175

Mr. Len Hill, P.E.
AECOM
701 Corporate Center Drive, Suite 475
Raleigh, North Carolina 27607

Subject: **Foundation Recommendation and Subsurface Investigation Report**
NCRR/NS Bridge over Mallard Creek Church Road
Mecklenburg County, North Carolina
TIP No. P-5208G

Dear Mr. Hill:

Kleinfelder has completed the authorized structure foundation recommendation and subsurface investigation report for the above referenced project. Included in the Appendix are the Foundation Recommendation Summary Sheets, notes and comments, and calculations for vertical pile capacity, wave equation analysis for driven piles, vertical drilled pier capacity, lateral analysis of drilled piers, end bent slope stability structural loading conditions, structure plans, and subsurface investigation report.

Kleinfelder appreciates the opportunity to continue our services to you on this project. Should you have any questions or require additional information, please call.

Respectfully submitted,

KLEINFELDER SOUTHEAST, INC.

NORTH CAROLINA PROFESSIONAL SEAL 37998 ENGINEER THOMAS R. WELLS

Thomas R. Wells, P.E. 4/29/13
North Carolina License No. 37998

Xavier C. Barrett, P.E.
Principal Professional

TRW/XCB:cas
Attachments

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FOUNDATION RECOMMENDATIONS

PROJECT	50000.1.STR11T1B	DESCRIPTION	NCRR/NS Railroad Bridge
TIP NO.	P-5208G		over Mallard Creek Church Road
COUNTY	Mecklenburg		
STATION	10640+78.96		

	INITIALS	DATE
DESIGN	TRW	4/29/13
CHECK	XCB	4/29/13

P.E. SEAL

NORTH CAROLINA PROFESSIONAL SEAL 37998 ENGINEER THOMAS R. WELLS

4/29/13

SIGNATURE

	BENT STATION	FOUNDATION TYPE	ALLOWABLE BEARING CAPACITY	ADDITIONAL INFORMATION
END BENT 1	10639+80.80 -M1G-	Cap on HP 12 x 53 Steel H-Piles	90 Tons/Pile	Bottom of Cap Elev. = 715.80 ft Average Estimated Pile Length = 30 to 45 ft (L to R) Number of Piles/Cap = 47
BENT 1	10640+20.80 -M1G-	Column on 72" Diameter Drilled Pier	1,495, 1,980, 1,710 (L,C,R) Tons/Pier	Bottom of Cap Elev. = 710.20 ft Point of Fixity Elev. = 671.5, 669.0, 668.5 ft (L,C,R) Tip No Higher Than Elev. = 663.0, 657.5, 662.5 ft (L,C,R) Number of Piers/Cap = 3
BENT 3	10641+37.30 -M1G-	Column on 72" Diameter Drilled Pier	1,480, 2,060, 1,705 (L,C,R) Tons/Pier	Bottom of Cap Elev. = 710.30 ft Point of Fixity Elev. = 672.0, 668.5, 679.0 ft (L,C,R) Tip No Higher Than Elev. = 666.0, 660.0, 677.0 ft (L,C,R) Number of Piers/Cap = 3
END BENT 2	10641+79.30 -M1G-	Cap on HP 12 x 53 Steel H-Piles	90 Tons/Pile	Bottom of Cap Elev. = 716.50 ft Average Estimated Pile Length = 45 to 55 ft (L to R) Number of Piles/Cap = 47

(SEE NOTES ON PLANS AND COMMENTS ON FOLLOWING PAGES.)

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FOUNDATION RECOMMENDATIONS NOTES ON PLANS

1. FOR DRILLED PIERS, SEE SPECIAL PROVISIONS.

2. DRILLED PIERS AT BENT NO. 1 AND BENT NO. 2 ARE DESIGNED FOR BOTH SKIN FRICTION AND END BEARING. CHECK FIELD CONDITIONS FOR THE REQUIRED END BEARING CAPACITY OF 100 TSF.

3. DRILLED PIERS AT BENT NO. 1 ARE DESIGNED FOR AN APPLIED LOAD OF 1,495, 1,980, AND 1,710 (L, C, R) TONS EACH AT THE TOP OF THE COLUMN.

4. DRILLED PIERS AT BENT NO. 2 ARE DESIGNED FOR AN APPLIED LOAD OF 1,480, 2,060, AND 1,705 (L, C, R) TONS EACH AT THE TOP OF THE COLUMN.

5. INSTALL DRILLED PIERS AT BENT NO. 1 THAT EXTEND TO AN ELEVATION NO HIGHER THAN 663.0, 657.5, AND 662.5 (L, C, R) FT AND SATISFY THE REQUIRED END BEARING CAPACITY.

6. INSTALL DRILLED PIERS AT BENT NO. 2 THAT EXTEND TO AN ELEVATION NO HIGHER THAN 666.0, 660.0, AND 677.0 (L, C, R) FT AND SATISFY THE REQUIRED END BEARING CAPACITY.

7. DO NOT USE SLURRY CONSTRUCTION FOR DRILLED PIERS AT BENT NO. 1 AND BENT NO. 2.

8. SID INSPECTIONS ARE REQUIRED FOR DRILLED PIERS AT BENT NO. 1 AND BENT NO. 2.

9. CSL TUBES AND TESTING ARE REQUIRED FOR DRILLED PIERS AT BENT NO. 1 AND BENT NO. 2. FOR CROSSHOLE SONIC LOGGING, SEE SPECIAL PROVISIONS.

10. FOR PILES, SEE PECIAL PROVISIONS.

11. DRIVE PILES AT END BENT NO. 1 AND END BENT NO. 2 TO A REQUIRED BEARING CAPACITY OF 180 TONS PER PILE. THE REQUIRED BEARING CAPACITY IS EQUAL TO THE ALLOWABLE BEARING CAPACITY WITH A MINIMUM FACTOR OF SAFETY OF TWO PLUS ANY ADDITIONAL CAPACITY TO ACCOUNT FOR DOWNDRAG OR NEGATIVE SKIN FRICTION AND SCOUR.

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FOUNDATION RECOMMENDATIONS NOTES ON PLANS

12. THE ALLOWABLE BEARING CAPACITY FOR PILES AT END BENT NO. 1 AND END BENT NO. 2 IS 90 TONS PER PILE.

10. IT HAS BEEN ESTIMATED THAT A HAMMER WITH AN EQUIVALENT RATED ENERGY IN THE RANGE OF 27,093 TO 66,198 FT-LBS PER BLOW WILL BE REQUIRED TO DRIVE PILES AT END BENT NO. 1 AND END BENT NO. 2. THIS ESTIMATED ENERGY RANGE DOES NOT RELEASE THE CONTRACTOR FROM ARTICLE 450-5 OF THE STANDARD SPECIFICATIONS.

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NCRR/NS Railroad Bridge Mecklenburg

FOUNDATION RECOMMENDATIONS SPECIAL NOTES ON PLANS

1. FOUNDATION DESIGN WAS PERFORMED USING ASD AND AREMA METHODS.

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FOUNDATION RECOMMENDATIONS COMMENTS

1. Bridge end bent slopes of 2:1 (H:V) are ok with slope protection.

2. Brace piles are required for End Bent No. 1 and End Bent No. 2.

3. The average applied axial load for End Bent No.1 is 81 tons per pile.

4. The average applied axial load for End Bent No.2 is 84 tons per pile.

5. The maximum applied axial load for Bent No.1 is 1,493, 1,979, and 1,711 (L, C, R) tons per pier.

6. The maximum applied axial load for Bent No.2 is 1,481, 2,060, and 1,704 (L, C, R) tons per pier.

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PILE PAY ITEMS

(Revised 8/15/12)

WBS ELEMENT 50000.1.STR11T1B

DATE 4/29/2013

TIP NO. P-5208G

DESIGNED BY TRW

COUNTY Mecklenburg

CHECKED BY XCB

STATION 10639+80.8
10641+79.3

DESCRIPTION NCRR/NS Railroad Bridge over Mallard Creek Church Road

NUMBER OF BENTS WITH PILES
NUMBER OF PILES PER BENT
NUMBER OF END BENTS WITH PILES 2
NUMBER OF PILES PER END BENT 47

Only required for "Predrilling for Piles" & "Pile Excavation" pay items

Bent # or End Bent #	PILE PAY ITEM QUANTITIES						
	Steel Pile Points (yes/no)	Pipe Pile Plates (yes/no/maybe)	Predrilling For Piles (per linear ft)	Pile Redrives (per each)	Pile Excavation (per linear ft)		PDA Testing (per each)
					In Soil	Not In Soil	
End Bent 1	no	no					
End Bent 2	no	no					
TOTALS			0	0	0	0	0

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DRILLED PIER PAY ITEM QUANTITIES

WBS ELEMENT 50000.1.STR11T1B

DATE 4/29/2013

TIP NO. P-5208G

DESIGNED BY TRW

COUNTY Mecklenburg

CHECKED BY XCB

STATION 10640+20.80 -M1G-
10641+37.30 -M1G-

SHEET

DESCRIPTION NCRR/NS Railroad Bridge over Mallard Creek Church Road

NUMBER OF BENTS WITH DRILLED PIERS 2

NUMBER OF DRILLED PIERS PER BENT 3

	DRILLED PIER PAY ITEMS					
BENT #	PERMANENT STEEL CASING FOR 72" DIA. DRILLED PIER (yes/no/maybe)	72" DIA. DRILLED PIERS NOT IN SOIL (per linear foot)	SPT TESTING (per each)	SID INSPECTION* (per each)	CROSSHOLE SONIC LOGGING (per each)	CSL TUBES**
Bent 1	NO	27.0			1	
Bent 2	NO	22.0			1	
TOTALS		49.0		6	2	

* If SID inspections are required with a Note on Plans, show "SID Inspection" pay item per bent or end bent. If SID inspections may be required with a Note on Plans, show "SID Inspection" pay item as a total per structure only (do not show per bent or end bent).

** CSL tubes are required on all drilled piers.

Notes:
Blanks or "no" represent quantity of zero.

If permanent steel casing is required or may be required, Structure Design should calculate the pay item quantity, "Permanent Steel Casing for 72" Dia. Drilled Pier", as the difference between the top of drilled pier elevation or the top of permanent steel casing elevation (whichever is lower) and the elevation the permanent steel casing can not extend below as shown with a Note on Plans.

Structure Design should determine the pay item quantity, 72" Dia. Drilled Piers in Soil", based upon the total drilled pier length per bent or end bent minus the 72" Dia. Drilled Piers not in Soil" per bent or end bent shown in the table above.

Show "Crosshole Sonic Logging" pay item as a total only equal to the anticipated number of drilled piers to be CSL tested. Crosshole Sonic Logging (CSL) tests are required for most bridges with drilled piers. CSL tests and tubes may be omitted by not including the CSL provision in the Contract if, based on the subsurface conditions, there is a low risk of drilled pier construction problems.

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WBS NO.:	50000.1.STR11T1B	TIP NO.:	P-5208G	COUNTY:	Mecklenburg
SUBJECT:	NCRR/NS Railroad Bridge				
	Interior Bent Summary				
PREPARED BY:	TRW	DATE:	4/29/13	STATION:	10640+20.8, 10641+37.3
CHECKED BY:	XCB	DATE:	4/29/13	SHEET: 1 OF	1

INTERIOR BENT 1 Column on 72 inch Drilled Pier

	BENT 1		
Bottom of Cap Elevation:	710.2	ft	*(Reported by Structure Design)*
Bearing Elevation:	663.0, 657.5, 662.5 (L,C,R)	ft	*(Reported from Subsurface Borings)*
Required Pier Length:	35.5, 41.0, 36.0 (L,C,R)	ft	*(BOC Elev. - Bearing El.)*
Point of Fixity El.:	671.5, 669.0, 668.5 (L,C,R)	ft	
Tip elevation no higher than:	663.0, 657.5, 662.5 (L,C,R)	ft	*(Required For Lateral Stability)*
Number of Piers :	3		*(Reported by Structure Design)*
Max. Applied Load:	1,495, 1,980, 1,710 (L,C,R)	Tons	*(Reported by Structure Design)*
Allowable Bearing Capacity:	1,495, 1,980, 1,710 (L,C,R)	Tons	*(Must be >= the Maximum LFD Load)*

INTERIOR BENT 2 Column on 72 inch Drilled Pier

	BENT 1		
Bottom of Cap Elevation:	710.3	ft	*(Reported by Structure Design)*
Bearing Elevation:	666.0, 660.0, 678.5 (L,C,R)	ft	*(Reported from Subsurface Borings)*
Required Pier Length:	30.0, 36.5, 22.0 (L,C,R)	ft	*(BOC Elev. - Bearing El.)*
Point of Fixity El.:	672.0, 668.5, 679.0 (L,C,R)	ft	
Tip elevation no higher than:	666.0, 660.0, 677.0 (L,C,R)	ft	*(Required For Lateral Stability)*
Number of Piers:	3		*(Reported by Structure Design)*
Max. Applied Load:	1,480, 2,060, 1,705 (L,C,R)	Tons	*(Reported by Structure Design)*
Allowable Bearing Capacity:	1,480, 2,060, 1,705 (L,C,R)	Tons	*(Must be >= the Maximum LFD Load)*

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WBS NO.:	50000.1.STR11T1B	TIP NO.:	P-5208G	COUNTY:	Mecklenburg		
SUBJECT:	NCRR/NS Railroad Bridge						
	End Bents Summary						
PREPARED BY:	TRW	DATE:	4/29/13	STATION:	10639+80.8, 10641+79.3		
CHECKED BY:	XCB	DATE:	4/29/13	SHEET:	1	OF	1

END BENT 1

Pile Type :	HP 12x53 steel piles		
Bottom of Cap Elevation:	715.8	ft	*(Reported by Structure Design)*
Bearing Elevation:	685.8 to 670.5 (L to R)	ft	*(Reported from Subsurface Borings)*
Required Pile Length:	30 to 45 (L to R)	ft	*(BOC Elev. - Bearing El.)*
Pile Length for Contract:	45	ft	
Tip elevation no higher than:	N/A	ft	*(Required For Lateral Stability)*
Number of Piles :	47		*(Reported by Structure Design)*
Allowable Bearing Capacity:	90	Tons	*(Sent to Structure Design)*
Required Driving Capacity:	180	Tons	*(PDA will not be used, FS = 2)*

END BENT 2

Pile Type :	HP 12x53 steel piles		
Bottom of Cap Elevation:	716.5	ft	*(Reported by Structure Design)*
Avg. Bearing Elevation:	671.5 to 661.5 (L to R)	ft	*(Reported from Subsurface Borings)*
Required Pile Length:	45 to 55 (L to R)	ft	*(BOC Elev. - Bearing El.)*
Pile Length for Contract:	55	ft	
Tip elevation no higher than:	N/A	ft	*(Required For Lateral Stability)*
Number of Piles :	47		*(Reported by Structure Design)*
Allowable Bearing Capacity:	90	Tons	*(Sent to Structure Design)*
Required Driving Capacity:	180	Tons	*(PDA will not be used, FS = 2)*

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PILE FOUNDATION VERTICAL CAPACITY

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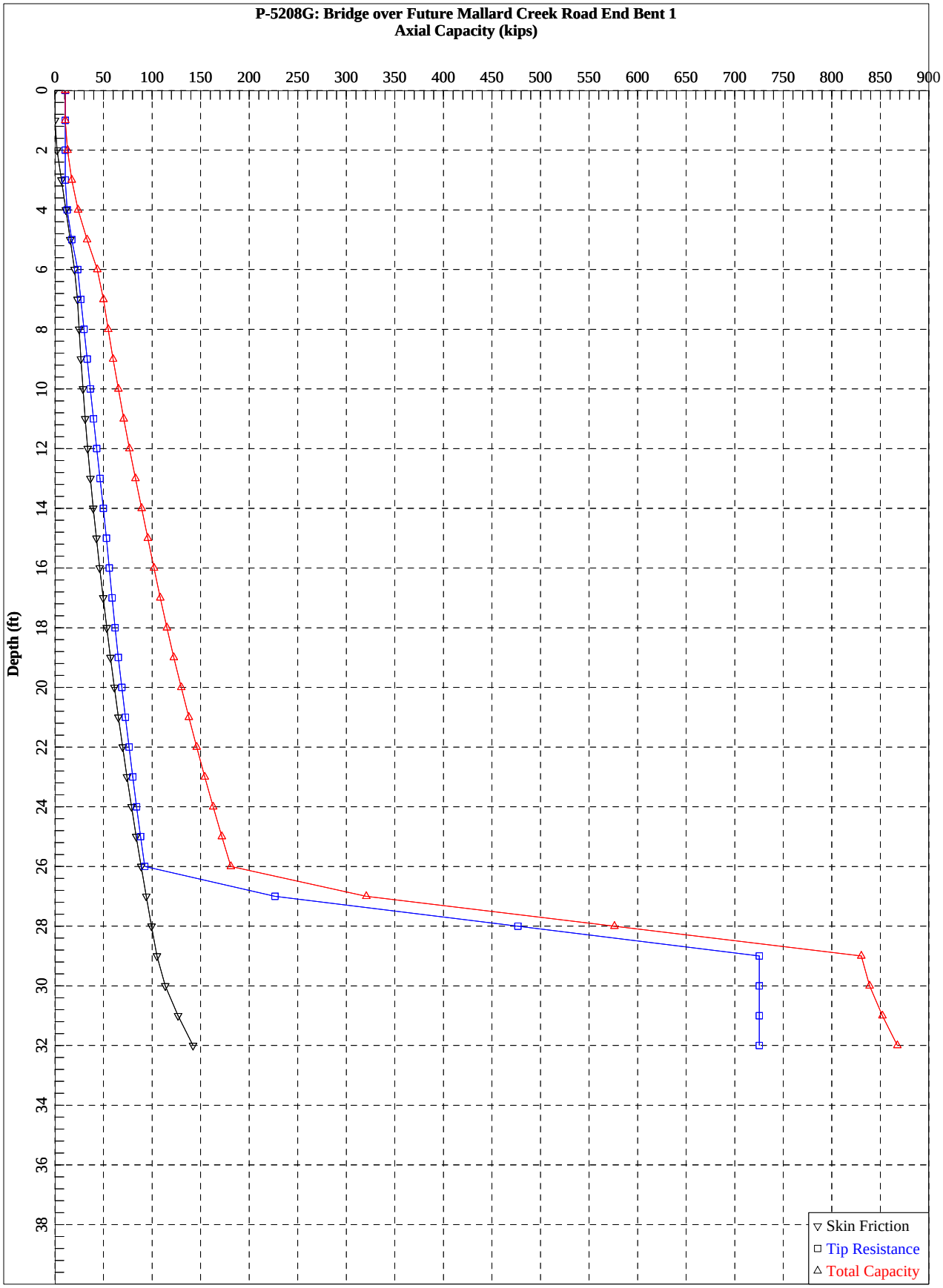

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AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

P-5208G: Bridge over Future Mallard Creek Road

DESIGNER : T. Wells

DATE : 2/26/13

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 47.60 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 0.98 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 0.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 32.00 FT.
MODULUS OF ELASTICITY = 0.290E+08 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 0.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	107.00	0.00	0.00
5.50	CLAY	0.00	107.00	0.00	0.00
5.50	SAND	1.00	109.00	33.00	0.00
14.50	SAND	1.00	109.00	33.00	0.00
14.50	SAND	1.00	44.90	33.00	0.00
29.00	SAND	1.00	56.90	35.00	0.00
29.00	SAND	1.00	82.60	45.00	0.00
29.90	SAND	1.00	82.60	45.00	0.00
29.90	SAND	0.00	102.60	60.00	0.00
35.00	SAND	0.00	102.60	60.00	0.00

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	1.20	1.20	0.00	0.00	0.00
0.10E+08	0.10E+08	1.20	1.20	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	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

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

1

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

PILE PENETR-ATION FT.	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP
	* FED. HWY. METHOD *			* ARMY CORPS METHOD *			* LAMBDA 2 METHOD *		
0.0	0.0	10.6	10.6	0.0	10.6	10.6	0.0	10.6	10.6
1.0	0.0	10.6	10.6	3.1	10.6	13.7	3.5	10.6	14.1
2.0	2.2	10.6	12.9	6.2	10.6	16.8	6.2	10.6	16.8
3.0	6.7	10.6	17.4	9.3	10.6	19.9	8.7	10.6	19.4
4.0	11.2	12.6	23.8	12.4	13.4	25.8	11.1	8.4	19.5
5.0	15.7	17.3	33.1	15.5	19.9	35.4	13.4	4.2	17.7
6.0	20.2	23.4	43.6	18.6	28.0	46.5	15.7	0.0	15.7
7.0	23.2	26.6	49.9	20.8	31.9	52.7	16.8	0.0	16.8
8.0	24.9	29.9	54.8	22.3	35.8	58.1	18.0	0.0	18.0
9.0	26.8	33.2	59.9	23.9	39.7	63.7	19.4	0.0	19.4
10.0	28.9	36.4	65.3	25.8	43.6	69.4	20.9	0.0	20.9
11.0	31.2	39.7	70.9	27.9	47.5	75.4	22.6	0.0	22.6
12.0	33.7	43.0	76.7	30.2	51.5	81.6	24.4	0.0	24.4
13.0	36.5	46.4	82.9	32.9	55.5	88.4	26.2	0.0	26.2
14.0	39.5	49.8	89.3	35.7	58.6	94.3	28.2	0.0	28.2
15.0	42.7	53.0	95.7	38.6	60.8	99.4	30.3	0.0	30.3
16.0	46.1	55.9	102.0	41.6	62.3	103.9	32.4	0.0	32.4
17.0	49.7	58.9	108.5	44.7	63.7	108.4	34.6	0.0	34.6
18.0	53.4	61.9	115.3	47.9	66.7	114.6	36.7	0.0	36.7
19.0	57.2	65.2	122.4	51.4	71.2	122.6	38.8	0.0	38.8
20.0	61.2	68.9	130.1	54.9	75.7	130.6	40.9	0.0	40.9
21.0	65.4	72.6	137.9	58.4	77.3	135.7	43.0	0.0	43.0
22.0	69.7	76.3	146.0	61.8	78.9	140.7	45.1	0.0	45.1
23.0	74.2	80.1	154.3	65.3	80.5	145.8	47.2	0.0	47.2
24.0	78.9	84.1	162.9	68.8	82.1	150.9	49.3	0.0	49.3
25.0	83.7	88.2	171.9	72.3	83.7	156.0	51.4	0.0	51.4
26.0	88.8	92.5	181.2	75.8	85.3	161.0	53.4	0.0	53.4
27.0	94.0	226.6	320.6	79.3	155.6	234.8	55.5	0.0	55.5
28.0	99.4	476.8	576.2	82.7	381.4	464.1	57.6	0.0	57.6
29.0	105.0	725.3	830.4	89.2	691.3	780.5	59.7	0.0	59.7
30.0	113.6	725.3	838.9	95.6	869.8	965.4	62.3	0.0	62.3
31.0	126.8	725.3	852.1	102.0	869.8	971.8	63.4	0.0	63.4
32.0	142.2	725.3	867.5	108.4	869.8	978.2	64.8	0.0	64.8

****
* API RP-2A (1994) *
****

PILE PENETRATION FT.	TOTAL SKIN FRICTION KIP	END BEARING KIP	ULTIMATE CAPACITY KIP
0.00	0.0	10.6	10.6
1.00	1.3	10.6	11.9
2.00	2.7	10.6	13.3
3.00	4.4	10.6	15.0

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4.00	6.1	8.4	14.5
5.00	8.0	4.2	12.2
6.00	10.0	0.0	10.0
7.00	11.8	0.0	11.8
8.00	13.5	0.0	13.5
9.00	15.4	0.0	15.4
10.00	17.6	0.0	17.6
11.00	20.0	0.0	20.0
12.00	22.6	0.0	22.6
13.00	25.5	0.0	25.5
14.00	28.5	0.0	28.5
15.00	31.8	0.0	31.8
16.00	35.3	0.0	35.3
17.00	38.9	0.0	38.9
18.00	42.7	0.0	42.7
19.00	46.5	0.0	46.5
20.00	50.5	0.0	50.5
21.00	54.6	0.0	54.6
22.00	58.8	0.0	58.8
23.00	63.2	0.0	63.2
24.00	67.7	0.0	67.7
25.00	72.4	0.0	72.4
26.00	77.2	0.0	77.2
27.00	82.1	0.0	82.1
28.00	87.2	0.0	87.2
29.00	92.5	0.0	92.5
30.00	99.2	0.0	99.2
31.00	103.2	0.0	103.2
32.00	103.2	0.0	103.2

AN ASTERISK WILL BE 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                      *
*************************************************
```

T-Z CURVE NO.	NO. OF POINTS	DEPTH TO CURVE FT.	LOAD TRANSFER PSI	PILE MOVEMENT IN.
1	10	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.1180E+01	0.2424E-01
			0.1967E+01	0.4697E-01
			0.2950E+01	0.8636E-01
			0.3540E+01	0.1212E+00
			0.3933E+01	0.1515E+00
			0.3540E+01	0.3030E+00
			0.3540E+01	0.4545E+00
			0.3540E+01	0.7576E+00
			0.3540E+01	0.3030E+01
2	10	0.2775E+01		
			0.0000E+00	0.0000E+00
			0.2360E+01	0.2424E-01
			0.3933E+01	0.4697E-01
			0.5900E+01	0.8636E-01
			0.7080E+01	0.1212E+00
			0.7867E+01	0.1515E+00
			0.7080E+01	0.3030E+00
			0.7080E+01	0.4545E+00
			0.7080E+01	0.7576E+00
			0.7080E+01	0.3030E+01
3	10	0.5458E+01		
			0.0000E+00	0.0000E+00

			0.1972E+01	0.2424E-01
			0.3287E+01	0.4697E-01
			0.4931E+01	0.8636E-01
			0.5917E+01	0.1212E+00
			0.6575E+01	0.1515E+00
			0.5917E+01	0.3030E+00
			0.5917E+01	0.4545E+00
			0.5917E+01	0.7576E+00
			0.5917E+01	0.3030E+01
4	10	0.5500E+01		
			0.0000E+00	0.0000E+00
			0.6575E+00	0.1000E-01
			0.1315E+01	0.2000E-01
			0.2630E+01	0.4000E-01
			0.3945E+01	0.6000E-01
			0.5260E+01	0.8000E-01
			0.5917E+01	0.9000E-01
			0.6575E+01	0.1000E+00
			0.6575E+01	0.5000E+00
			0.6575E+01	0.2000E+01
5	10	0.1003E+02		
			0.0000E+00	0.0000E+00
			0.4265E+00	0.1000E-01
			0.8530E+00	0.2000E-01
			0.1706E+01	0.4000E-01
			0.2559E+01	0.6000E-01
			0.3412E+01	0.8000E-01
			0.3839E+01	0.9000E-01
			0.4265E+01	0.1000E+00
			0.4265E+01	0.5000E+00
			0.4265E+01	0.2000E+01
6	10	0.1446E+02		
			0.0000E+00	0.0000E+00
			0.5795E+00	0.1000E-01
			0.1159E+01	0.2000E-01
			0.2318E+01	0.4000E-01
			0.3477E+01	0.6000E-01
			0.4636E+01	0.8000E-01
			0.5216E+01	0.9000E-01
			0.5795E+01	0.1000E+00
			0.5795E+01	0.5000E+00
			0.5795E+01	0.2000E+01
7	10	0.1450E+02		
			0.0000E+00	0.0000E+00
			0.5795E+00	0.1000E-01
			0.1159E+01	0.2000E-01
			0.2318E+01	0.4000E-01
			0.3477E+01	0.6000E-01
			0.4636E+01	0.8000E-01
			0.5216E+01	0.9000E-01
			0.5795E+01	0.1000E+00
			0.5795E+01	0.5000E+00
			0.5795E+01	0.2000E+01
8	10	0.2177E+02		
			0.0000E+00	0.0000E+00
			0.7724E+00	0.1000E-01
			0.1545E+01	0.2000E-01
			0.3090E+01	0.4000E-01
			0.4635E+01	0.6000E-01
			0.6179E+01	0.8000E-01
			0.6952E+01	0.9000E-01
			0.7724E+01	0.1000E+00
			0.7724E+01	0.5000E+00
			0.7724E+01	0.2000E+01
9	10	0.2896E+02		
			0.0000E+00	0.0000E+00
			0.1239E+01	0.1000E-01
			0.2478E+01	0.2000E-01
			0.4957E+01	0.4000E-01
			0.7435E+01	0.6000E-01

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			0.9914E+01	0.8000E-01
			0.1115E+02	0.9000E-01
			0.1239E+02	0.1000E+00
			0.1239E+02	0.5000E+00
			0.1239E+02	0.2000E+01
10	10	0.2900E+02		
			0.0000E+00	0.0000E+00
			0.1903E+01	0.1000E-01
			0.3806E+01	0.2000E-01
			0.7611E+01	0.4000E-01
			0.1142E+02	0.6000E-01
			0.1522E+02	0.8000E-01
			0.1713E+02	0.9000E-01
			0.1903E+02	0.1000E+00
			0.1903E+02	0.5000E+00
			0.1903E+02	0.2000E+01
11	10	0.2952E+02		
			0.0000E+00	0.0000E+00
			0.1903E+01	0.1000E-01
			0.3806E+01	0.2000E-01
			0.7611E+01	0.4000E-01
			0.1142E+02	0.6000E-01
			0.1522E+02	0.8000E-01
			0.1713E+02	0.9000E-01
			0.1903E+02	0.1000E+00
			0.1903E+02	0.5000E+00
			0.1903E+02	0.2000E+01
12	10	0.2996E+02		
			0.0000E+00	0.0000E+00
			0.1903E+01	0.1000E-01
			0.3806E+01	0.2000E-01
			0.7611E+01	0.4000E-01
			0.1142E+02	0.6000E-01
			0.1522E+02	0.8000E-01
			0.1713E+02	0.9000E-01
			0.1903E+02	0.1000E+00
			0.1903E+02	0.5000E+00
			0.1903E+02	0.2000E+01
13	10	0.3000E+02		
			0.0000E+00	0.0000E+00
			0.2505E+01	0.1000E-01
			0.5010E+01	0.2000E-01
			0.1002E+02	0.4000E-01
			0.1503E+02	0.6000E-01
			0.2004E+02	0.8000E-01
			0.2255E+02	0.9000E-01
			0.2505E+02	0.1000E+00
			0.2505E+02	0.5000E+00
			0.2505E+02	0.2000E+01
14	10	0.3252E+02		
			0.0000E+00	0.0000E+00
			0.2698E+01	0.1000E-01
			0.5395E+01	0.2000E-01
			0.1079E+02	0.4000E-01
			0.1619E+02	0.6000E-01
			0.2158E+02	0.8000E-01
			0.2428E+02	0.9000E-01
			0.2698E+02	0.1000E+00
			0.2698E+02	0.5000E+00
			0.2698E+02	0.2000E+01
15	10	0.3496E+02		
			0.0000E+00	0.0000E+00
			0.2698E+01	0.1000E-01
			0.5395E+01	0.2000E-01
			0.1079E+02	0.4000E-01
			0.1619E+02	0.6000E-01
			0.2158E+02	0.8000E-01
			0.2428E+02	0.9000E-01
			0.2698E+02	0.1000E+00
			0.2698E+02	0.5000E+00

0.2698E+02	0.2000E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4533E+02	0.7576E-02
0.9066E+02	0.1515E-01
0.1813E+03	0.3030E-01
0.3627E+03	0.1970E+00
0.5440E+03	0.6364E+00
0.6528E+03	0.1106E+01
0.7253E+03	0.1515E+01
0.7253E+03	0.2273E+01
0.7253E+03	0.3030E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1146E+01	0.8009E-03	0.5984E+00	0.1000E-03
0.1154E+02	0.8027E-02	0.5984E+01	0.1000E-02
0.5736E+02	0.4040E-01	0.2992E+02	0.5000E-02
0.1115E+03	0.8054E-01	0.5984E+02	0.1000E-01
0.3357E+03	0.2887E+00	0.2028E+03	0.5000E-01
0.4119E+03	0.4029E+00	0.2572E+03	0.1000E+00
0.6424E+03	0.9999E+00	0.4877E+03	0.5000E+00
0.7829E+03	0.1620E+01	0.6282E+03	0.1000E+01
0.8800E+03	0.2703E+01	0.7253E+03	0.2000E+01

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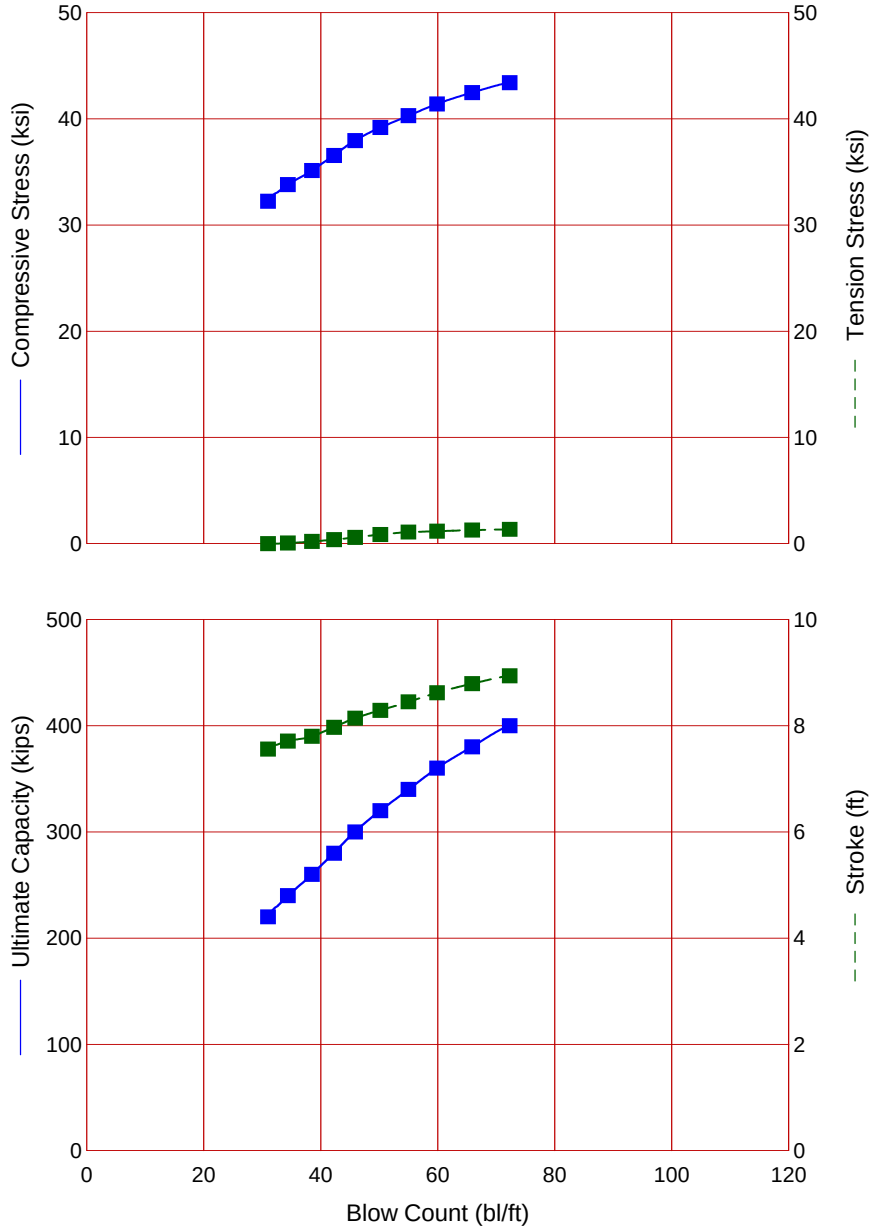
Klienfelder Southeast Inc
P-5208G: EB1

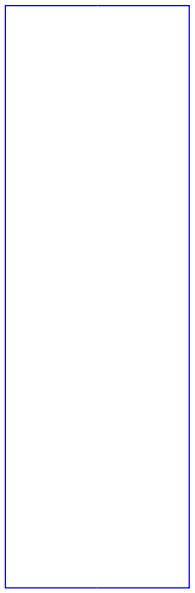
26-Feb-2013
GRLWEAP Version 2010



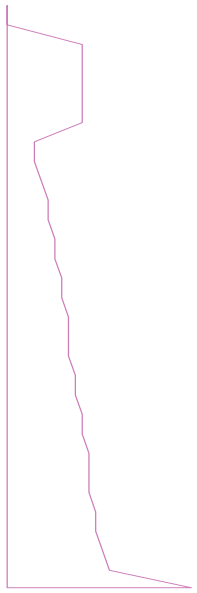
DELMAG D 19-42

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1520 (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	0.050	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	29.90	ft
Pile Penetration	29.90	ft
Pile Top Area	15.60	in2

Pile Model



Skin Friction Distribution



Res. Shaft = 15 %
(Proportional)

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0001ADD_P10a1

Klienfelder Southeast Inc
P-5208G: EB1

26-Feb-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
220.0	32.23	0.01	31.0	7.56	16.35
240.0	33.80	0.06	34.4	7.71	16.42
260.0	35.13	0.21	38.5	7.80	16.37
280.0	36.54	0.38	42.3	7.97	16.53
300.0	37.94	0.59	45.9	8.14	16.88
320.0	39.17	0.86	50.2	8.29	17.07
340.0	40.29	1.09	55.0	8.45	17.25
360.0	41.39	1.17	59.9	8.62	17.53
380.0	42.46	1.28	65.9	8.79	17.69
400.0	43.40	1.35	72.3	8.94	17.91

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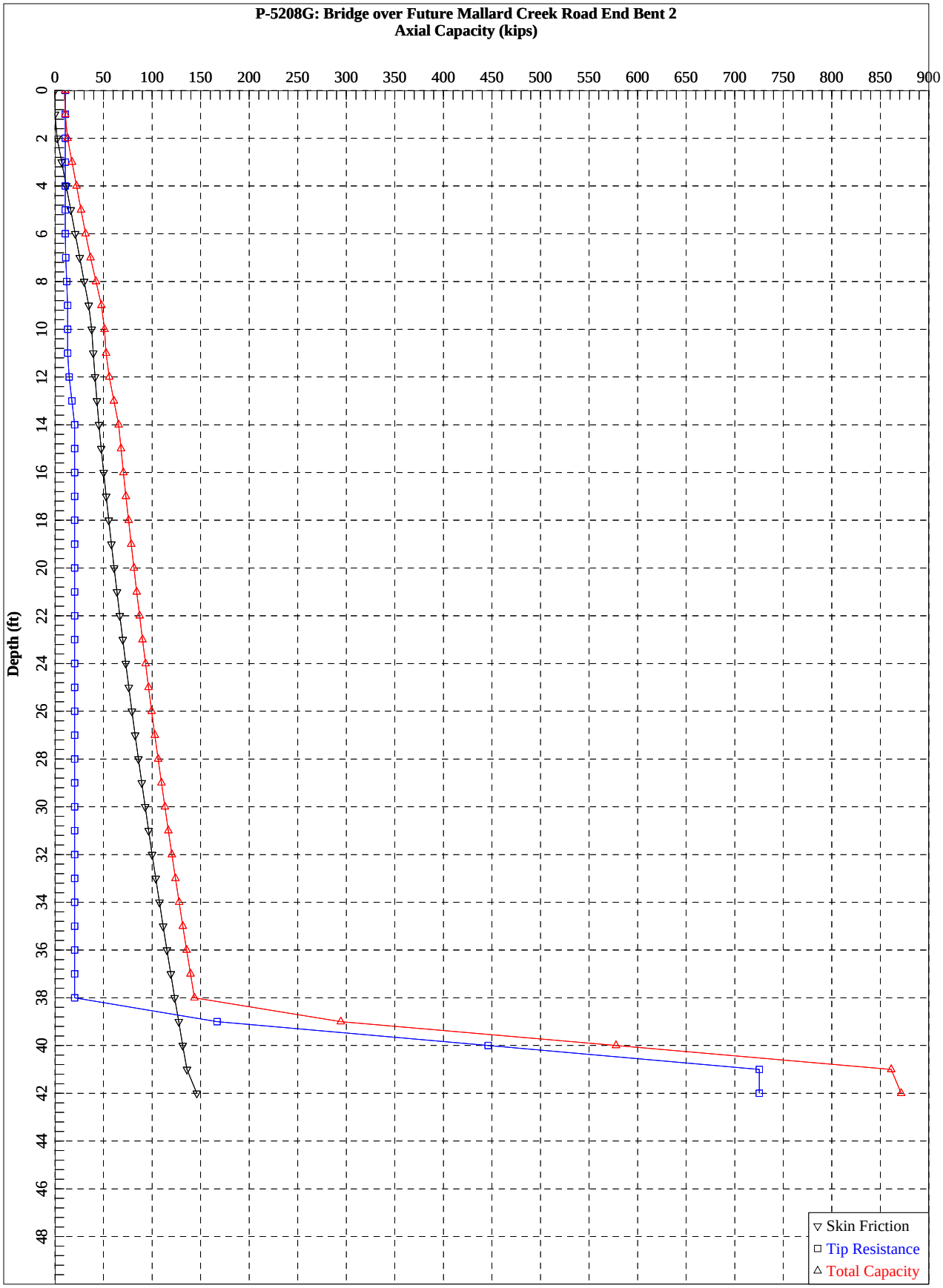
0001ADD_P10a1



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W:\share_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\EB2B.cpt

1

AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

P-5208G: Bridge over Future Mallard Creek Road

DESIGNER : T. Wells

DATE : 2/26/13

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 47.60 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 0.98 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 0.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 42.00 FT.
MODULUS OF ELASTICITY = 0.290E+08 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 0.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	107.00	0.00	0.00
8.30	CLAY	0.00	107.00	0.00	0.00
8.30	SAND	1.00	101.00	30.00	0.00
13.30	SAND	1.00	101.00	30.00	0.00
13.30	SAND	1.00	41.40	31.00	0.00
40.80	SAND	1.00	41.40	31.00	0.00
40.80	SAND	0.00	102.60	60.00	0.00
50.80	SAND	0.00	102.60	60.00	0.00

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	1.20	1.20	0.00	0.00	0.00
0.10E+08	0.10E+08	1.20	1.20	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	0.00	0.00	0.00	0.00	0.00

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

1

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

PILE PENETRATION FT.	FED. HWY. METHOD TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPACITY KIP	ARMY CORPS METHOD TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPACITY KIP	LAMBDA 2 METHOD TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPACITY KIP
0.0	0.0	10.6	10.6	0.0	10.6	10.6	0.0	10.6	10.6
1.0	0.0	10.6	10.6	3.1	10.6	13.7	3.5	10.6	14.1
2.0	2.3	10.6	12.9	6.2	10.6	16.8	6.2	10.6	16.8
3.0	7.0	10.6	17.6	9.3	10.6	19.9	8.7	10.6	19.4
4.0	11.6	10.6	22.2	12.4	10.6	23.0	11.1	10.6	21.8
5.0	16.2	10.6	26.9	15.5	10.6	26.1	13.4	10.6	24.1
6.0	20.9	10.6	31.5	18.6	10.6	29.2	15.7	10.6	26.3
7.0	25.5	11.1	36.6	21.7	13.1	34.7	17.9	8.4	26.3
8.0	30.1	12.1	42.3	24.8	18.4	43.2	20.1	4.2	24.3
9.0	34.8	13.1	47.9	27.8	24.7	52.5	22.3	0.0	22.3
10.0	37.9	13.1	51.0	30.3	26.9	57.2	23.6	0.0	23.6
11.0	39.5	13.1	52.6	32.1	29.2	61.3	25.0	0.0	25.0
12.0	41.3	14.6	55.9	34.1	31.7	65.8	26.6	0.0	26.6
13.0	43.2	17.5	60.7	36.5	33.6	70.1	28.2	0.0	28.2
14.0	45.3	20.3	65.6	38.9	34.6	73.6	29.9	0.0	29.9
15.0	47.6	20.3	68.0	41.3	34.6	76.0	31.8	0.0	31.8
16.0	50.2	20.3	70.5	43.7	34.6	78.4	33.6	0.0	33.6
17.0	52.8	20.3	73.1	46.2	34.6	80.8	35.4	0.0	35.4
18.0	55.5	20.3	75.8	48.6	34.6	83.2	37.2	0.0	37.2
19.0	58.2	20.3	78.5	51.0	34.6	85.6	39.0	0.0	39.0
20.0	61.0	20.3	81.3	53.4	34.6	88.0	40.8	0.0	40.8
21.0	63.9	20.3	84.2	55.8	34.6	90.4	42.6	0.0	42.6
22.0	66.8	20.3	87.2	58.2	34.6	92.9	44.4	0.0	44.4
23.0	69.9	20.3	90.2	60.6	34.6	95.3	46.1	0.0	46.1
24.0	72.9	20.3	93.3	63.0	34.6	97.7	47.9	0.0	47.9
25.0	76.1	20.3	96.4	65.5	34.6	100.1	49.7	0.0	49.7
26.0	79.3	20.3	99.6	67.9	34.6	102.5	51.4	0.0	51.4
27.0	82.6	20.3	102.9	70.3	34.6	104.9	53.2	0.0	53.2
28.0	86.0	20.3	106.3	72.7	34.6	107.3	54.9	0.0	54.9
29.0	89.4	20.3	109.7	75.1	34.6	109.7	56.6	0.0	56.6
30.0	92.9	20.3	113.2	77.5	34.6	112.1	58.3	0.0	58.3
31.0	96.5	20.3	116.8	79.9	34.6	114.6	60.1	0.0	60.1
32.0	100.1	20.3	120.4	82.3	34.6	117.0	62.2	0.0	62.2
33.0	103.8	20.3	124.1	84.7	34.6	119.4	64.9	0.0	64.9
34.0	107.6	20.3	127.9	87.2	34.6	121.8	67.7	0.0	67.7
35.0	111.4	20.3	131.7	89.6	34.6	124.2	70.5	0.0	70.5
36.0	115.3	20.3	135.6	92.0	34.6	126.6	73.4	0.0	73.4
37.0	119.3	20.3	139.6	94.4	34.6	129.0	76.3	0.0	76.3
38.0	123.3	20.3	143.7	96.8	34.6	131.4	79.3	0.0	79.3
39.0	127.5	167.0	294.4	99.2	191.6	290.8	82.4	0.0	82.4
40.0	131.6	446.1	577.8	101.6	490.5	592.1	85.5	0.0	85.5
41.0	135.9	725.3	861.2	105.0	789.4	894.4	88.6	0.0	88.6
42.0	146.1	725.3	871.4	107.2	789.4	896.6	90.1	0.0	90.1

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* API RP-2A (1994) *
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PILE TOTAL SKIN END ULTIMATE

0041DEL_P10a1
0001ADD_P10a1

PENETRATION FT.	FRICTION KIP	BEARING KIP	CAPACITY KIP
0.00	0.0	10.6	10.6
1.00	1.3	10.6	11.9
2.00	2.7	10.6	13.3
3.00	4.4	10.6	15.0
4.00	6.1	10.6	16.7
5.00	8.0	10.6	18.6
6.00	10.0	10.6	20.6
7.00	12.1	8.4	20.5
8.00	14.2	4.2	18.4
9.00	16.5	0.0	16.5
10.00	18.6	0.0	18.6
11.00	20.6	0.0	20.6
12.00	22.9	0.0	22.9
13.00	25.3	0.0	25.3
14.00	27.9	0.0	27.9
15.00	30.8	0.0	30.8
16.00	33.7	0.0	33.7
17.00	36.8	0.0	36.8
18.00	39.9	0.0	39.9
19.00	43.1	0.0	43.1
20.00	46.4	0.0	46.4
21.00	49.7	0.0	49.7
22.00	53.2	0.0	53.2
23.00	56.7	0.0	56.7
24.00	60.3	0.0	60.3
25.00	64.0	0.0	64.0
26.00	67.7	0.0	67.7
27.00	71.6	0.0	71.6
28.00	75.5	0.0	75.5
29.00	79.5	0.0	79.5
30.00	83.6	0.0	83.6
31.00	87.7	0.0	87.7
32.00	92.0	0.0	92.0
33.00	96.3	0.0	96.3
34.00	100.7	0.0	100.7
35.00	105.2	0.0	105.2
36.00	109.7	0.0	109.7
37.00	114.4	0.0	114.4
38.00	119.1	0.0	119.1
39.00	123.9	0.0	123.9
40.00	128.8	0.0	128.8
41.00	133.7	0.0	133.7
42.00	136.3	0.0	136.3

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

```
**************************************************
* 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	0.0000E+00		
			0.0000E+00	0.0000E+00
			0.1218E+01	0.2424E-01
			0.2030E+01	0.4697E-01
			0.3045E+01	0.8636E-01
			0.3653E+01	0.1212E+00
			0.4059E+01	0.1515E+00
			0.3653E+01	0.3030E+00

			0.3653E+01	0.4545E+00
			0.3653E+01	0.7576E+00
			0.3653E+01	0.3030E+01
2	10	0.4175E+01		
			0.0000E+00	0.0000E+00
			0.2436E+01	0.2424E-01
			0.4059E+01	0.4697E-01
			0.6089E+01	0.8636E-01
			0.7307E+01	0.1212E+00
			0.8119E+01	0.1515E+00
			0.7307E+01	0.3030E+00
			0.7307E+01	0.4545E+00
			0.7307E+01	0.7576E+00
			0.7307E+01	0.3030E+01
3	10	0.8258E+01		
			0.0000E+00	0.0000E+00
			0.2032E+01	0.2424E-01
			0.3386E+01	0.4697E-01
			0.5080E+01	0.8636E-01
			0.6096E+01	0.1212E+00
			0.6773E+01	0.1515E+00
			0.6096E+01	0.3030E+00
			0.6096E+01	0.4545E+00
			0.6096E+01	0.7576E+00
			0.6096E+01	0.3030E+01
4	10	0.8300E+01		
			0.0000E+00	0.0000E+00
			0.6773E+00	0.1000E-01
			0.1355E+01	0.2000E-01
			0.2709E+01	0.4000E-01
			0.4064E+01	0.6000E-01
			0.5418E+01	0.8000E-01
			0.6096E+01	0.9000E-01
			0.6773E+01	0.1000E+00
			0.6773E+01	0.5000E+00
			0.6773E+01	0.2000E+01
5	10	0.1083E+02		
			0.0000E+00	0.0000E+00
			0.2994E+00	0.1000E-01
			0.5988E+00	0.2000E-01
			0.1198E+01	0.4000E-01
			0.1797E+01	0.6000E-01
			0.2395E+01	0.8000E-01
			0.2695E+01	0.9000E-01
			0.2994E+01	0.1000E+00
			0.2994E+01	0.5000E+00
			0.2994E+01	0.2000E+01
6	10	0.1326E+02		
			0.0000E+00	0.0000E+00
			0.3860E+00	0.1000E-01
			0.7720E+00	0.2000E-01
			0.1544E+01	0.4000E-01
			0.2316E+01	0.6000E-01
			0.3088E+01	0.8000E-01
			0.3474E+01	0.9000E-01
			0.3860E+01	0.1000E+00
			0.3860E+01	0.5000E+00
			0.3860E+01	0.2000E+01
7	10	0.1330E+02		
			0.0000E+00	0.0000E+00
			0.3860E+00	0.1000E-01
			0.7720E+00	0.2000E-01
			0.1544E+01	0.4000E-01
			0.2316E+01	0.6000E-01
			0.3088E+01	0.8000E-01
			0.3474E+01	0.9000E-01
			0.3860E+01	0.1000E+00
			0.3860E+01	0.5000E+00
			0.3860E+01	0.2000E+01
8	10	0.2707E+02		

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			0.0000E+00	0.0000E+00
			0.5942E+00	0.1000E-01
			0.1188E+01	0.2000E-01
			0.2377E+01	0.4000E-01
			0.3565E+01	0.6000E-01
			0.4754E+01	0.8000E-01
			0.5348E+01	0.9000E-01
			0.5942E+01	0.1000E+00
			0.5942E+01	0.5000E+00
			0.5942E+01	0.2000E+01
9	10	0.4076E+02		
			0.0000E+00	0.0000E+00
			0.1264E+01	0.1000E-01
			0.2528E+01	0.2000E-01
			0.5055E+01	0.4000E-01
			0.7583E+01	0.6000E-01
			0.1011E+02	0.8000E-01
			0.1137E+02	0.9000E-01
			0.1264E+02	0.1000E+00
			0.1264E+02	0.5000E+00
			0.1264E+02	0.2000E+01
10	10	0.4080E+02		
			0.0000E+00	0.0000E+00
			0.1264E+01	0.1000E-01
			0.2528E+01	0.2000E-01
			0.5055E+01	0.4000E-01
			0.7583E+01	0.6000E-01
			0.1011E+02	0.8000E-01
			0.1137E+02	0.9000E-01
			0.1264E+02	0.1000E+00
			0.1264E+02	0.5000E+00
			0.1264E+02	0.2000E+01
11	10	0.4582E+02		
			0.0000E+00	0.0000E+00
			0.1783E+01	0.1000E-01
			0.3567E+01	0.2000E-01
			0.7133E+01	0.4000E-01
			0.1070E+02	0.6000E-01
			0.1427E+02	0.8000E-01
			0.1605E+02	0.9000E-01
			0.1783E+02	0.1000E+00
			0.1783E+02	0.5000E+00
			0.1783E+02	0.2000E+01
12	10	0.5076E+02		
			0.0000E+00	0.0000E+00
			0.1783E+01	0.1000E-01
			0.3567E+01	0.2000E-01
			0.7133E+01	0.4000E-01
			0.1070E+02	0.6000E-01
			0.1427E+02	0.8000E-01
			0.1605E+02	0.9000E-01
			0.1783E+02	0.1000E+00
			0.1783E+02	0.5000E+00
			0.1783E+02	0.2000E+01

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.4533E+02	0.7576E-02
0.9066E+02	0.1515E-01
0.1813E+03	0.3030E-01
0.3627E+03	0.1970E+00
0.5440E+03	0.6364E+00
0.6528E+03	0.1106E+01
0.7253E+03	0.1515E+01
0.7253E+03	0.2273E+01
0.7253E+03	0.3030E+01

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1408E+01	0.1090E-02	0.5984E+00	0.1000E-03
0.1421E+02	0.1093E-01	0.5984E+01	0.1000E-02
0.6899E+02	0.5480E-01	0.2992E+02	0.5000E-02
0.1315E+03	0.1089E+00	0.5984E+02	0.1000E-01
0.3496E+03	0.3676E+00	0.2028E+03	0.5000E-01
0.4188E+03	0.4941E+00	0.2572E+03	0.1000E+00
0.6493E+03	0.1153E+01	0.4877E+03	0.5000E+00
0.7898E+03	0.1810E+01	0.6282E+03	0.1000E+01
0.8869E+03	0.2919E+01	0.7253E+03	0.2000E+01

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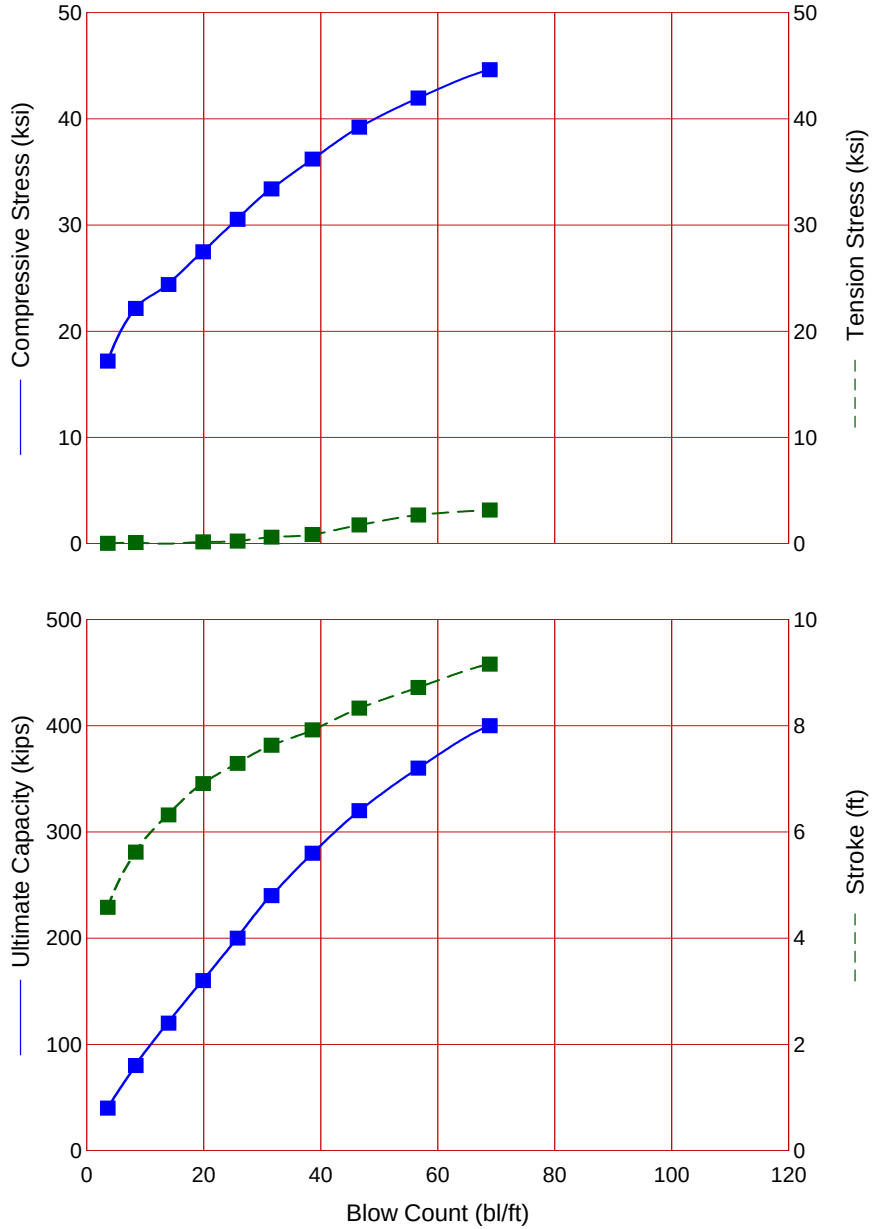
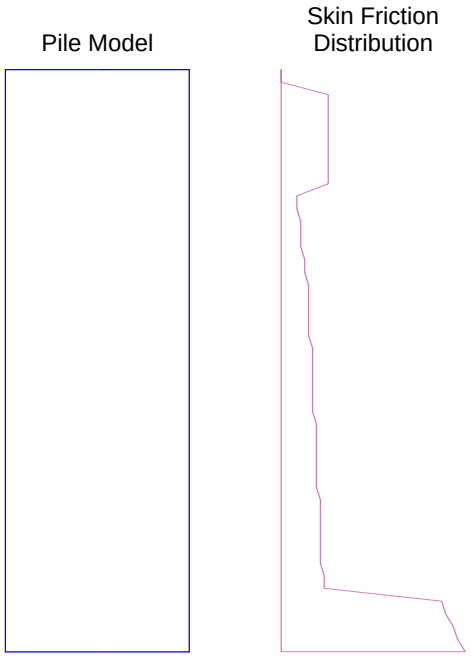
Klienfelder Southeast Inc
P-5208G: EB2

26-Feb-2013
GRLWEAP Version 2010



DELMAG D 19-42

Ram Weight	4.00	kips
Efficiency	0.800	
Pressure	1520 (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	0.040	in
Skin Damping	0.050	sec/ft
Toe Damping	0.150	sec/ft
Pile Length	46.00	ft
Pile Penetration	46.00	ft
Pile Top Area	15.60	in2



Res. Shaft = 15 %
(Proportional)

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Klienfelder Southeast Inc
P-5208G: EB2

26-Feb-2013
GRLWEAP Version 2010

Ultimate Capacity kips	Maximum Compression Stress ksi	Maximum Tension Stress ksi	Blow Count bl/ft	Stroke ft	Energy kips-ft
40.0	17.18	0.03	3.6	4.58	21.37
80.0	22.14	0.10	8.4	5.62	18.66
120.0	24.39	0.00	14.0	6.32	17.34
160.0	27.47	0.16	19.9	6.91	16.95
200.0	30.53	0.25	25.8	7.29	16.79
240.0	33.39	0.61	31.6	7.63	17.17
280.0	36.20	0.86	38.6	7.92	17.54
320.0	39.21	1.76	46.6	8.33	18.16
360.0	41.95	2.70	56.7	8.72	18.78
400.0	44.61	3.16	68.9	9.16	19.58

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DRILLED PIER FOUNDATION VERTICAL CAPACITY

0041DEL_P10a1
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KLEINFELDER SOUTHEAST, INC.

Project Name: Haydock to Junker
TIP No.: P-5208G
Project No.: 127855
Subject: Axial Capacity
Work: RR Bridge

Date: 03/04/13
Setup by: TRW
Computed By: TRW
Checked By:

References:

1 AREMA Manual For Railway Engineering. AREMA 2011
2 AASHTO LRFD Bridge Design Specifications. Customary US Units, 6th Edition 2012
3 Drilled Shafts: Construction Procedures and Design Methods. FHWA Report No. FHWA-IF-99-025
4 P-y Curves for Laterally Loaded Drilled Shafts Embedded in Weathered Rock. FHWA Report No. FHWA/NC/2002-008
4 Kleinfelder Soil Test Borings B1-A, B1-B, B2-A, and B2-B

1. Determine Structural Capacity of Shaft

Shaft Properties

Shaft Diameter (in): 72

Concrete Compressive Strength (psi): 4500 — NCDOT Std Specifications Table 1000-1
Concrete Modulus of Elasticity (psi): 3600000
Shaft Area (in): 4072

2. Assess Bearing Material Properties

Neglect Soil Above IGM (SPT<50 bpf)

Cohesionless Intermediate IGM Properties (50 bpf<SPT<60/0.1 bpf)

q_u = unconfined compressive strength
= 350 psi — Ref. 4, Table 6 (sites 6, 7, and 12)

RQD = 0 percent — Ref 5

Rock Mass Properties

RMR = Rock Mass Rating — AASHTO Table 10.4.6.4-1

Property #	1	2	3	4	5	Sum	
Rating	7	17	20	20	4	**68**	**=RMR**

m, s = Material Constants — AASHTO Table 10.4.6.4-4
rock type = E
m = 2.551 unitless (interpolated from table)
s = 0.0047267 unitless (interpolated from table)

q_u = unconfined compressive strength of rock core
= 12,000 psi

E_i = elastic modulus of rock core sample — NCDOT Rock Core Database
= 100 ksi

a_E = reduction factor for rock jointing — AASHTO Table 10.8.3.5.4b-1
= 0.9

E_m = elastic modulus of rock mass
$= 145(10)^{(RMR-10)/40} \leq E_i$ — AASHTO Eqn 10.4.6.5-1
$= 145(10)^{(68-10)/40}$

KLEINFELDER SOUTHEAST, INC.

Project Name: Haydock to Junker — Date: 03/04/13
TIP No.: P-5208G
Project No.: 127855 — Setup by: TRW
Subject: Axial Capacity — Computed By: TRW
Work: RR Bridge — Checked By:

= 4087 ksi **unreasonable for rock type - neglect**
use E_m = 100.0 ksi
OR
= $E_i(E_m/E_i)$ where — AASHTO Eqn 10.4.6.5-2
E_m/E_i = 0.80 — AASHTO Tables 10.4.6.5-1, 10.8.3.5.4b-1
= 100(0.8)
= 80 ksi

3. Determine Allowable Shaft Capacity $Q_A = Q_T/FS + Q_S/FS$

a3. Ultimate Shaft Tip Resistance in Cohesionless IGM (50< SPT <60.0.1 bpf)

$q_T = 0.59(\sigma'_v)(N_{60}(p_a/\sigma'_v))^{0.8}$ where — AASHTO Eqn 10.8.3.5.2c-2

σ'_{vb} = Effective Overburden Stress at Bearing Elevation
= 1500 psf
N_{60} = SPT value (hammer efficiency correction only), limited to max of 100 bpf
= 100 bpf
p_a = Atmospheric pressure, psf (14.7 psi x 144 in^2/ft^2 = 2116.8 psf)
= 2116.8 psf

= $0.59(1500)((100(2116.8/1500))^{0.8}$
= 46410 psf
= 46 ksf
SAY 45 ksf

Ultimate Shaft Tip Capacity in IGM (50< SPT <60/0.1 bpf)

$Q_T = q_T \times A_T$
= 45 X 28.3
= **1274 kips**

a4. Ultimate Shaft Tip Unit Resistance in Jointed Rock

$q_T = q_u(s^{0.5}+(ms^{0.5}+s)^{0.5}) \leq 2.5q_u < 300$ ksf, where — AASHTO Eqn 10.8.3.5.4c-2

= $12000(0.004727^{0.5}+(2.551(0.004727^{0.5})+0.004727^{0.5})$
= 5917.5 psi
= 852.1 ksf
≤ 208.3 ksf

USE 200.0 ksf

Ultimate Shaft Tip Capacity in Jointed Rock

$Q_T = q_T \times A_T$
= 200.0 X 28.3
= **5655 kips**

b2. Ultimate Side Unit Resistance in IGM (50< SPT <60/0.1 bpf) — AASHTO 10.8.3.5.5

$q_s = \sigma'_{vz}k_o\tan\varphi'_z$, where — FHWA eqn 11.26

σ'_{vz} = Overburden pressure at midpoint of layer (psf)
= 1500 psf
ϕ'_z = design value for internal friction angle (degrees)

KLEINFELDER SOUTHEAST, INC.

Project Name: Haydock to Junker — Date: 03/04/13
TIP No.: P-5208G
Project No.: 127855 — Setup by: TRW
Subject: Axial Capacity — Computed By: TRW
Work: RR Bridge — Checked By:

$\tan^{-1}((N'/(12.3+20.3(\sigma'_z/p_a)^{0.34})$, where — FHWA eqn 11.27

N' = Corrected SPT value limited to max of 100 bpf

p_a = Atmospheric pressure, psf (14.7 psi x 144 in^2/ft^2 = 2116.8 psf)

$= \tan^{-1}((100/(12.3+20.3(1500/2116.8)^{0.34})$

= 57.5 degrees

$\tan\phi'_z$ = 1.567

k_o = design value of earth pressure (unitless)

$= (1-\sin\varphi')(0.2p_aN'/\sigma'_z)^{\sin\varphi'}$ — FHWA eqn 11.28

$= (1-\sin 57.5)(0.2(2116.8)(100)/1500)^{\sin 57.5}$

= 2.62

= 1500 X 2.62 X 1.567

= 6158 psf

= 6.2 ksf

SAY 6.0 ksf

Ultimate Side Capacity in IGM (50< SPT <60/0.1 bpf)

$R_s = q_s \times A_s \times L$

= 6.0 X 18.8 X L

= **113.1 kips/ft**

b3. Ultimate Side Unit Resistance in Jointed Crystalline Rock

$q_s = 0.65a_Ep_a(q_u/p_a)^{0.5} \leq 0.65p_a(f'_c/p_a)^{0.5}$ where — AASHTO Eqn 10.8.3.5.4b-1

a_E = reduction factor for rock jointing

= 0.6

p_a = atmospheric pressure (psi)

= 14.7 psi

q_u = unconfined compressive strength of rock

= 12000 psi

f'_c = shaft concrete compressive strength

= 4500 psi

$= 0.65(0.6)(14.7)(12000/14.7)^{0.5}$

= 251.2 psi

= 36.2 ksf

$\leq 0.65(14.7)(4500/14.7)^{0.5}$

$\leq$ 167.2 psi

$\leq$ 24.1 ksf

USE 24.1 ksf

Ultimate Side Capacity in Jointed Crystalline Rock:

$Q_S = q_s \times A_s \times L$

= 24.1 x 18.8 x L

= **454.3 kips/ft**

4. Determine Tip Elevations to Provide the Allowable Capacity — **FS = 2.5**

KLEINFELDER SOUTHEAST, INC.

Project Name: Haydock to Junker
TIP No.: P-5208G
Project No.: 127855
Subject: Axial Capacity
Work: RR Bridge

Date: 03/04/13
Setup by: TRW
Computed By: TRW
Checked By:

Tip Elev. = T/Rock - (Max. Load -(Q_SIGM/FS + Q_TRock/FS)/Q_SRock/FS)

Boring	Bent No	T/Column	T/Shaft	Maximum Load (kips)	T/IGM	T/Rock	IGM Length (ft)	Tip
B1-A	1	710.2	698.7	2985.87	675.6	664.1	11.5	663.0
	1	710.2	699.0	3956.27	675.6	664.1	11.5	657.6
B1-B	1	710.2	699.3	3421.06	676.6	666.4	10.2	662.6
B2-A	2	710.3	698.8	2960.14	671.5	669.6	1.9	666.2
	2	710.3	699.0	4119.16	671.5	669.6	1.9	659.9
B2-B	2	710.3	699.3	3406.24	684.8	684.8	0.0	678.5

5. Check Settlement of Shaft (Use Service Load + Weight of Column + Shaft)

a. Weight of Column + Shaft (Use longest shaft/column)

T/Column Elev = 710.3 feet
T/Shaft Elev = 684.8 feet
Tip Elev = 657.6 feet Weight = 223.5 kips
Length = 52.7 feet

b. Total Load for Settlement

= Max Service Load + Weight of Column & Shaft
= 4119.2 + 223.5
= 4342.7 kips

c. Elastic Shortening of Shaft (use service load + 1/2 weight of col and shaft)

dL = PL/AE L = Shaft Length = 41.7 ft
= (4119.2+223.5/2)(1000)(52.7)(12)/(4072)(3600000)
= 0.144 inches

d. Short Term Settlements

d = $Q_{T1}I/E_{sL}B$ where FHWA Eqn C.30

Q_{T1} = Total Load on Shaft (kips)
I = Elastic Settlement Influence Factor (unitless) - USE 1.0 (conservative)
E_{sL} = Youngs Modulus of Bearing Materials (psi)
B = Shaft Diameter (in)

= (4119.2)(1000)(1.0)/(3600000)(72)
= <0.1 inches In Elastic Zone; less than 1 in settlement expected

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DRILLED PIER FOUNDATION LATERAL CAPACITY

PILE+ 5.0 INPUT SHEET (ENGLISH)

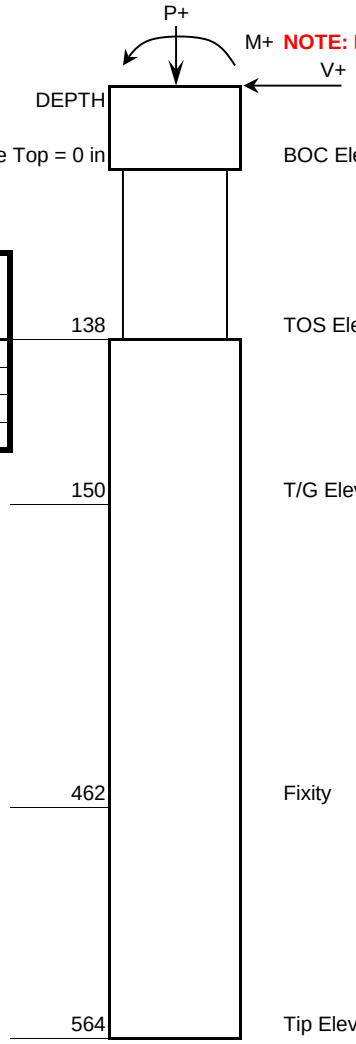
0041D1_P1_pat1
0001A0_P1_pat1

Designer: TRW Date: 3/4/13
Checker: XCB Date: 3/5/13

Project Title Haydock to Junker Bridge on NCRR/NS

TIP # P-5208G Bent # 1 Left
COUNTY: Mecklenburg

NOTE: LOADS GIVEN AT T/SHAFT



BOC Elev. =	Input Elevation 710.2	ft
TOS Elev. =	698.7	ft
T/G Elev. =	697.7	ft
Fixity	671.7	ft
Tip Elev. =	663.2	ft

Pile Properties

Total Pile Length	564	(inches)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	150.0	(inches)
Combined Ground Slope & Batter Angles	0	(degrees)

Drilled Shaft Sections

Section #	Depth (inches)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0	66	931419	3421	3600000
2	138	66	931419	3421	3600000
3	138	72	1319166	4072	3600000
4	564	72	1319166	4072	3600000

Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Moment	17000	24885840	2591960

Soil Layers

Layer #	Soil Type	Layer Top (inches)	Layer Bottom (inches)
1	4	150.0	415.0
2	2	415.0	463.2
3	4	463.2	553.2
4	6	553.2	703.2

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}	First Neg.	Pile Length
0.45	400.44	564.0
	676.8	
Max. Neg. @	462.48	671.7

SOIL AND ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain e_{50}
4	0.0362	300		35	
2	0.0478	1500	55.5		0.004
4	0.0450	1500		40	

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	Young's Mod.* Er, (lbs/in^2)	Uniax. Comp. Str. (lbs/in^2)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6	0.0623	12,000

COMMENTS:

PT. OF FIXITY ELEV. = 671.7 ft

TIP NO HIGHER THAN EL. = 663.2 ft

File: B1, L

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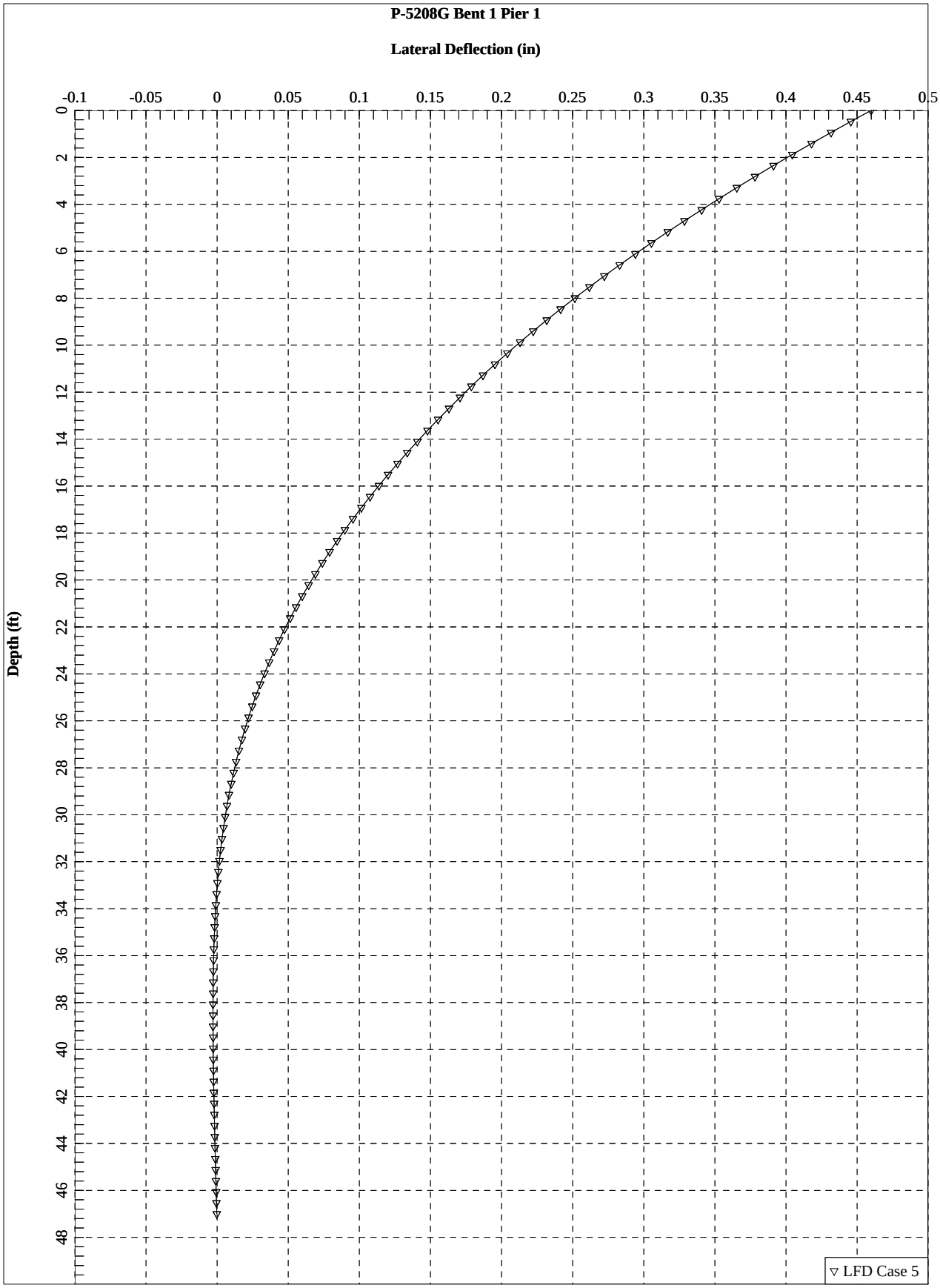
0001ADD_P10a1



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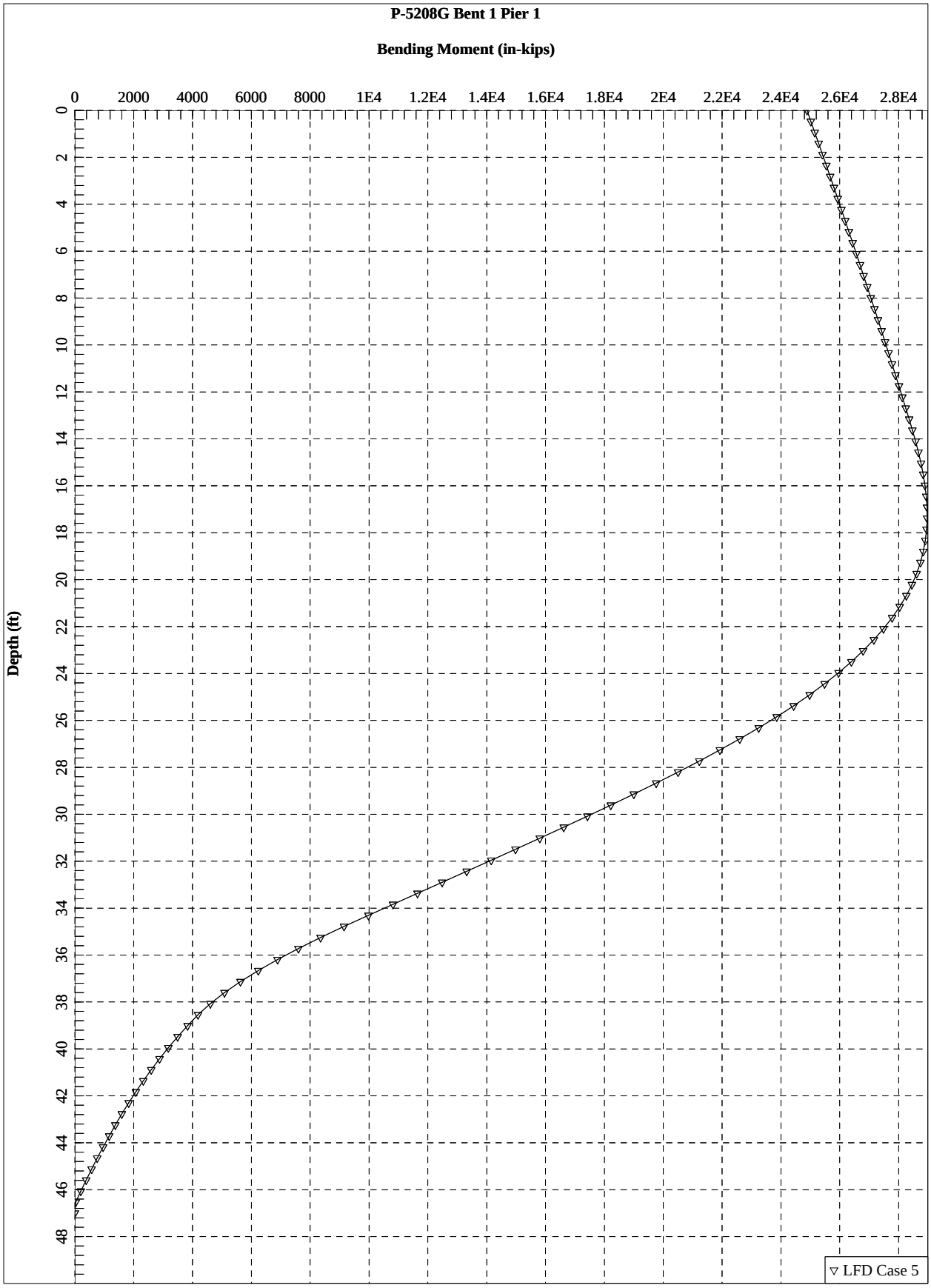

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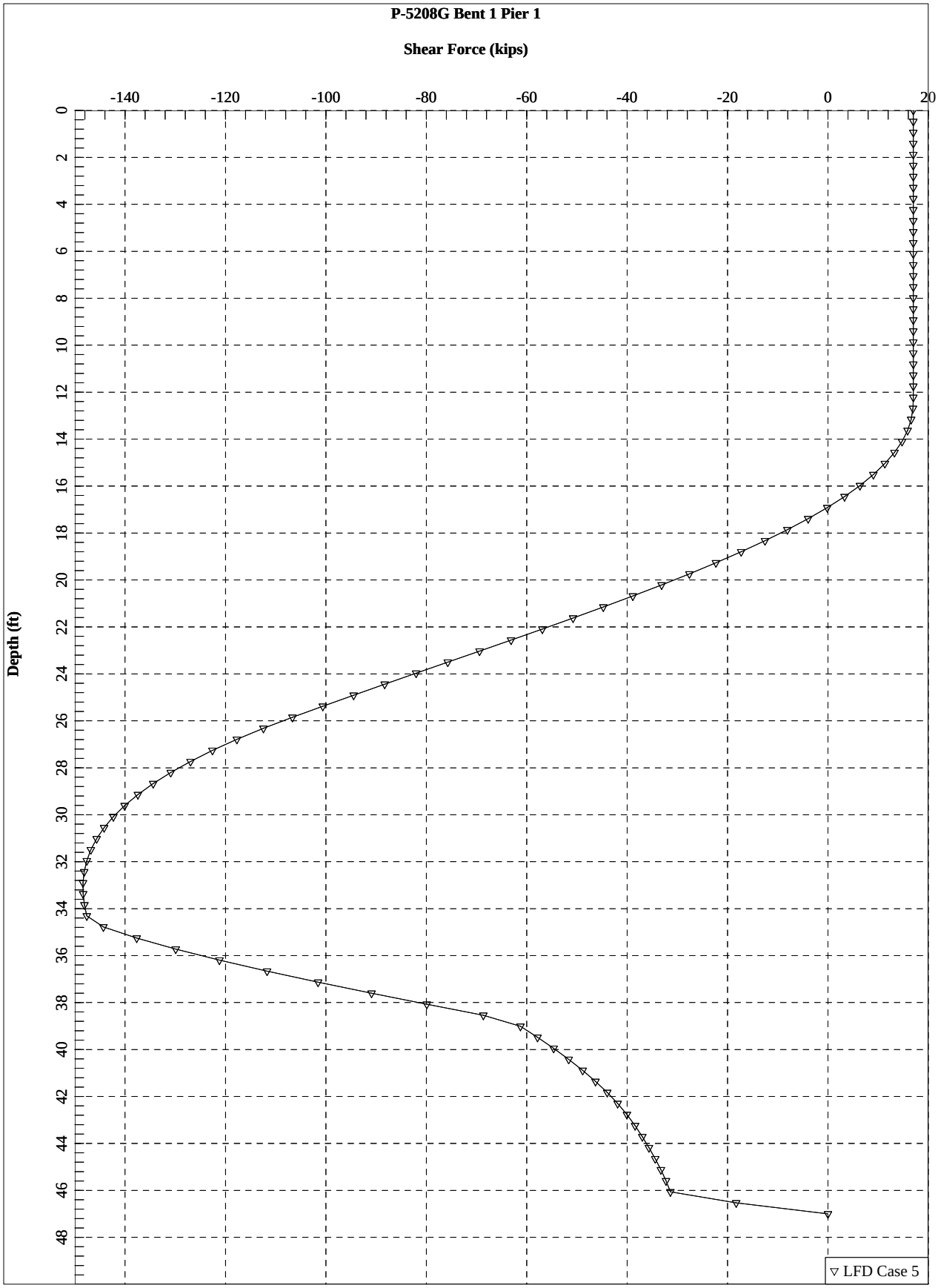

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```
==============================================================================

                  LPILE Plus for Windows, Version 5.0 (5.0.45)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method

                          (c) 1985-2010 by Ensoft, Inc.
                               All Rights Reserved

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

This program is licensed to:

Thomas Wells
Kleinfelder Southeast, Inc.

------------------------------------------------------------------------------
                            Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:      W:\share\_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G
RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\
Name of input data file:     B1, Left.lpd
Name of output file:         B1, Left.lpo
Name of plot output file:    B1, Left.lpp
Name of runtime file:        B1, Left.lpr


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

               Date:  March  4, 2013     Time:  13:49:01


-----------------------------------------------------------------------------
                                Problem Title
-----------------------------------------------------------------------------

P-5208G Bent 1 Left Pier


-----------------------------------------------------------------------------
                                Program Options
-----------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          100
- Maximum number of iterations allowed =          100
- Deflection tolerance for convergence =   1.0000E-05 in
- Maximum allowable deflection         =   1.0000E+02 in
```



```
Printing Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) =  1


-----------------------------------------------------------------------------
                      Pile Structural Properties and Geometry
-----------------------------------------------------------------------------

Pile Length                                =     564.00 in

Depth of ground surface below top of pile =     150.00 in

Slope angle of ground surface              =       0.00 deg.

Structural properties of pile defined using  4 points

Point    Point         Pile      Moment of       Pile      Modulus of
 No.     Depth       Diameter     Inertia        Area      Elasticity
           in           in         in**4        Sq.in      lbs/Sq.in
-----  ---------   -----------   ----------   ----------   -----------
  1       0.0000   66.00000000  931419.0000    3421.0000      3600000.
  2     138.0000   66.00000000  931419.0000    3421.0000      3600000.
  3     138.0000   72.00000000     1319166.    4072.0000      3600000.
  4     564.0000   72.00000000     1319166.    4072.0000      3600000.


-----------------------------------------------------------------------------
                        Soil and Rock Layering Information
-----------------------------------------------------------------------------

The soil profile is modelled using  4 layers

Layer  1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      150.000 in
Distance from top of pile to bottom of layer =      415.200 in
p-y subgrade modulus k for top of soil layer =      300.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      300.000 lbs/in**3

Layer  2 is stiff clay with water-induced erosion
Distance from top of pile to top of layer    =      415.200 in
Distance from top of pile to bottom of layer =      463.200 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      463.200 in
Distance from top of pile to bottom of layer =      553.200 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  4 is strong rock (vuggy limestone)
Distance from top of pile to top of layer    =      553.200 in
Distance from top of pile to bottom of layer =      703.200 in


(Depth of lowest layer extends  139.20 in below pile tip)


-----------------------------------------------------------------------------
                      Effective Unit Weight of Soil vs. Depth
-----------------------------------------------------------------------------

Effective unit weight of soil with depth defined using  8 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ---------------
  1          150.00        0.03620
```

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2	415.20	0.03620
3	415.20	0.04780
4	463.20	0.04780
5	463.20	0.04500
6	553.20	0.04500
7	553.20	0.06230
8	703.20	0.06230

Shear Strength of Soils

Shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	150.000	0.00000	35.00	------	------
2	415.200	0.00000	35.00	------	------
3	415.200	55.50000	0.00	0.00400	0.0
4	463.200	55.50000	0.00	0.00400	0.0
5	463.200	0.00000	40.00	------	------
6	553.200	0.00000	40.00	------	------
7	553.200	12000.00000	0.00	------	------
8	703.200	12000.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 17000.000 lbs
Bending moment at pile head = 24885840.000 in-lbs
Axial load at pile head = 2591960.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 17000.000 lbs
Specified moment at pile head = 24885840.000 in-lbs
Specified axial load at pile head = 2591960.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	0.459892	2.4886E+07	17000.0000	-0.0025391	1639.3621	0.0000	0.0000
5.640	0.445689	2.5019E+07	17000.0000	-0.0024971	1644.0634	0.0000	0.0000
11.280	0.431724	2.5151E+07	17000.0000	-0.0024549	1648.7428	0.0000	0.0000
16.920	0.417998	2.5282E+07	17000.0000	-0.0024125	1653.4004	0.0000	0.0000
22.560	0.404511	2.5413E+07	17000.0000	-0.0023699	1658.0359	0.0000	0.0000
28.200	0.391266	2.5543E+07	17000.0000	-0.0023270	1662.6493	0.0000	0.0000
33.840	0.378262	2.5673E+07	17000.0000	-0.0022839	1667.2404	0.0000	0.0000
39.480	0.365503	2.5802E+07	17000.0000	-0.0022406	1671.8092	0.0000	0.0000
45.120	0.352988	2.5930E+07	17000.0000	-0.0021971	1676.3555	0.0000	0.0000
50.760	0.340719	2.6058E+07	17000.0000	-0.0021534	1680.8792	0.0000	0.0000
56.400	0.328697	2.6185E+07	17000.0000	-0.0021095	1685.3801	0.0000	0.0000
62.040	0.316924	2.6311E+07	17000.0000	-0.0020653	1689.8583	0.0000	0.0000
67.680	0.305400	2.6437E+07	17000.0000	-0.0020210	1694.3136	0.0000	0.0000
73.320	0.294128	2.6562E+07	17000.0000	-0.0019764	1698.7458	0.0000	0.0000
78.960	0.283107	2.6686E+07	17000.0000	-0.0019316	1703.1549	0.0000	0.0000
84.600	0.272339	2.6810E+07	17000.0000	-0.0018866	1707.5407	0.0000	0.0000
90.240	0.261826	2.6933E+07	17000.0000	-0.0018414	1711.9032	0.0000	0.0000
95.880	0.251568	2.7056E+07	17000.0000	-0.0017960	1716.2422	0.0000	0.0000
101.520	0.241566	2.7178E+07	17000.0000	-0.0017504	1720.5577	0.0000	0.0000
107.160	0.231823	2.7299E+07	17000.0000	-0.0017046	1724.8495	0.0000	0.0000
112.800	0.222339	2.7419E+07	17000.0000	-0.0016586	1729.1175	0.0000	0.0000
118.440	0.213114	2.7539E+07	17000.0000	-0.0016124	1733.3616	0.0000	0.0000
124.080	0.204151	2.7658E+07	17000.0000	-0.0015659	1737.5817	0.0000	0.0000
129.720	0.195451	2.7777E+07	17000.0000	-0.0015193	1741.7777	0.0000	0.0000
135.360	0.187013	2.7894E+07	17000.0000	-0.0014725	1745.9495	0.0000	0.0000
141.000	0.178841	2.8011E+07	17000.0000	-0.0014324	1400.9603	0.0000	0.0000
146.640	0.170856	2.8128E+07	17000.0000	-0.0013991	1404.1417	0.0000	0.0000
152.280	0.163059	2.8244E+07	16925.6101	-0.0013656	1407.3097	-26.3794	912.4275
157.920	0.155452	2.8359E+07	16587.3067	-0.0013320	1410.4415	-93.5864	3395.4349
163.560	0.148035	2.8470E+07	15864.4117	-0.0012982	1413.4786	-162.7594	6201.0041
169.200	0.140808	2.8576E+07	14748.6460	-0.0012644	1416.3609	-232.9022	9328.8002
174.840	0.133773	2.8673E+07	13237.2750	-0.0012304	1419.0275	-303.0449	12776.7101
180.480	0.126929	2.8761E+07	11332.9520	-0.0011963	1421.4174	-372.2469	16540.4807
186.120	0.120279	2.8836E+07	9043.3038	-0.0011621	1423.4706	-439.6851	20617.3069
191.760	0.113821	2.8897E+07	6367.4876	-0.0011278	1425.1284	-509.1859	25230.8469
197.400	0.107557	2.8941E+07	3304.7265	-0.0010934	1426.3305	-576.8996	30250.9413
203.040	0.101487	2.8966E+07	-133.0566	-0.0010590	1427.0181	-642.1724	35687.7019
208.680	0.095611	2.8970E+07	-3930.3370	-0.0010246	1427.1346	-704.3809	41550.5744
214.320	0.089929	2.8952E+07	-8068.1650	-0.0009902	1426.6258	-762.9339	47848.0401
219.960	0.084441	2.8908E+07	-12524.3504	-0.0009559	1425.4410	-817.2737	54587.2464
225.600	0.079147	2.8838E+07	-17279.5126	-0.0009216	1423.5331	-868.9540	61921.4996
231.240	0.074046	2.8740E+07	-22316.2515	-0.0008874	1420.8572	-917.1236	69856.4948
236.880	0.069137	2.8613E+07	-27610.5679	-0.0008534	1417.3715	-960.2935	78337.9870
242.520	0.064420	2.8454E+07	-33133.1578	-0.0008195	1413.0387	-998.0717	87381.6913
248.160	0.059893	2.8263E+07	-38852.6093	-0.0007858	1407.8260	-1030.1026	97001.8897
253.800	0.055556	2.8039E+07	-44735.6154	-0.0007524	1401.7056	-1056.0697	107211.
259.440	0.051407	2.7780E+07	-50751.8519	-0.0007192	1394.6552	-1077.3475	118199.
265.080	0.047444	2.7487E+07	-56884.3969	-0.0006864	1386.6565	-1097.3139	130446.
270.720	0.043664	2.7159E+07	-63112.4283	-0.0006539	1377.6921	-1111.2079	143531.
276.360	0.040067	2.6794E+07	-69401.1924	-0.0006219	1367.7503	-1118.8503	157493.
282.000	0.036649	2.6394E+07	-75715.0406	-0.0005903	1356.8245	-1120.1030	172373.
287.640	0.033408	2.5958E+07	-82017.6668	-0.0005592	1344.9139	-1114.8709	188212.
293.280	0.030341	2.5485E+07	-88272.3578	-0.0005287	1332.0231	-1103.1046	205051.
298.920	0.027445	2.4977E+07	-94469.9643	-0.0004987	1318.1627	-1094.6282	224950.
304.560	0.024716	2.4434E+07	-100608.	-0.0004694	1303.3403	-1081.8575	246875.
310.200	0.022150	2.3856E+07	-106657.	-0.0004407	1287.5671	-1063.4095	270771.
315.840	0.019745	2.3244E+07	-112426.	-0.0004127	1270.8595	-982.3307	280601.
321.480	0.017495	2.2600E+07	-117734.	-0.0003855	1253.2881	-899.9906	290144.
327.120	0.015396	2.1927E+07	-122579.	-0.0003591	1234.9248	-818.0803	299687.
332.760	0.013444	2.1228E+07	-126965.	-0.0003334	1215.8409	-737.1210	309230.
338.400	0.011635	2.0505E+07	-130898.	-0.0003087	1196.1071	-657.5935	318773.

344.040	0.009963	1.9760E+07	-134388.	-0.0002848	1175.7927	-579.9377	328316.
349.680	0.008423	1.8997E+07	-137446.	-0.0002617	1154.9655	-504.5520	337859.
355.320	0.007010	1.8218E+07	-140087.	-0.0002396	1133.6913	-431.7933	347401.
360.960	0.005720	1.7424E+07	-142325.	-0.0002185	1112.0337	-361.9771	356944.
366.600	0.004546	1.6619E+07	-144179.	-0.0001983	1090.0536	-295.3774	366487.
372.240	0.003483	1.5803E+07	-145667.	-0.0001790	1067.8092	-232.2270	376030.
377.880	0.002526	1.4981E+07	-146809.	-0.0001607	1045.3557	-172.7175	385573.
383.520	0.001670	1.4152E+07	-147626.	-0.0001434	1022.7452	-117.0003	395116.
389.160	0.000909	1.3320E+07	-148139.	-0.0001271	1000.0264	-65.1865	404659.
394.800	0.000236	1.2485E+07	-148372.	-0.0001118	977.2447	-17.3477	414202.
400.440	-0.000352	1.1649E+07	-148346.	-9.7463E-05	954.4420	26.4833	423744.
406.080	-0.000863	1.0814E+07	-148085.	-8.4124E-05	931.6568	66.3119	433287.
411.720	-0.001301	9981384.	-147610.	-7.1775E-05	908.9241	102.1812	442830.
417.360	-0.001673	9151453.	-144306.	-6.0414E-05	886.2753	1069.2122	3604971.
423.000	-0.001983	8355375.	-137670.	-5.0018E-05	864.5503	1284.1872	3652686.
428.640	-0.002237	7600001.	-129909.	-4.0544E-05	843.9362	1467.6897	3700400.
434.280	-0.002440	6891182.	-121197.	-3.1939E-05	824.5926	1621.6618	3748114.
439.920	-0.002597	6233828.	-111695.	-2.4145E-05	806.6534	1748.0068	3795829.
445.560	-0.002713	5631968.	-101553.	-1.7099E-05	790.2287	1848.5538	3843543.
451.200	-0.002790	5088813.	-90911.2019	-1.0733E-05	775.4060	1925.0245	3891258.
456.840	-0.002834	4606804.	-79901.8462	-4.9754E-06	762.2520	1979.0023	3938972.
462.480	-0.002846	4187666.	-68647.4894	2.4684E-07	750.8137	2011.9043	3986686.
468.120	-0.002831	3832453.	-61236.7675	5.0093E-06	741.1199	616.0113	1227304.
473.760	-0.002790	3496769.	-57849.6141	9.3614E-06	731.9591	585.1070	1182901.
479.400	-0.002725	3179635.	-54646.2133	1.3326E-05	723.3046	550.8508	1140007.
485.040	-0.002639	2879970.	-51643.9216	1.6924E-05	715.1267	513.7917	1097880.
490.680	-0.002534	2596597.	-48856.9561	2.0176E-05	707.3935	474.4939	1055954.
496.320	-0.002412	2328273.	-46296.3123	2.3101E-05	700.0709	433.5358	1013804.
501.960	-0.002274	2073699.	-43969.6911	2.5715E-05	693.1236	391.5072	971121.
507.600	-0.002122	1831543.	-41881.4472	2.8034E-05	686.5152	349.0048	927702.
513.240	-0.001958	1600457.	-40032.5678	3.0072E-05	680.2088	306.6262	883439.
518.880	-0.001783	1379097.	-38420.6912	3.1841E-05	674.1679	264.9613	838324.
524.520	-0.001598	1166141.	-36982.7542	3.3352E-05	668.3564	244.9454	864307.
530.160	-0.001406	960956.	-35644.3433	3.4615E-05	662.7569	229.6684	921045.
535.800	-0.001208	763060.	-34398.7987	3.5639E-05	657.3563	212.0142	989932.
541.440	-0.001004	571896.	-33260.2526	3.6432E-05	652.1394	191.7256	1076636.
547.080	-0.000797	386820.	-32244.7354	3.7001E-05	647.0887	168.3869	1191639.
552.720	-0.000587	207093.	-31371.5333	3.7354E-05	642.1840	141.2592	1357266.
558.360	-0.000376	31856.6666	-18262.1457	3.7496E-05	637.4018	4507.4598	6.7680E+07
564.000	-0.000164	0.0000	0.0000	3.7515E-05	636.5324	1968.4784	3.3840E+07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     0.45989158 in
Computed slope at pile head      =    -0.00253908
Maximum bending moment           =      28970429. lbs-in
Maximum shear force              =  -148372.23307 lbs
Depth of maximum bending moment  =      208.68000 in
Depth of maximum shear force     =      394.80000 in
Number of iterations             =             12
Number of zero deflection points =              2
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
```



```
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 17000.	M= 2.49E+07	2591960.	0.4598916	2.8970E+07	-148372.

The analysis ended normally.

PILE+ 5.0 INPUT SHEET (ENGLISH)

0041D1_P1.pat
0001A0_P1.pat

Designer:	TRW	Date:	3/4/13
Checker:	XCB	Date:	3/5/13

Project Title Haydock to Junker Bridge on NCRR/NS

TIP # P-5208G Bent # 1 Center

COUNTY: Mecklenburg

P+ M+ V+ **NOTE: LOADS GIVEN AT T/SHAFT**

Pile Properties

Total Pile Length	627.6	(inches)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	146.4	(inches)
Combined Ground Slope & Batter Angles	0	(degrees)

Drilled Shaft Sections

Section #	Depth (inches)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0	66	931419	3421	3600000
2	134.4	66	931419	3421	3600000
3	134.4	72	1319166	4072	3600000
4	627.6	72	1319166	4072	3600000

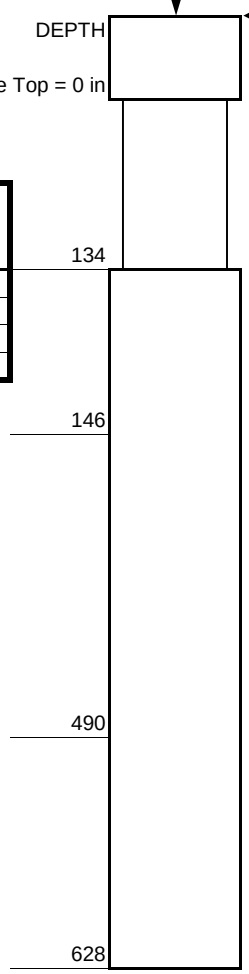
Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Moment	69050	27080040	3556170

Soil Layers

Layer #	Soil Type	Layer Top (inches)	Layer Bottom (inches)
1	4	146.4	415.2
2	2	415.2	463.2
3	4	463.2	553.2
4	6	553.2	703.2

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)



		Input Elevation	
BOC Elev. =		710.2	ft
TOS Elev. =		699.0	ft
T/G Elev. =		698.0	ft
Fixity		669.4	ft
Tip Elev. =		657.9	ft

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}		First Neg.	Pile Length
0.81		439.32	627.6
		673.6	
Max. Neg.	@	489.53	669.4

SOIL AND ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain e_{50}
4	0.0362	300		35	
2	0.0478	1500	55.5		0.004
4	0.0450	1500		40	

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	Young's Mod.* Er, (lbs/in^2)	Uniax. Comp. Str. (lbs/in^2)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6	0.0623	12,000

COMMENTS:

PT. OF FIXITY ELEV. = **669.4** ft

TIP NO HIGHER THAN EL. = **657.9** ft

File: B1, C

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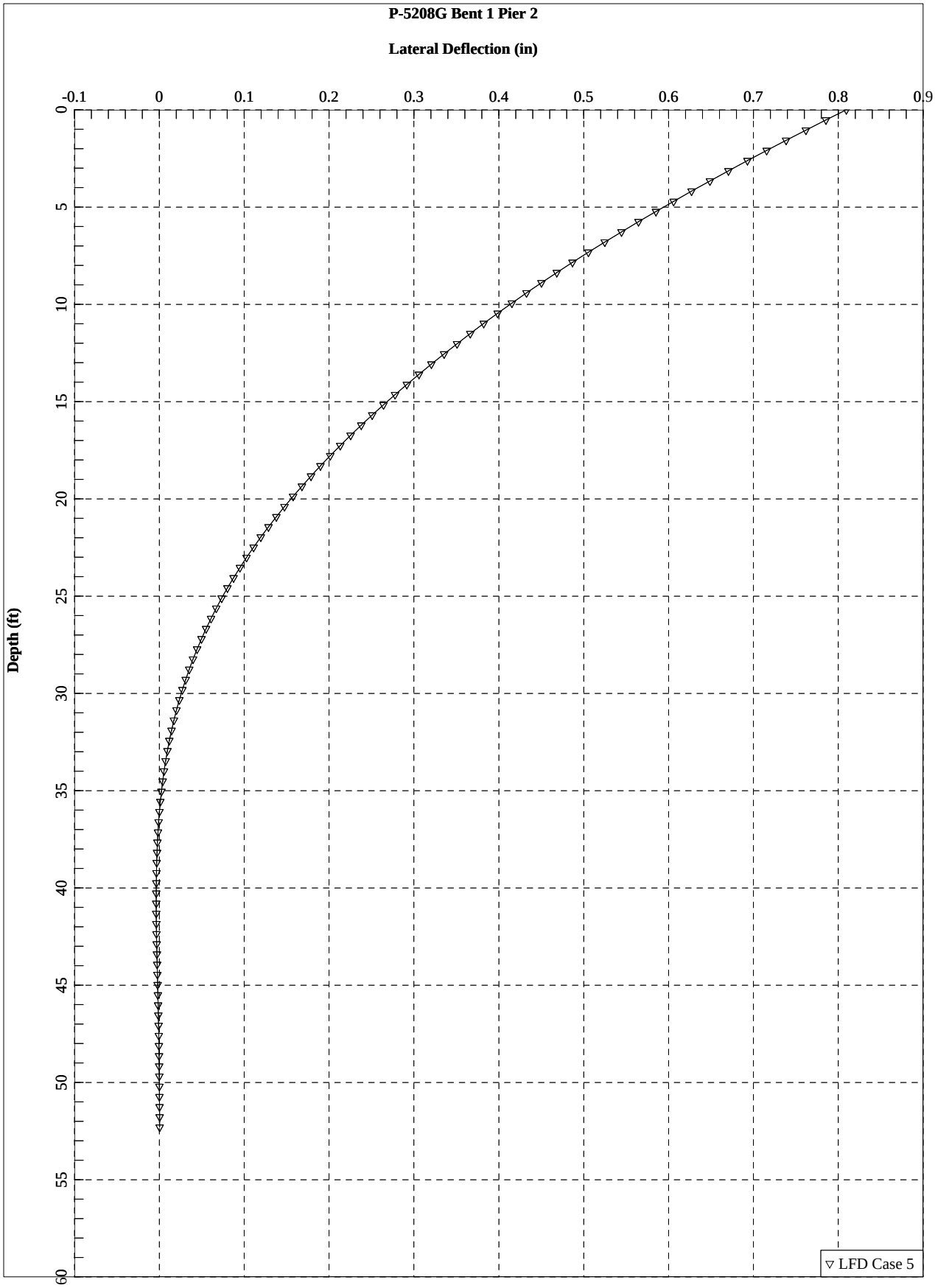

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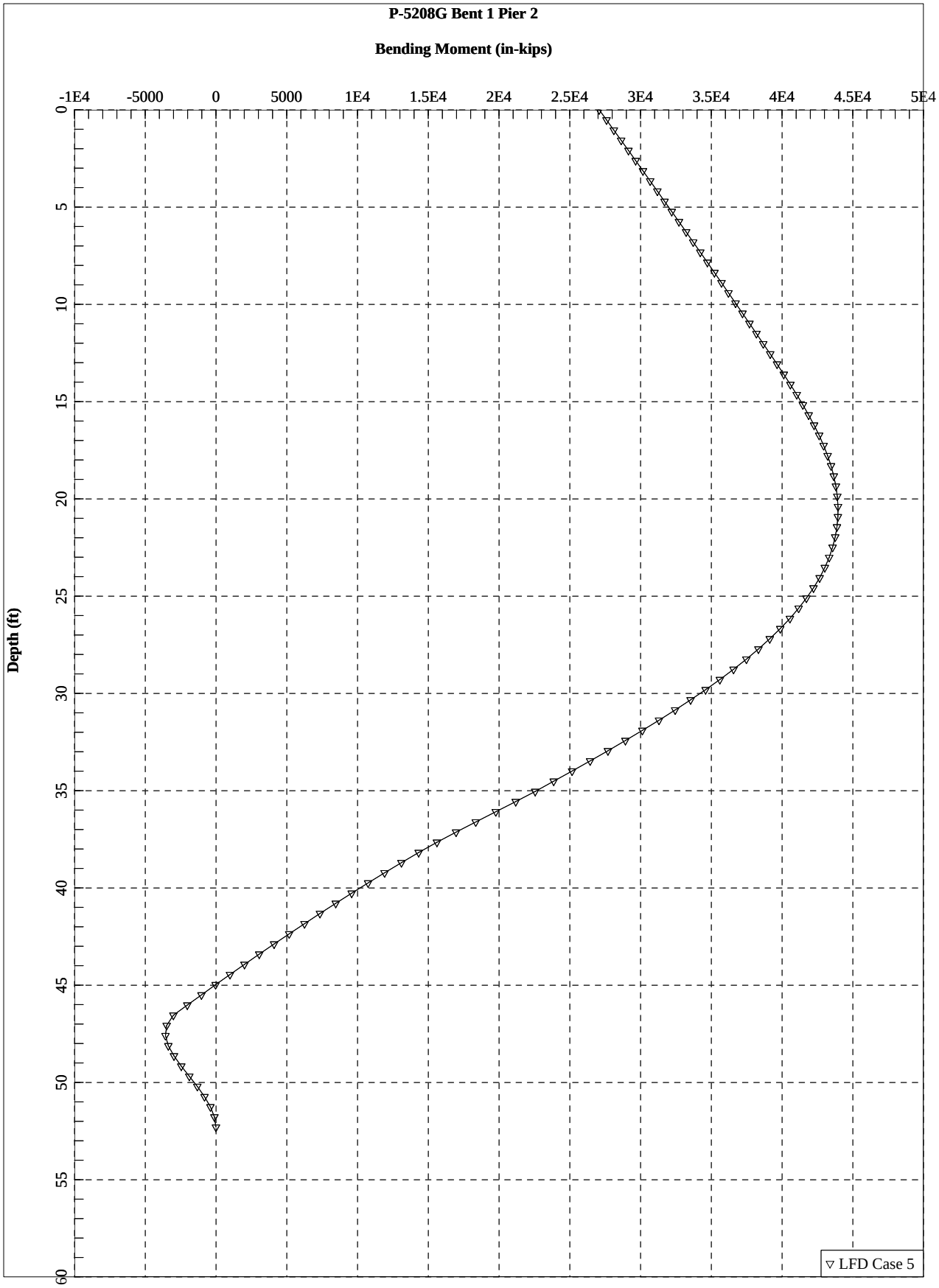

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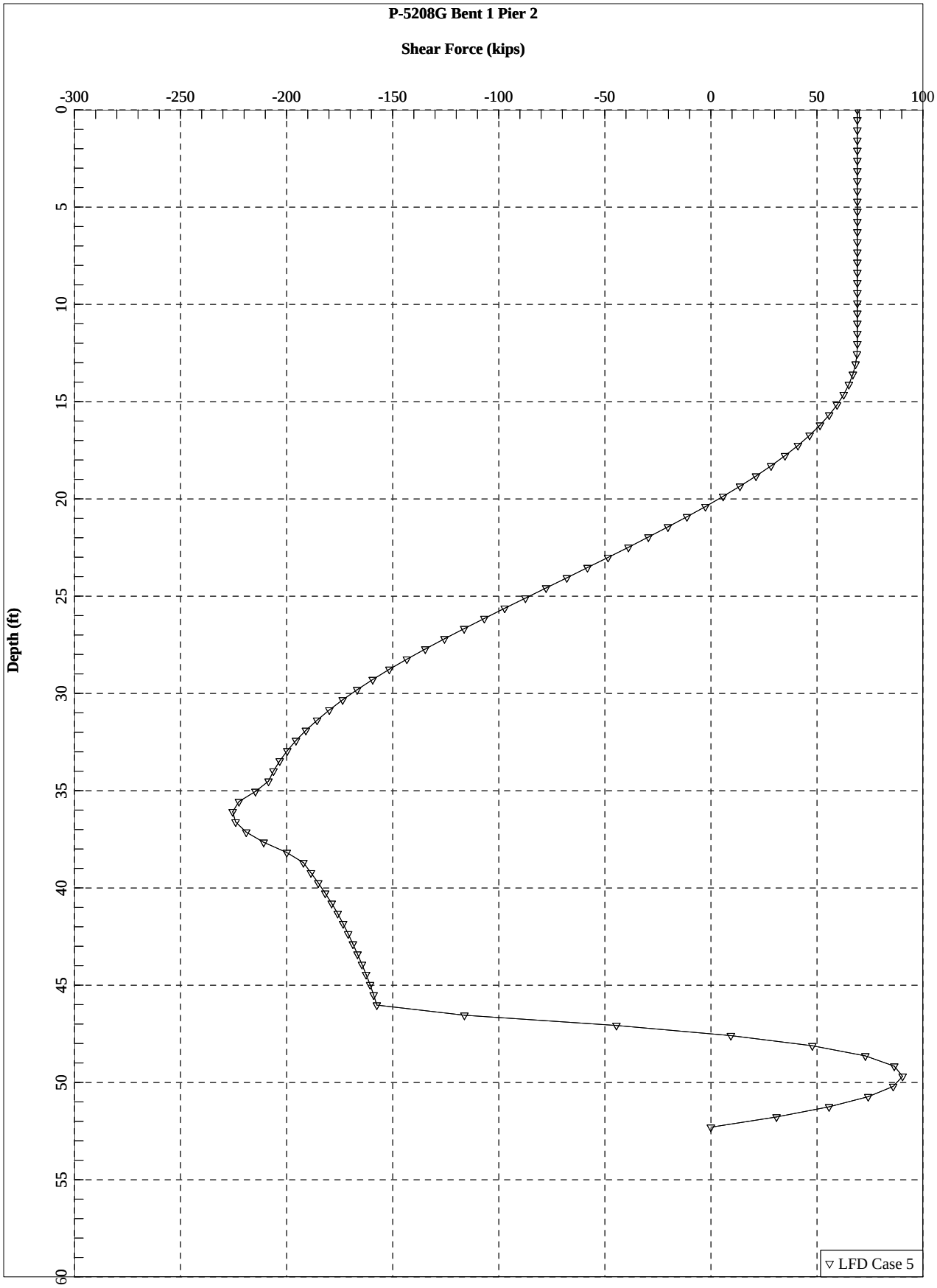

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==============================================================================

                  LPILE Plus for Windows, Version 5.0 (5.0.45)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method

                          (c) 1985-2010 by Ensoft, Inc.
                               All Rights Reserved

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

This program is licensed to:

Thomas Wells
Kleinfelder Southeast, Inc.

------------------------------------------------------------------------------
                            Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:      W:\share\_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G
RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\
Name of input data file:     B1, Center.lpd
Name of output file:         B1, Center.lpo
Name of plot output file:    B1, Center.lpp
Name of runtime file:        B1, Center.lpr


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

               Date:  March  4, 2013     Time:  14:17:54


-----------------------------------------------------------------------------
                                Problem Title
-----------------------------------------------------------------------------

P-5208G Bent 1 Center Pier


-----------------------------------------------------------------------------
                                Program Options
-----------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          100
- Maximum number of iterations allowed =          100
- Deflection tolerance for convergence =   1.0000E-05 in
- Maximum allowable deflection         =   1.0000E+02 in
```



```
Printing Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) =  1


-----------------------------------------------------------------------------
                      Pile Structural Properties and Geometry
-----------------------------------------------------------------------------

Pile Length                                =     627.60 in

Depth of ground surface below top of pile =     146.40 in

Slope angle of ground surface              =       0.00 deg.

Structural properties of pile defined using  4 points

Point    Point         Pile      Moment of       Pile      Modulus of
 No.     Depth       Diameter     Inertia        Area      Elasticity
           in           in         in**4        Sq.in      lbs/Sq.in
-----  ---------   -----------   ----------   ----------   -----------
  1       0.0000   66.00000000  931419.0000    3421.0000      3600000.
  2     134.4000   66.00000000  931419.0000    3421.0000      3600000.
  3     134.4000   72.00000000     1319166.    4072.0000      3600000.
  4     627.6000   72.00000000     1319166.    4072.0000      3600000.


-----------------------------------------------------------------------------
                        Soil and Rock Layering Information
-----------------------------------------------------------------------------

The soil profile is modelled using  4 layers

Layer  1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      146.400 in
Distance from top of pile to bottom of layer =      415.200 in
p-y subgrade modulus k for top of soil layer =      300.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      300.000 lbs/in**3

Layer  2 is stiff clay with water-induced erosion
Distance from top of pile to top of layer    =      415.200 in
Distance from top of pile to bottom of layer =      463.200 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  3 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      463.200 in
Distance from top of pile to bottom of layer =      553.200 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  4 is strong rock (vuggy limestone)
Distance from top of pile to top of layer    =      553.200 in
Distance from top of pile to bottom of layer =      703.200 in


(Depth of lowest layer extends   75.60 in below pile tip)


-----------------------------------------------------------------------------
                      Effective Unit Weight of Soil vs. Depth
-----------------------------------------------------------------------------

Effective unit weight of soil with depth defined using  8 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ---------------
  1          146.40        0.03620
```

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2	415.20	0.03620
3	415.20	0.04780
4	463.20	0.04780
5	463.20	0.04500
6	553.20	0.04500
7	553.20	0.06230
8	703.20	0.06230

Shear Strength of Soils

Shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	146.400	0.00000	35.00	------	------
2	415.200	0.00000	35.00	------	------
3	415.200	55.50000	0.00	0.00400	0.0
4	463.200	55.50000	0.00	0.00400	0.0
5	463.200	0.00000	40.00	------	------
6	553.200	0.00000	40.00	------	------
7	553.200	12000.00000	0.00	------	------
8	703.200	12000.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 69050.000 lbs
Bending moment at pile head = 27080040.000 in-lbs
Axial load at pile head = 3556170.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 69050.000 lbs
Specified moment at pile head = 27080040.000 in-lbs
Specified axial load at pile head = 3556170.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	0.809421	2.7080E+07	69050.0000	-0.0038437	1998.9526	0.0000	0.0000
6.276	0.785457	2.7599E+07	69050.0000	-0.0037926	2017.3257	0.0000	0.0000
12.552	0.761816	2.8116E+07	69050.0000	-0.0037404	2035.6580	0.0000	0.0000
18.828	0.738507	2.8632E+07	69050.0000	-0.0036873	2053.9487	0.0000	0.0000
25.104	0.715533	2.9147E+07	69050.0000	-0.0036333	2072.1970	0.0000	0.0000
31.380	0.692902	2.9661E+07	69050.0000	-0.0035782	2090.4022	0.0000	0.0000
37.656	0.670619	3.0174E+07	69050.0000	-0.0035222	2108.5635	0.0000	0.0000
43.932	0.648691	3.0685E+07	69050.0000	-0.0034653	2126.6801	0.0000	0.0000
50.208	0.627123	3.1195E+07	69050.0000	-0.0034074	2144.7513	0.0000	0.0000
56.484	0.605922	3.1704E+07	69050.0000	-0.0033485	2162.7764	0.0000	0.0000
62.760	0.585093	3.2211E+07	69050.0000	-0.0032887	2180.7545	0.0000	0.0000
69.036	0.564643	3.2717E+07	69050.0000	-0.0032279	2198.6849	0.0000	0.0000
75.312	0.544576	3.3222E+07	69050.0000	-0.0031662	2216.5669	0.0000	0.0000
81.588	0.524900	3.3725E+07	69050.0000	-0.0031036	2234.3998	0.0000	0.0000
87.864	0.505621	3.4227E+07	69050.0000	-0.0030400	2252.1827	0.0000	0.0000
94.140	0.486743	3.4728E+07	69050.0000	-0.0029754	2269.9150	0.0000	0.0000
100.416	0.468273	3.5227E+07	69050.0000	-0.0029100	2287.5959	0.0000	0.0000
106.692	0.450217	3.5725E+07	69050.0000	-0.0028436	2305.2246	0.0000	0.0000
112.968	0.432581	3.6221E+07	69050.0000	-0.0027762	2322.8005	0.0000	0.0000
119.244	0.415370	3.6715E+07	69050.0000	-0.0027080	2340.3227	0.0000	0.0000
125.520	0.398590	3.7208E+07	69050.0000	-0.0026388	2357.7906	0.0000	0.0000
131.796	0.382248	3.7700E+07	69050.0000	-0.0025687	2375.2035	0.0000	0.0000
138.072	0.366348	3.8190E+07	69050.0000	-0.0025082	1915.5145	0.0000	0.0000
144.348	0.350765	3.8678E+07	69050.0000	-0.0024574	1928.8531	0.0000	0.0000
150.624	0.335503	3.9166E+07	68862.6503	-0.0024059	1942.1605	-59.7035	1116.8286
156.900	0.320566	3.9650E+07	68197.2233	-0.0023539	1955.3723	-152.3510	2982.7101
163.176	0.305957	4.0127E+07	66939.8851	-0.0023011	1968.3884	-248.3304	5093.9189
169.452	0.291682	4.0593E+07	65074.4945	-0.0022478	1981.1053	-346.1216	7447.3625
175.728	0.277743	4.1044E+07	62594.3503	-0.0021939	1993.4174	-444.2366	10038.1691
182.004	0.264144	4.1477E+07	59501.9760	-0.0021393	2005.2190	-541.2236	12859.3347
188.280	0.250890	4.1887E+07	55794.3578	-0.0020843	2016.4055	-640.2991	16017.0620
194.556	0.237983	4.2270E+07	51469.7960	-0.0020286	2026.8700	-737.8277	19457.7474
200.832	0.225426	4.2623E+07	46542.1659	-0.0019726	2036.5073	-832.4814	23176.7840
207.108	0.213223	4.2942E+07	41032.7515	-0.0019160	2045.2155	-923.2274	27174.2289
213.384	0.201376	4.3224E+07	34969.1697	-0.0018591	2052.8968	-1009.0804	31448.5224
219.660	0.189888	4.3464E+07	28382.6447	-0.0018018	2059.4586	-1089.8760	36021.5560
225.936	0.178760	4.3660E+07	21298.7327	-0.0017442	2064.8140	-1167.5848	40992.1415
232.212	0.167994	4.3809E+07	13747.7632	-0.0016864	2068.8791	-1238.7152	46276.3897
238.488	0.157592	4.3908E+07	5773.3014	-0.0016285	2071.5775	-1302.5409	51872.8256
244.764	0.147554	4.3955E+07	-2576.7011	-0.0015704	2072.8404	-1358.3904	57777.2496
251.040	0.137880	4.3946E+07	-11250.2593	-0.0015123	2072.6078	-1405.6498	63982.0221
257.316	0.128571	4.3881E+07	-20206.0951	-0.0014543	2070.8289	-1448.3450	70698.7176
263.592	0.119626	4.3757E+07	-29419.2078	-0.0013964	2067.4579	-1487.6373	78046.7267
269.868	0.111044	4.3574E+07	-38851.3853	-0.0013387	2062.4526	-1518.1554	85803.5813
276.144	0.102823	4.3329E+07	-48446.3439	-0.0012813	2055.7803	-1539.5115	93967.2520
282.420	0.094961	4.3023E+07	-58145.5635	-0.0012242	2047.4184	-1551.3807	102531.
288.696	0.087457	4.2654E+07	-67888.6936	-0.0011676	2037.3542	-1553.5046	111482.
294.972	0.080306	4.2223E+07	-77648.2619	-0.0011115	2025.5858	-1556.6191	121652.
301.248	0.073505	4.1729E+07	-87412.7758	-0.0010560	2012.1102	-1555.0807	132776.
307.524	0.067050	4.1173E+07	-97140.5962	-0.0010013	1996.9295	-1544.9258	144607.
313.800	0.060937	4.0555E+07	-106777.	-0.0009472	1980.0550	-1526.1073	157175.
320.076	0.055161	3.9875E+07	-116269.	-0.0008941	1961.5074	-1498.6396	170511.
326.352	0.049715	3.9135E+07	-125562.	-0.0008419	1941.3169	-1462.6020	184640.
332.628	0.044593	3.8336E+07	-134583.	-0.0007907	1919.5227	-1412.4518	198787.
338.904	0.039790	3.7481E+07	-143263.	-0.0007406	1896.1793	-1353.3703	213466.
345.180	0.035297	3.6571E+07	-151544.	-0.0006917	1871.3511	-1285.8459	228630.
351.456	0.031108	3.5610E+07	-159378.	-0.0006440	1845.1113	-1210.4567	244210.
357.732	0.027214	3.4599E+07	-166716.	-0.0005976	1817.5417	-1127.9197	260119.
364.008	0.023607	3.3544E+07	-173528.	-0.0005526	1788.7318	-1043.0134	277290.
370.284	0.020278	3.2446E+07	-179826.	-0.0005090	1758.7739	-963.9722	298346.
376.560	0.017218	3.1309E+07	-185613.	-0.0004668	1727.7536	-880.1984	320826.

382.836	0.014418	3.0137E+07	-190862.	-0.0004262	1695.7620	-792.6090	345003.
389.112	0.011868	2.8933E+07	-195553.	-0.0003872	1662.8941	-702.1960	371319.
395.388	0.009558	2.7700E+07	-199671.	-0.0003498	1629.2482	-610.0016	400524.
401.664	0.007478	2.6442E+07	-203207.	-0.0003140	1594.9243	-517.0760	433956.
407.940	0.005617	2.5163E+07	-206162.	-0.0002799	1560.0233	-424.4033	474186.
414.216	0.003965	2.3867E+07	-208493.	-0.0002475	1524.6458	-318.5524	504244.
420.492	0.002510	2.2557E+07	-214670.	-0.0002168	1488.9067	-1649.9915	4124855.
426.768	0.001243	2.1182E+07	-222449.	-0.0001879	1451.3759	-828.8025	4183938.
433.044	0.000152	1.9773E+07	-225371.	-0.0001609	1412.9372	-102.5275	4243020.
439.320	-0.000776	1.8360E+07	-224024.	-0.0001357	1374.3723	531.8799	4302102.
445.596	-0.001551	1.6967E+07	-218973.	-0.0001123	1336.3644	1077.9327	4361184.
451.872	-0.002186	1.5617E+07	-210759.	-9.0790E-05	1299.5015	1539.4661	4420267.
458.148	-0.002691	1.4326E+07	-199902.	-7.1005E-05	1264.2808	1920.5018	4479349.
464.424	-0.003077	1.3111E+07	-192080.	-5.2876E-05	1231.1129	572.0484	1166768.
470.700	-0.003355	1.1917E+07	-188525.	-3.6338E-05	1198.5493	561.0191	1049621.
476.976	-0.003533	1.0746E+07	-185072.	-2.1362E-05	1166.5792	539.1442	957695.
483.252	-0.003623	9595369.	-181784.	-7.9215E-06	1135.1800	508.7611	881396.
489.528	-0.003633	8464548.	-178707.	4.0120E-06	1104.3199	471.7992	815129.
495.804	-0.003572	7352061.	-175877.	1.4463E-05	1073.9602	429.9665	755390.
502.080	-0.003451	6256292.	-173320.	2.3455E-05	1044.0567	384.8411	699868.
508.356	-0.003278	5175497.	-170972.	3.1009E-05	1014.5618	363.6452	696255.
514.632	-0.003062	4108873.	-168719.	3.7144E-05	985.4537	354.1131	725852.
520.908	-0.002812	3056075.	-166538.	4.1878E-05	956.7229	340.9320	761009.
527.184	-0.002536	2016616.	-164451.	4.5230E-05	928.3561	324.3091	802542.
533.460	-0.002244	989871.	-162477.	4.7217E-05	900.3362	304.4889	851623.
539.736	-0.001943	-24909.2328	-160638.	4.7854E-05	874.0025	281.7673	909899.
546.012	-0.001643	-1028591.	-158949.	4.7158E-05	901.3929	256.5084	979671.
552.288	-0.001352	-2022139.	-157425.	4.5142E-05	928.5068	229.1688	1064157.
558.564	-0.001077	-3006600.	-116164.	4.1819E-05	955.3727	12919.4992	7.5312E+07
564.840	-0.000827	-3482098.	-44495.0183	3.7532E-05	968.3490	9919.6095	7.5312E+07
571.116	-0.000606	-3566777.	9434.3217	3.2874E-05	970.6599	7266.2860	7.5312E+07
577.392	-0.000414	-3365145.	47825.3744	2.8294E-05	965.1574	4967.9565	7.5312E+07
583.668	-0.000250	-2967736.	72843.1092	2.4109E-05	954.3121	3004.5531	7.5312E+07
589.944	-0.000111	-2451895.	86465.4040	2.0528E-05	940.2348	1336.5224	7.5312E+07
596.220	7.29E-06	-1883338.	90384.9111	1.7664E-05	924.7189	-87.4761	7.5312E+07
602.496	0.000110	-1318172.	85955.6053	1.5548E-05	909.2956	-1324.0298	7.5312E+07
608.772	0.000202	-805118.	74177.3783	1.4145E-05	895.2943	-2429.3886	7.5312E+07
615.048	0.000288	-387729.	55713.3734	1.3357E-05	883.9038	-3454.6156	7.5312E+07
621.324	0.000370	-106400.	30936.1387	1.3030E-05	876.2263	-4441.2527	7.5312E+07
627.600	0.000451	0.0000	0.0000	1.2960E-05	873.3227	-5417.3001	3.7656E+07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     0.80942087 in
Computed slope at pile head      =    -0.00384375
Maximum bending moment           =      43954528. lbs-in
Maximum shear force              =  -225371.42923 lbs
Depth of maximum bending moment  =      244.76400 in
Depth of maximum shear force     =      433.04400 in
Number of iterations             =             15
Number of zero deflection points =              2
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
```



```
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 69050.	M= 2.71E+07	3556170.	0.8094209	4.3955E+07	-225371.

The analysis ended normally.

PILE+ 5.0 INPUT SHEET (ENGLISH)

0041D1_P1_pat1
0001A0_P1_pat1

Designer:	TRW	Date:	3/4/13
Checker:	XCB	Date:	3/5/13

Project Title Haydock to Junker Bridge on NCRR/NS

TIP # P-5208G Bent # 1 Right

COUNTY: Mecklenburg

P+ M+ V+ **NOTE: LOADS GIVEN AT T/SHAFT**

Pile Properties

Total Pile Length	565.2	(inches)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	142.8	(inches)
Combined Ground Slope & Batter Angles	0	(degrees)

Drilled Shaft Sections

Section #	Depth (inches)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0	66	931419	3421	3600000
2	130.8	66	931419	3421	3600000
3	130.8	72	1319166	4072	3600000
4	565.2	72	1319166	4072	3600000

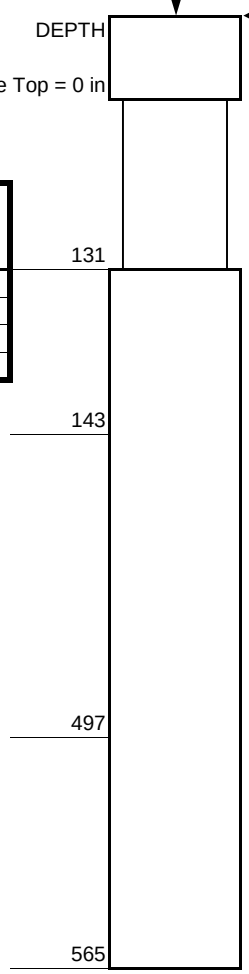
Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Moment	154450	35647560	2324700

Soil Layers

Layer #	Soil Type	Layer Top (inches)	Layer Bottom (inches)
1	4	142.8	403.2
2	2	403.2	525.6
3	6	525.6	760.8

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)



		Input Elevation	
BOC Elev. =		710.2	ft
TOS Elev. =		699.3	ft
T/G Elev. =		698.3	ft
Fixity		668.8	ft
Tip Elev. =		663.1	ft

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}		First Neg.	Pile Length
1.44		463.46	565.2
		671.6	
Max. Neg.	@	497.38	668.8

SOIL AND ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain e_{50}
4	0.0420	600		35	
2	0.0478	1500	55.5		0.004

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	Young's Mod.* Er, (lbs/in^2)	Uniax. Comp. Str. (lbs/in^2)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)		Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6		0.0623	12,000

COMMENTS:

PT. OF FIXITY ELEV. = **668.8** ft

TIP NO HIGHER THAN EL. = **663.1** ft

File: B1, R

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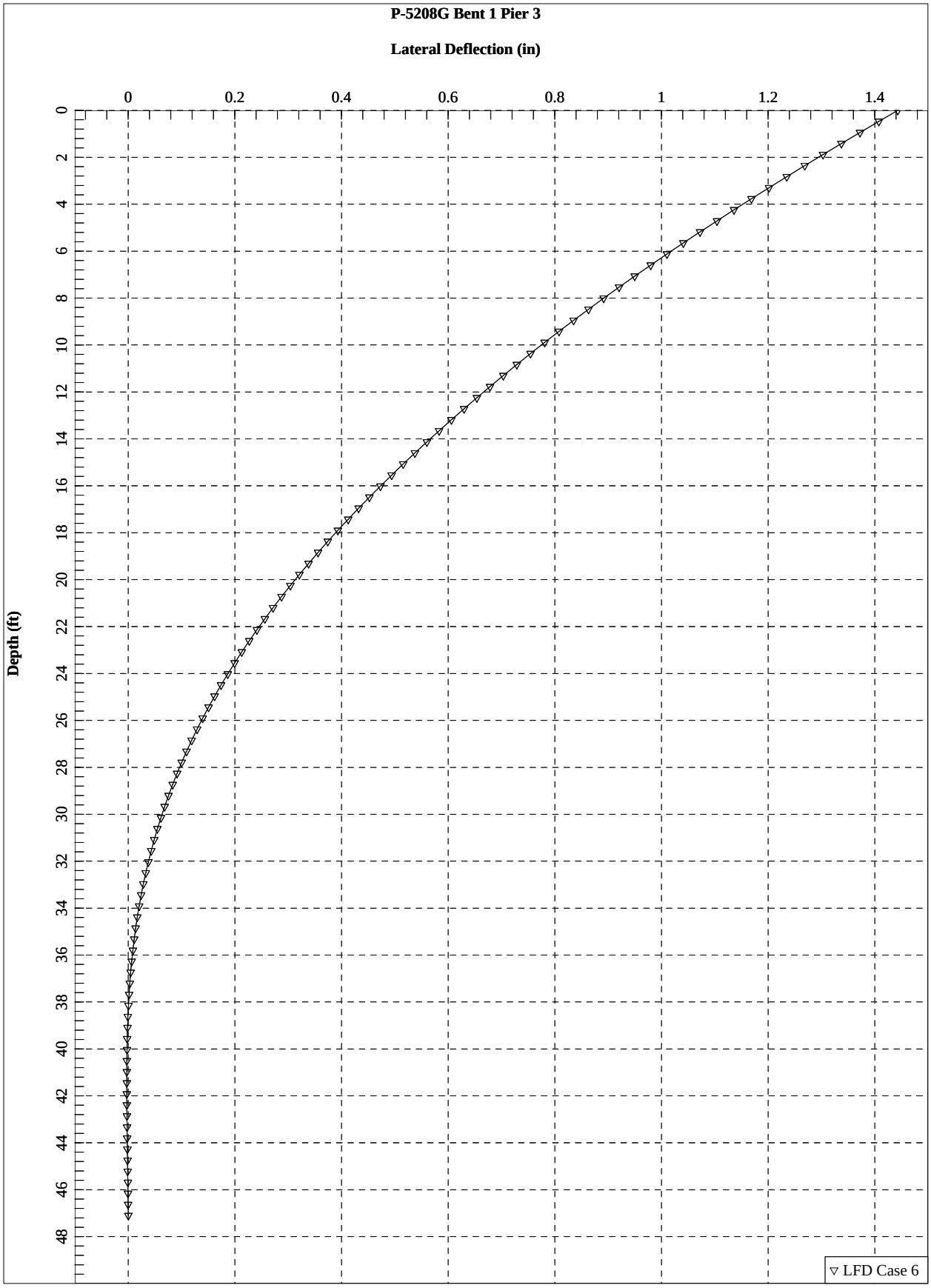

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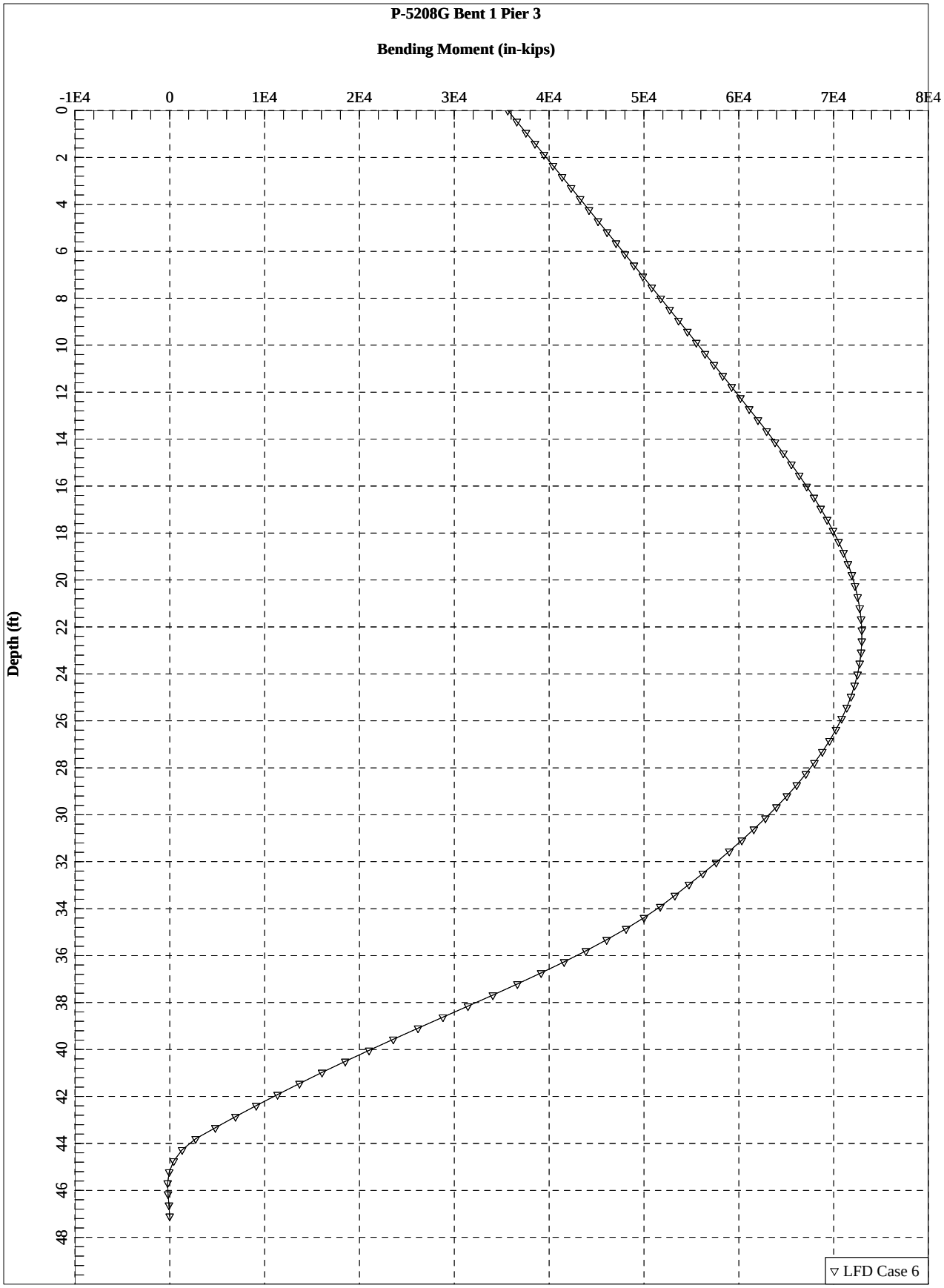

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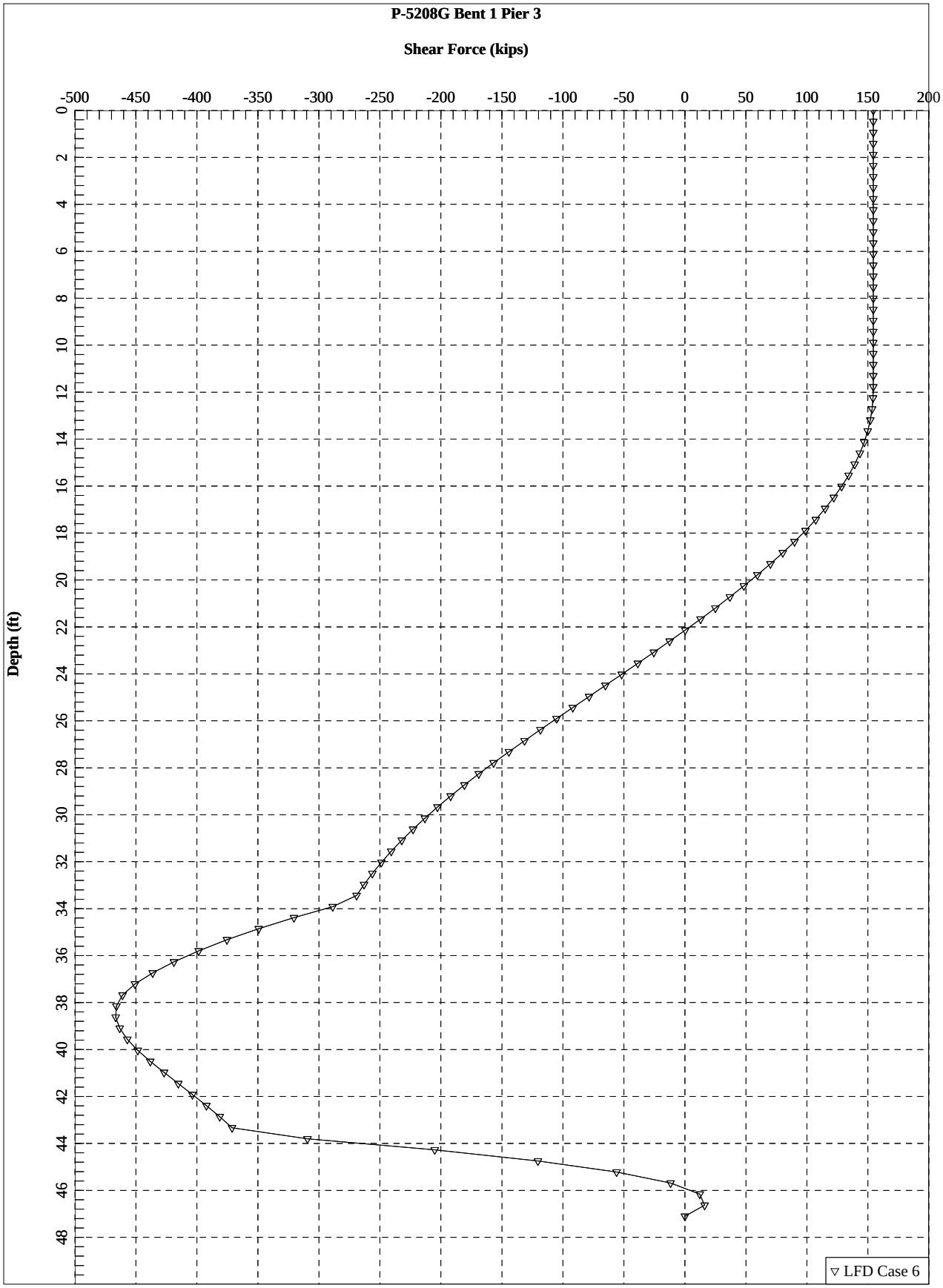

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```
==============================================================================

                  LPILE Plus for Windows, Version 5.0 (5.0.45)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method

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                               All Rights Reserved

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

This program is licensed to:

Thomas Wells
Kleinfelder Southeast, Inc.

------------------------------------------------------------------------------
                             Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:      W:\share\_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G
RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\
Name of input data file:     B1, Right.lpd
Name of output file:         B1, Right.lpo
Name of plot output file:    B1, Right.lpp
Name of runtime file:        B1, Right.lpr


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

               Date:  March  4, 2013     Time:  14:16:47


-----------------------------------------------------------------------------
                                 Problem Title
-----------------------------------------------------------------------------

P-5208G Bent 1 Right Pier


-----------------------------------------------------------------------------
                                 Program Options
-----------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          100
- Maximum number of iterations allowed =          100
- Deflection tolerance for convergence =   1.0000E-05 in
- Maximum allowable deflection         =   1.0000E+02 in
```



```
Printing Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) =  1


-----------------------------------------------------------------------------
                     Pile Structural Properties and Geometry
-----------------------------------------------------------------------------

Pile Length                                =     565.20 in

Depth of ground surface below top of pile =     142.80 in

Slope angle of ground surface              =       0.00 deg.

Structural properties of pile defined using  4 points

Point    Point         Pile      Moment of       Pile      Modulus of
 No.     Depth       Diameter     Inertia        Area      Elasticity
           in           in         in**4        Sq.in      lbs/Sq.in
-----  ---------   -----------   ----------   ----------   -----------
  1       0.0000   66.00000000  931419.0000    3421.0000      3600000.
  2     130.8000   66.00000000  931419.0000    3421.0000      3600000.
  3     130.8000   72.00000000     1319166.    4072.0000      3600000.
  4     565.2000   72.00000000     1319166.    4072.0000      3600000.


-----------------------------------------------------------------------------
                         Soil and Rock Layering Information
-----------------------------------------------------------------------------

The soil profile is modelled using  3 layers

Layer  1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      142.800 in
Distance from top of pile to bottom of layer =      403.200 in
p-y subgrade modulus k for top of soil layer =      600.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      600.000 lbs/in**3

Layer  2 is stiff clay with water-induced erosion
Distance from top of pile to top of layer    =      403.200 in
Distance from top of pile to bottom of layer =      525.600 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  3 is strong rock (vuggy limestone)
Distance from top of pile to top of layer    =      525.600 in
Distance from top of pile to bottom of layer =      760.800 in


(Depth of lowest layer extends  195.60 in below pile tip)


-----------------------------------------------------------------------------
                     Effective Unit Weight of Soil vs. Depth
-----------------------------------------------------------------------------

Effective unit weight of soil with depth defined using  6 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ----------------
  1          142.80        0.04200
  2          403.20        0.04200
  3          403.20        0.04780
  4          525.60        0.04780
  5          525.60        0.06230
  6          760.80        0.06230
```

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0001ADD_P10a1

Shear Strength of Soils

Shear strength parameters with depth defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	142.800	0.00000	35.00	------	------
2	403.200	0.00000	35.00	------	------
3	403.200	55.50000	0.00	0.00400	0.0
4	525.600	55.50000	0.00	0.00400	0.0
5	525.600	12000.00000	0.00	------	------
6	760.800	12000.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 154450.000 lbs
Bending moment at pile head = 35647560.000 in-lbs
Axial load at pile head = 2324700.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 154450.000 lbs
Specified moment at pile head = 35647560.000 in-lbs
Specified axial load at pile head = 2324700.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	1.443	3.5648E+07	154450.	-0.0063291	1942.5245	0.0000	0.0000

5.652	1.408	3.6603E+07	154450.	-0.0062682	1976.3853	0.0000	0.0000
11.304	1.373	3.7558E+07	154450.	-0.0062057	2010.2174	0.0000	0.0000
16.956	1.338	3.8512E+07	154450.	-0.0061415	2044.0200	0.0000	0.0000
22.608	1.303	3.9465E+07	154450.	-0.0060758	2077.7924	0.0000	0.0000
28.260	1.269	4.0418E+07	154450.	-0.0060085	2111.5339	0.0000	0.0000
33.912	1.235	4.1369E+07	154450.	-0.0059396	2145.2436	0.0000	0.0000
39.564	1.202	4.2320E+07	154450.	-0.0058690	2178.9209	0.0000	0.0000
45.216	1.169	4.3269E+07	154450.	-0.0057969	2212.5649	0.0000	0.0000
50.868	1.136	4.4218E+07	154450.	-0.0057232	2246.1750	0.0000	0.0000
56.520	1.104	4.5166E+07	154450.	-0.0056478	2279.7504	0.0000	0.0000
62.172	1.072	4.6112E+07	154450.	-0.0055709	2313.2904	0.0000	0.0000
67.824	1.041	4.7058E+07	154450.	-0.0054924	2346.7942	0.0000	0.0000
73.476	1.010	4.8003E+07	154450.	-0.0054123	2380.2610	0.0000	0.0000
79.128	0.979998	4.8946E+07	154450.	-0.0053306	2413.6902	0.0000	0.0000
84.780	0.950103	4.9889E+07	154450.	-0.0052473	2447.0810	0.0000	0.0000
90.432	0.920683	5.0830E+07	154450.	-0.0051624	2480.4326	0.0000	0.0000
96.084	0.891747	5.1770E+07	154450.	-0.0050759	2513.7444	0.0000	0.0000
101.736	0.863305	5.2709E+07	154450.	-0.0049878	2547.0155	0.0000	0.0000
107.388	0.835365	5.3647E+07	154450.	-0.0048982	2580.2453	0.0000	0.0000
113.040	0.807936	5.4584E+07	154450.	-0.0048070	2613.4329	0.0000	0.0000
118.692	0.781026	5.5519E+07	154450.	-0.0047142	2646.5778	0.0000	0.0000
124.344	0.754646	5.6454E+07	154450.	-0.0046198	2679.6790	0.0000	0.0000
129.996	0.728804	5.7387E+07	154450.	-0.0045239	2712.7360	0.0000	0.0000
135.648	0.703508	5.8318E+07	154450.	-0.0044408	2162.4061	0.0000	0.0000
141.300	0.678605	5.9249E+07	154450.	-0.0043709	2187.8088	0.0000	0.0000
146.952	0.654100	6.0179E+07	154221.	-0.0042998	2213.1862	-80.9878	699.8058
152.604	0.630000	6.1106E+07	153437.	-0.0042276	2238.4674	-196.5344	1763.1939
158.256	0.606311	6.2025E+07	151986.	-0.0041543	2263.5511	-316.8671	2953.8179
163.908	0.583039	6.2933E+07	149846.	-0.0040800	2288.3321	-440.5471	4270.6756
169.560	0.560191	6.3826E+07	147001.	-0.0040046	2312.7022	-566.1534	5712.1567
175.212	0.537772	6.4700E+07	143444.	-0.0039281	2336.5515	-692.2847	7275.9335
180.864	0.515788	6.5550E+07	139174.	-0.0038506	2359.7697	-818.9035	8973.5349
186.516	0.494245	6.6374E+07	134184.	-0.0037721	2382.2460	-946.7607	10826.7953
192.168	0.473149	6.7166E+07	128476.	-0.0036926	2403.8686	-1072.8919	12816.2335
197.820	0.452504	6.7923E+07	122064.	-0.0036122	2424.5272	-1196.2268	14941.4627
203.472	0.432316	6.8641E+07	114965.	-0.0035309	2444.1140	-1315.7304	17201.5401
209.124	0.412590	6.9316E+07	107204.	-0.0034488	2462.5244	-1430.4048	19594.8503
214.776	0.393331	6.9944E+07	98812.0640	-0.0033660	2479.6583	-1539.2905	22118.9685
220.428	0.374541	7.0521E+07	89810.1626	-0.0032824	2495.4204	-1646.0957	24840.3267
226.080	0.356227	7.1045E+07	80223.2106	-0.0031981	2509.7174	-1746.3148	27707.5607
231.732	0.338390	7.1512E+07	70090.6913	-0.0031133	2522.4617	-1839.1486	30718.6312
237.384	0.321034	7.1919E+07	59456.4344	-0.0030280	2533.5721	-1923.8581	33870.7249
243.036	0.304162	7.2264E+07	48368.3212	-0.0029422	2542.9746	-1999.7488	37159.7838
248.688	0.287776	7.2543E+07	36878.0290	-0.0028560	2550.6029	-2066.1721	40580.2478
254.340	0.271878	7.2756E+07	25017.3911	-0.0027695	2556.3991	-2130.7982	44296.6793
259.992	0.256469	7.2899E+07	12803.8277	-0.0026829	2560.3066	-2191.0572	48286.0001
265.644	0.241551	7.2971E+07	276.5465	-0.0025960	2562.2728	-2241.8094	52455.7097
271.296	0.227123	7.2970E+07	-12509.4093	-0.0025092	2562.2536	-2282.5911	56802.6869
276.948	0.213187	7.2895E+07	-25496.5106	-0.0024224	2560.2133	-2312.9862	61321.8684
282.600	0.199740	7.2746E+07	-38625.0206	-0.0023357	2556.1255	-2332.6295	66005.8129
288.252	0.186783	7.2520E+07	-51845.6809	-0.0022493	2549.9731	-2345.5942	70976.8495
293.904	0.174314	7.2219E+07	-65146.6887	-0.0021632	2541.7449	-2361.0610	76555.4747
299.556	0.162331	7.1841E+07	-78507.6593	-0.0020774	2531.4275	-2366.8125	82407.0542
305.208	0.150831	7.1386E+07	-91873.2233	-0.0019922	2519.0162	-2362.6865	88535.5263
310.860	0.139811	7.0854E+07	-105187.	-0.0019076	2504.5146	-2348.5700	94943.1793
316.512	0.129268	7.0247E+07	-118393.	-0.0018236	2487.9354	-2324.4019	101630.
322.164	0.119197	6.9564E+07	-131434.	-0.0017404	2469.2998	-2290.1755	108594.
327.816	0.109595	6.8807E+07	-144250.	-0.0016581	2448.6380	-2244.7398	115766.
333.468	0.100455	6.7977E+07	-156778.	-0.0015767	2425.9899	-2188.3975	123128.
339.120	0.091772	6.7076E+07	-168957.	-0.0014963	2401.4050	-2121.4546	130655.
344.772	0.083540	6.6106E+07	-180729.	-0.0014170	2374.9421	-2044.2226	138304.
350.424	0.075754	6.5070E+07	-192037.	-0.0013390	2346.6688	-1957.1288	146022.
356.076	0.068405	6.3971E+07	-202826.	-0.0012622	2316.6616	-1860.7266	153744.
361.728	0.061486	6.2811E+07	-213081.	-0.0011867	2285.0049	-1767.9619	162517.
367.380	0.054990	6.1593E+07	-222822.	-0.0011127	2251.7801	-1678.7797	172550.
373.032	0.048908	6.0321E+07	-232038.	-0.0010402	2217.0655	-1582.5005	182881.
378.684	0.043232	5.8998E+07	-240692.	-0.0009692	2180.9456	-1479.9326	193483.
384.336	0.037952	5.7626E+07	-248752.	-0.0008998	2143.5103	-1372.0039	204324.
389.988	0.033061	5.6210E+07	-256189.	-0.0008320	2104.8544	-1259.7603	215367.
395.640	0.028547	5.4752E+07	-262983.	-0.0007660	2065.0762	-1144.3630	226571.

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401.292	0.024402	5.3257E+07	-269120.	-0.0007017	2024.2770	-1027.0809	237895.
406.944	0.020615	5.1728E+07	-288640.	-0.0006392	1982.5597	-5880.1596	1612175.
412.596	0.017176	5.0011E+07	-320425.	-0.0005787	1935.6942	-5367.3284	1766220.
418.248	0.014073	4.8121E+07	-349323.	-0.0005203	1884.1281	-4858.4335	1951232.
423.900	0.011294	4.6076E+07	-375353.	-0.0004643	1828.3060	-4352.4070	2178102.
429.552	0.008825	4.3891E+07	-398526.	-0.0004107	1768.6700	-3847.3820	2464030.
435.204	0.006651	4.1582E+07	-418838.	-0.0003599	1705.6611	-3340.1236	2838271.
440.856	0.004757	3.9165E+07	-436260.	-0.0003118	1639.7226	-2824.8243	3356084.
446.508	0.003127	3.6658E+07	-450715.	-0.0002667	1571.3048	-2290.1325	4139783.
452.160	0.001743	3.4078E+07	-460958.	-0.0002246	1500.8748	-1334.6103	4328532.
457.812	0.000588	3.1454E+07	-466016.	-0.0001856	1429.2668	-455.2096	4376449.
463.464	-0.000355	2.8815E+07	-466516.	-0.0001497	1357.2485	278.1483	4424367.
469.116	-0.001105	2.6184E+07	-463260.	-0.0001170	1285.4604	874.1285	4472285.
474.768	-0.001678	2.3581E+07	-456998.	-8.7392E-05	1214.4232	1341.9531	4520202.
480.420	-0.002093	2.1020E+07	-448426.	-6.0851E-05	1144.5459	1691.2942	4568120.
486.072	-0.002366	1.8514E+07	-438186.	-3.7325E-05	1076.1340	1932.1846	4616038.
491.724	-0.002515	1.6068E+07	-426922.	-1.6747E-05	1009.3986	2053.5658	4615905.
497.376	-0.002555	1.3688E+07	-415268.	9.6054E-07	944.4466	2070.0910	4579098.
503.028	-0.002504	1.1374E+07	-403627.	1.5874E-05	881.2935	2049.1433	4625940.
508.680	-0.002376	9125077.	-392196.	2.8073E-05	819.9219	1996.0901	4748916.
514.332	-0.002186	6939830.	-381247.	3.7632E-05	760.2866	1878.2659	4855626.
519.984	-0.001950	4814475.	-371157.	4.4627E-05	702.2857	1692.0188	4903544.
525.636	-0.001682	2743097.	-309340.	4.9124E-05	645.7579	20182.2716	6.7824E+07
531.288	-0.001395	1316401.	-204999.	5.1540E-05	606.8234	16739.7415	6.7824E+07
536.940	-0.001099	424437.	-120415.	5.2576E-05	582.4817	13190.9508	6.7824E+07
542.592	-0.000801	-46146.9354	-55985.0387	5.2801E-05	572.1582	9607.8994	6.7824E+07
548.244	-0.000502	-209805.	-11796.3677	5.2649E-05	576.6244	6028.5730	6.7824E+07
553.896	-0.000206	-180877.	12209.8103	5.2416E-05	575.8349	2466.1821	6.7824E+07
559.548	9.01E-05	-73162.8300	16122.6161	5.2265E-05	572.8954	-1081.6083	6.7824E+07
565.200	0.000385	0.0000	0.0000	5.2222E-05	570.8988	-4623.4930	3.3912E+07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     1.44338973 in
Computed slope at pile head      =    -0.00632906
Maximum bending moment           =      72970914. lbs-in
Maximum shear force              =  -466516.49422 lbs
Depth of maximum bending moment  =      265.64400 in
Depth of maximum shear force     =      463.46400 in
Number of iterations             =             17
Number of zero deflection points =              2
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 1.54E+05	M= 3.56E+07	2324700.	1.4434	7.2971E+07	-466516.

The analysis ended normally.

PILE+ 5.0 INPUT SHEET (ENGLISH)

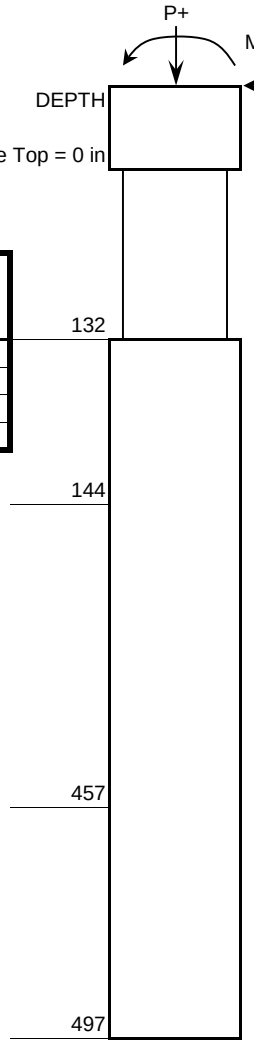
0041D1_P_pat1
0001A0_P_pat1

Designer: TRW Date: 3/4/13
Checker: XCB Date: 3/5/13

Project Title Haydock to Junker Bridge on NCRR/NS

TIP # P-5208G Bent # 2 Left
COUNTY: Mecklenburg

NOTE: LOADS GIVEN AT T/SHAFT



BOC Elev. =	Input Elevation 710.3	ft
TOS Elev. =	699.3	ft
T/G Elev. =	698.3	ft
Fixity	672.2	ft
Tip Elev. =	668.9	ft

Pile Properties

Total Pile Length	496.8	(inches)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	150.0	(inches)
Combined Ground Slope & Batter Angles	0	(degrees)

Drilled Shaft Sections

Section #	Depth (inches)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0	66	931419	3421	3600000
2	138	66	931419	3421	3600000
3	138	72	1319166	4072	3600000
4	496.8	72	1319166	4072	3600000

Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Moment	31660	31001280	2548740

Soil Layers

Layer #	Soil Type	Layer Top (inches)	Layer Bottom (inches)
1	4	150.0	273.6
2	4	273.6	465.6
3	2	465.6	488.4
4	6	488.4	675.6

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}	First Neg.	Pile Length
0.65	407.38	496.8
	676.4	
Max. Neg. @	452.09	672.6

SOIL AND ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain e_{50}
4	0.0362	300		33	
4	0.0478	1000		40	
2	0.0478	1500	55.5		0.004

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	Young's Mod.* Er, (lbs/in^2)	Uniax. Comp. Str. (lbs/in^2)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6	0.0623	12,000

COMMENTS:

PT. OF FIXITY ELEV. = 672.2 ft

TIP NO HIGHER THAN EL. = 668.9 ft

File: B2, L

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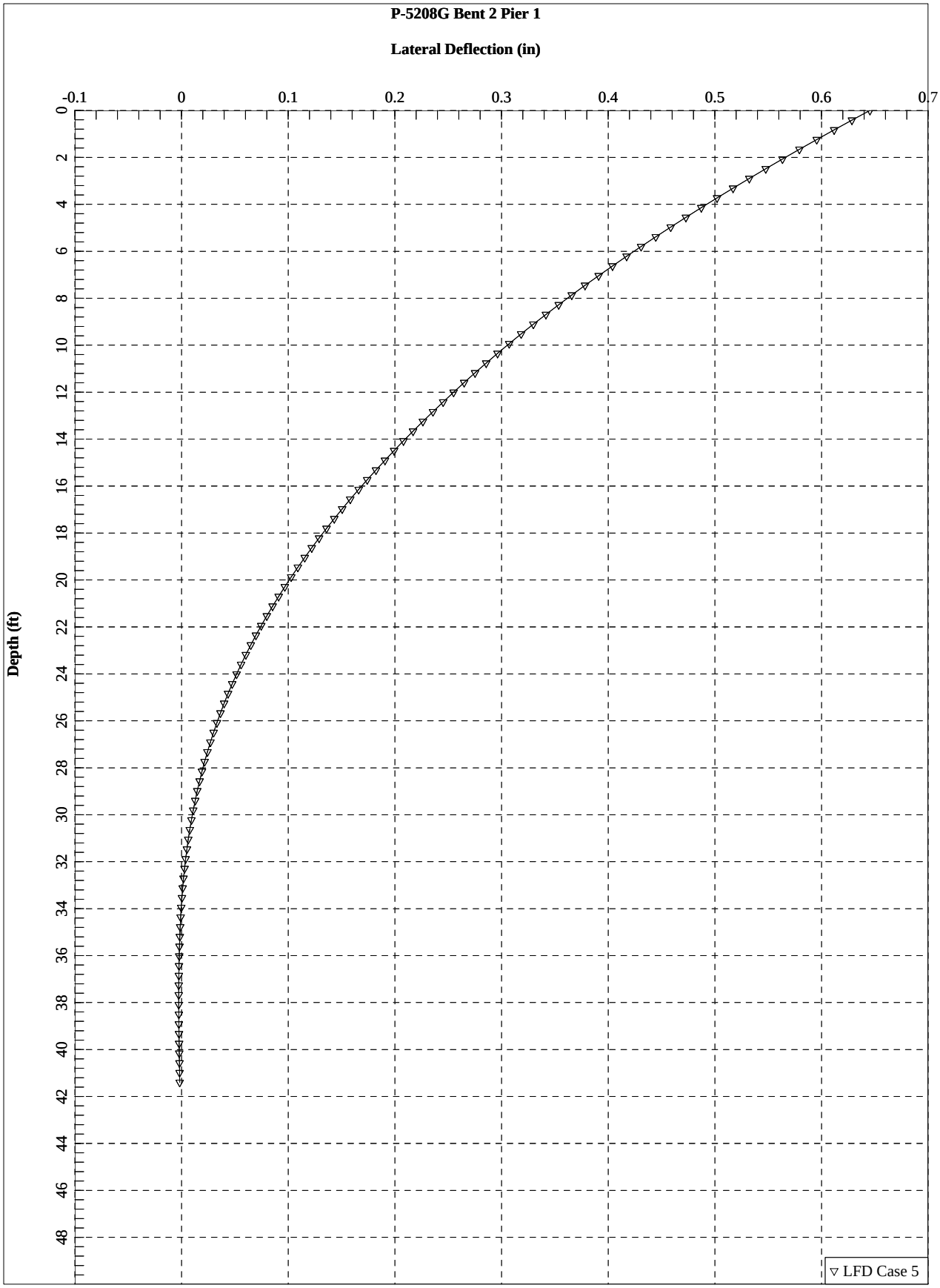

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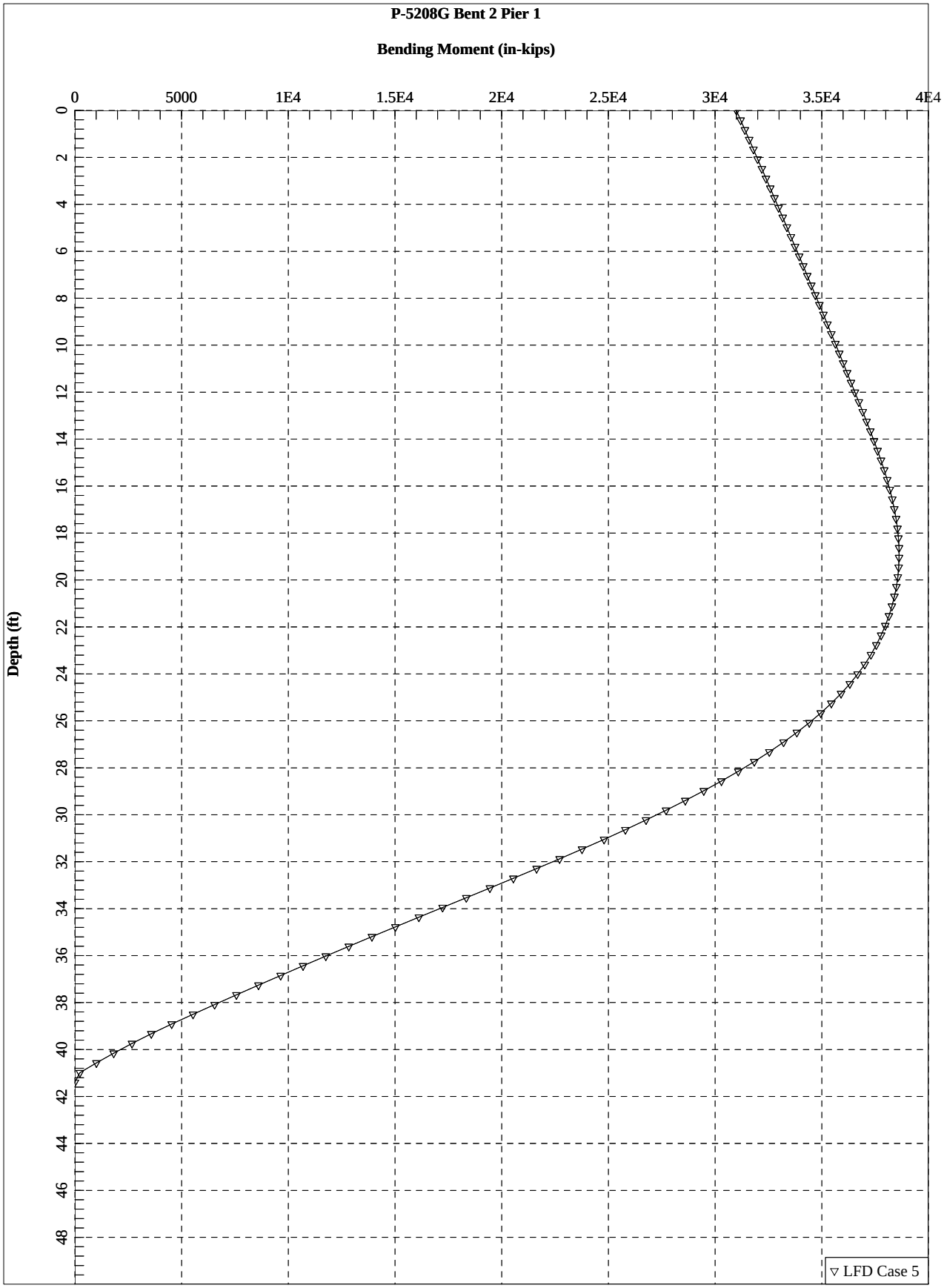

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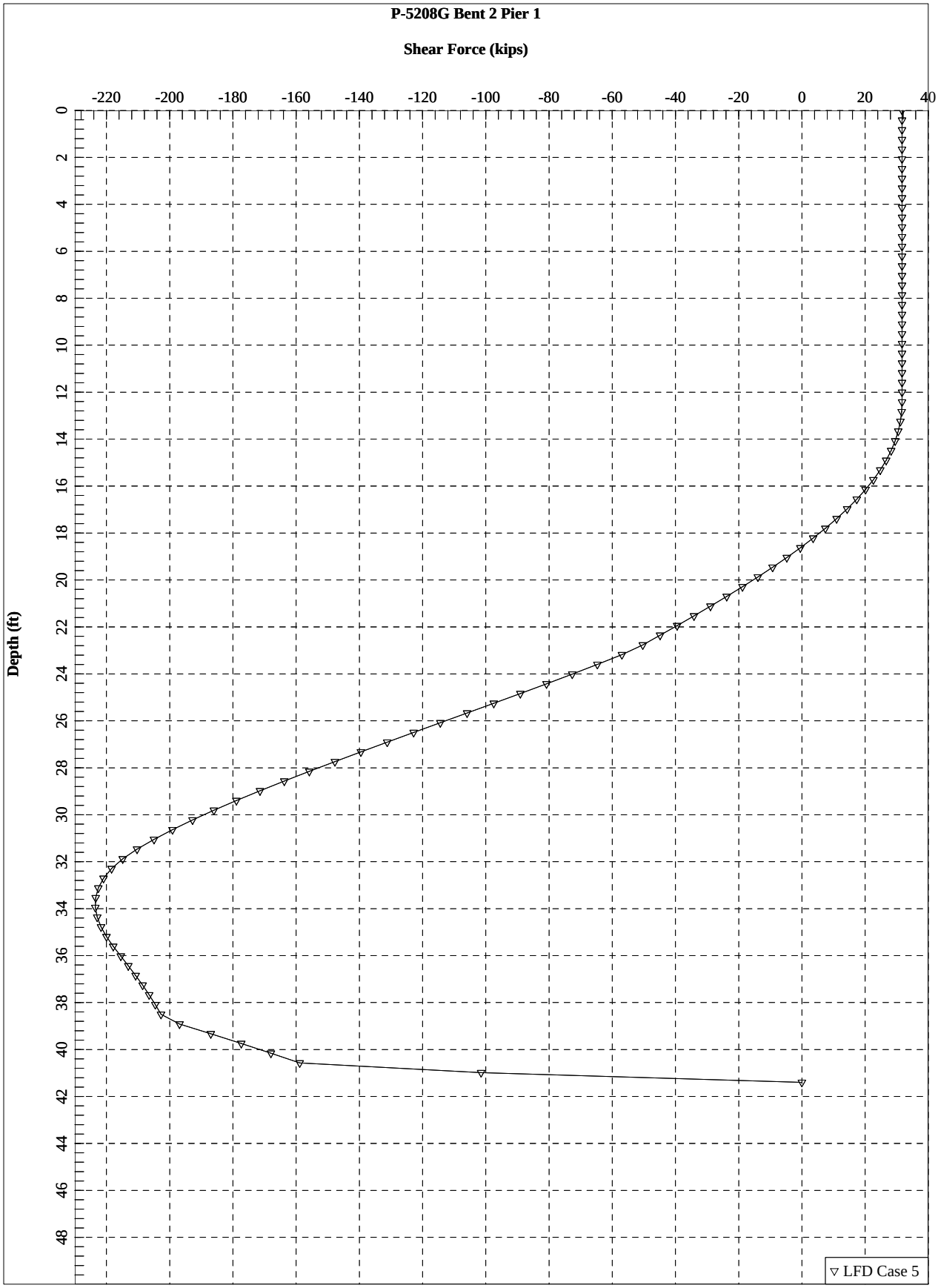

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```
==============================================================================

                  LPILE Plus for Windows, Version 5.0 (5.0.45)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method

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                               All Rights Reserved

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

This program is licensed to:

Thomas Wells
Kleinfelder Southeast, Inc.

------------------------------------------------------------------------------
                            Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:      W:\share\_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G
RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\
Name of input data file:     B2, Left.lpd
Name of output file:         B2, Left.lpo
Name of plot output file:    B2, Left.lpp
Name of runtime file:        B2, Left.lpr


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

               Date:  March  5, 2013     Time:   8:24:34


------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

P-5208G Bent 2 Left Pier


------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          100
- Maximum number of iterations allowed =          100
- Deflection tolerance for convergence =   1.0000E-05 in
- Maximum allowable deflection         =   1.0000E+02 in
```



```
Printing Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) =  1


------------------------------------------------------------------------------
                      Pile Structural Properties and Geometry
------------------------------------------------------------------------------

Pile Length                                =     496.80 in

Depth of ground surface below top of pile =     150.00 in

Slope angle of ground surface              =       0.00 deg.

Structural properties of pile defined using  4 points

Point    Point         Pile      Moment of       Pile      Modulus of
 No.     Depth       Diameter     Inertia        Area      Elasticity
           in           in         in**4        Sq.in      lbs/Sq.in
-----  ---------   -----------   ----------   ----------   -----------
  1       0.0000   66.00000000  931419.0000    3421.0000      3600000.
  2     138.0000   66.00000000  931419.0000    3421.0000      3600000.
  3     138.0000   72.00000000     1319166.    4072.0000      3600000.
  4     496.8000   72.00000000     1319166.    4072.0000      3600000.


------------------------------------------------------------------------------
                        Soil and Rock Layering Information
------------------------------------------------------------------------------

The soil profile is modelled using  4 layers

Layer  1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      150.000 in
Distance from top of pile to bottom of layer =      273.600 in
p-y subgrade modulus k for top of soil layer =      300.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      300.000 lbs/in**3

Layer  2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      273.600 in
Distance from top of pile to bottom of layer =      465.600 in
p-y subgrade modulus k for top of soil layer =     1000.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1000.000 lbs/in**3

Layer  3 is stiff clay with water-induced erosion
Distance from top of pile to top of layer    =      465.600 in
Distance from top of pile to bottom of layer =      488.400 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  4 is strong rock (vuggy limestone)
Distance from top of pile to top of layer    =      488.400 in
Distance from top of pile to bottom of layer =      675.600 in


(Depth of lowest layer extends  178.80 in below pile tip)


------------------------------------------------------------------------------
                      Effective Unit Weight of Soil vs. Depth
------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using  8 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ---------------
  1          150.00        0.03620
```

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2	273.60	0.03620
3	273.60	0.04490
4	465.60	0.04490
5	465.60	0.04780
6	488.40	0.04780
7	488.40	0.06230
8	675.60	0.06230

Shear Strength of Soils

Shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	150.000	0.00000	33.00	------	------
2	273.600	0.00000	33.00	------	------
3	273.600	0.00000	40.00	------	------
4	465.600	0.00000	40.00	------	------
5	465.600	55.50000	0.00	0.00400	0.0
6	488.400	55.50000	0.00	0.00400	0.0
7	488.400	12000.00000	0.00	------	------
8	675.600	12000.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 31660.000 lbs
Bending moment at pile head = 31001280.000 in-lbs
Axial load at pile head = 2548740.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 31660.000 lbs
Specified moment at pile head = 31001280.000 in-lbs
Specified axial load at pile head = 2548740.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	0.645395	3.1001E+07	31660.0000	-0.0034152	1843.3973	0.0000	0.0000
4.968	0.628542	3.1202E+07	31660.0000	-0.0033692	1850.4918	0.0000	0.0000
9.936	0.611919	3.1401E+07	31660.0000	-0.0033228	1857.5655	0.0000	0.0000
14.904	0.595527	3.1600E+07	31660.0000	-0.0032761	1864.6184	0.0000	0.0000
19.872	0.579368	3.1799E+07	31660.0000	-0.0032291	1871.6502	0.0000	0.0000
24.840	0.563443	3.1997E+07	31660.0000	-0.0031819	1878.6610	0.0000	0.0000
29.808	0.547753	3.2194E+07	31660.0000	-0.0031343	1885.6504	0.0000	0.0000
34.776	0.532300	3.2391E+07	31660.0000	-0.0030865	1892.6185	0.0000	0.0000
39.744	0.517085	3.2587E+07	31660.0000	-0.0030384	1899.5650	0.0000	0.0000
44.712	0.502111	3.2782E+07	31660.0000	-0.0029899	1906.4899	0.0000	0.0000
49.680	0.487377	3.2977E+07	31660.0000	-0.0029412	1913.3930	0.0000	0.0000
54.648	0.472887	3.3171E+07	31660.0000	-0.0028922	1920.2741	0.0000	0.0000
59.616	0.458640	3.3365E+07	31660.0000	-0.0028429	1927.1333	0.0000	0.0000
64.584	0.444639	3.3558E+07	31660.0000	-0.0027933	1933.9702	0.0000	0.0000
69.552	0.430886	3.3750E+07	31660.0000	-0.0027435	1940.7848	0.0000	0.0000
74.520	0.417380	3.3942E+07	31660.0000	-0.0026933	1947.5770	0.0000	0.0000
79.488	0.404125	3.4133E+07	31660.0000	-0.0026429	1954.3467	0.0000	0.0000
84.456	0.391120	3.4323E+07	31660.0000	-0.0025922	1961.0936	0.0000	0.0000
89.424	0.378369	3.4513E+07	31660.0000	-0.0025412	1967.8178	0.0000	0.0000
94.392	0.365871	3.4702E+07	31660.0000	-0.0024899	1974.5190	0.0000	0.0000
99.360	0.353629	3.4891E+07	31660.0000	-0.0024384	1981.1971	0.0000	0.0000
104.328	0.341643	3.5078E+07	31660.0000	-0.0023865	1987.8521	0.0000	0.0000
109.296	0.329916	3.5266E+07	31660.0000	-0.0023344	1994.4837	0.0000	0.0000
114.264	0.318448	3.5452E+07	31660.0000	-0.0022820	2001.0919	0.0000	0.0000
119.232	0.307242	3.5638E+07	31660.0000	-0.0022294	2007.6765	0.0000	0.0000
124.200	0.296297	3.5823E+07	31660.0000	-0.0021764	2014.2374	0.0000	0.0000
129.168	0.285617	3.6008E+07	31660.0000	-0.0021232	2020.7746	0.0000	0.0000
134.136	0.275201	3.6192E+07	31660.0000	-0.0020697	2027.2877	0.0000	0.0000
139.104	0.265052	3.6375E+07	31660.0000	-0.0020239	1618.5832	0.0000	0.0000
144.072	0.255092	3.6557E+07	31660.0000	-0.0019858	1623.5683	0.0000	0.0000
149.040	0.245321	3.6740E+07	31660.0000	-0.0019474	1628.5402	0.0000	0.0000
154.008	0.235742	3.6921E+07	31544.2830	-0.0019089	1633.4989	-46.5849	981.7253
158.976	0.226355	3.7101E+07	31165.4444	-0.0018702	1638.4128	-105.9266	2324.8609
163.944	0.217160	3.7278E+07	30488.8397	-0.0018313	1643.2420	-166.4586	3808.0937
168.912	0.208159	3.7451E+07	29510.0666	-0.0017922	1647.9455	-227.5725	5431.3208
173.880	0.199353	3.7617E+07	28227.7153	-0.0017529	1652.4823	-288.6720	7193.8813
178.848	0.190742	3.7776E+07	26643.3047	-0.0017135	1656.8110	-349.1744	9094.4561
183.816	0.182328	3.7925E+07	24761.2130	-0.0016739	1660.8909	-408.5115	11130.9547
188.784	0.174111	3.8064E+07	22583.9920	-0.0016341	1664.6819	-467.9865	13353.3219
193.752	0.166091	3.8191E+07	20111.0589	-0.0015942	1668.1439	-527.5583	15779.9328
198.720	0.158270	3.8304E+07	17346.0069	-0.0015542	1671.2368	-585.5866	18381.1752
203.688	0.150648	3.8402E+07	14297.5148	-0.0015141	1673.9215	-641.6646	21160.4611
208.656	0.143226	3.8485E+07	10976.2434	-0.0014739	1676.1601	-695.4011	24120.9740
213.624	0.136004	3.8549E+07	7394.7557	-0.0014336	1677.9163	-746.4216	27265.5865
218.592	0.128982	3.8594E+07	3567.4318	-0.0013933	1679.1559	-794.3690	30596.7599
223.560	0.122160	3.8620E+07	-491.6030	-0.0013529	1679.8465	-839.7030	34148.9072
228.528	0.115540	3.8624E+07	-4771.6751	-0.0013125	1679.9576	-883.3534	37982.6056
233.496	0.109120	3.8605E+07	-9259.7616	-0.0012721	1679.4597	-923.4447	42042.5478
238.464	0.102900	3.8564E+07	-13937.5166	-0.0012317	1678.3259	-959.7095	46334.4590
243.432	0.096882	3.8498E+07	-18785.3136	-0.0011914	1676.5318	-991.8996	50863.7275
248.400	0.091063	3.8407E+07	-23782.3416	-0.0011512	1674.0556	-1019.7864	55635.2551
253.368	0.085444	3.8291E+07	-28906.7057	-0.0011111	1670.8787	-1043.1621	60653.2689
258.336	0.080023	3.8148E+07	-34136.4745	-0.0010711	1666.9853	-1062.2198	65944.6247
263.304	0.074801	3.7979E+07	-39462.5643	-0.0010313	1662.3627	-1081.9387	71857.9245
268.272	0.069777	3.7782E+07	-44875.5425	-0.0009916	1656.9976	-1097.1990	78118.8596
273.240	0.064949	3.7558E+07	-50352.9218	-0.0009522	1650.8798	-1107.8651	84741.9915
278.208	0.060316	3.7306E+07	-56931.4334	-0.0009131	1644.0023	-1540.4890	126885.
283.176	0.055876	3.7016E+07	-64688.0320	-0.0008742	1636.0737	-1582.1353	140668.
288.144	0.051630	3.6686E+07	-72646.5662	-0.0008356	1627.0661	-1621.7835	156054.
293.112	0.047574	3.6315E+07	-80787.0914	-0.0007974	1616.9529	-1655.4006	172870.
298.080	0.043706	3.5903E+07	-89073.7859	-0.0007597	1605.7115	-1680.6278	191034.

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303.048	0.040025	3.5449E+07	-97464.2006	-0.0007224	1593.3252	-1697.1559	210653.
308.016	0.036529	3.4953E+07	-105914.	-0.0006855	1579.7830	-1704.7291	231846.
312.984	0.033214	3.4414E+07	-114380.	-0.0006492	1565.0800	-1703.1465	254749.
317.952	0.030078	3.3833E+07	-122814.	-0.0006135	1549.2173	-1692.2651	279512.
322.920	0.027118	3.3209E+07	-131190.	-0.0005785	1532.2026	-1679.6870	307720.
327.888	0.024330	3.2544E+07	-139500.	-0.0005441	1514.0446	-1665.8830	340158.
332.856	0.021712	3.1837E+07	-147721.	-0.0005104	1494.7527	-1643.6815	376101.
337.824	0.019259	3.1089E+07	-155811.	-0.0004775	1474.3423	-1613.0342	416100.
342.792	0.016967	3.0301E+07	-163727.	-0.0004454	1452.8342	-1573.9275	460844.
347.760	0.014833	2.9474E+07	-171428.	-0.0004141	1430.2550	-1526.3790	511217.
352.728	0.012853	2.8608E+07	-178872.	-0.0003837	1406.6370	-1470.4317	568378.
357.696	0.011020	2.7706E+07	-186011.	-0.0003543	1382.0183	-1403.4271	632663.
362.664	0.009332	2.6769E+07	-192777.	-0.0003258	1356.4444	-1320.3437	702876.
367.632	0.007783	2.5799E+07	-199109.	-0.0002983	1329.9714	-1228.8409	784353.
372.600	0.006368	2.4798E+07	-204966.	-0.0002718	1302.6614	-1129.1788	880871.
377.568	0.005082	2.3769E+07	-210309.	-0.0002464	1274.5820	-1021.5321	998539.
382.536	0.003920	2.2715E+07	-214854.	-0.0002221	1245.8058	-808.0968	1024165.
387.504	0.002875	2.1640E+07	-218369.	-0.0001989	1216.4772	-607.0667	1048847.
392.472	0.001943	2.0550E+07	-220920.	-0.0001768	1186.7319	-419.9615	1073528.
397.440	0.001118	1.9450E+07	-222577.	-0.0001559	1156.6963	-247.2054	1098209.
402.408	0.000394	1.8343E+07	-223413.	-0.0001362	1126.4871	-89.0971	1122890.
407.376	-0.000235	1.7233E+07	-223499.	-0.0001176	1096.2113	54.1858	1147571.
412.344	-0.000774	1.6125E+07	-222911.	-0.0001001	1065.9658	182.5828	1172252.
417.312	-0.001229	1.5021E+07	-221722.	-8.3811E-05	1035.8374	296.1470	1196933.
422.280	-0.001607	1.3924E+07	-220005.	-6.8671E-05	1005.9031	395.0402	1221614.
427.248	-0.001912	1.2837E+07	-217833.	-5.4674E-05	976.2298	479.5290	1246295.
432.216	-0.002150	1.1761E+07	-215444.	-4.1808E-05	946.8749	482.0592	1114013.
437.184	-0.002327	1.0697E+07	-213073.	-3.0061E-05	917.8403	472.5504	1008905.
442.152	-0.002448	9644634.	-210767.	-1.9421E-05	889.1202	455.7217	924675.
447.120	-0.002520	8603349.	-208559.	-9.8763E-06	860.7036	433.2186	854102.
452.088	-0.002547	7572643.	-206473.	-1.4153E-06	832.5757	406.3774	792780.
457.056	-0.002534	6551866.	-204529.	5.9726E-06	804.7187	376.3437	737853.
462.024	-0.002487	5540290.	-202739.	1.2297E-05	777.1128	344.1360	687375.
466.992	-0.002412	4537135.	-196889.	1.7569E-05	749.7367	2011.1275	4142750.
471.960	-0.002313	3583556.	-187001.	2.1816E-05	723.7136	1969.4059	4230593.
476.928	-0.002195	2678537.	-177343.	2.5092E-05	699.0157	1918.6580	4342577.
481.896	-0.002063	1820837.	-167957.	2.7445E-05	675.6091	1860.2657	4478984.
486.864	-0.001922	1009026.	-158875.	2.8925E-05	653.4548	1795.5658	4640488.
491.832	-0.001776	241518.	-101477.	2.9579E-05	632.5095	21311.6279	5.9616E+07
496.800	-0.001628	0.0000	0.0000	2.9706E-05	625.9185	19540.6959	2.9808E+07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     0.64539532 in
Computed slope at pile head      =    -0.00341524
Maximum bending moment           =      38623683. lbs-in
Maximum shear force              =  -223499.37842 lbs
Depth of maximum bending moment  =      228.52800 in
Depth of maximum shear force     =      407.37600 in
Number of iterations             =             16
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
```



```
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 31660.	M= 3.10E+07	2548740.	0.6453953	3.8624E+07	-223499.

The analysis ended normally.

PILE+ 5.0 INPUT SHEET (ENGLISH)

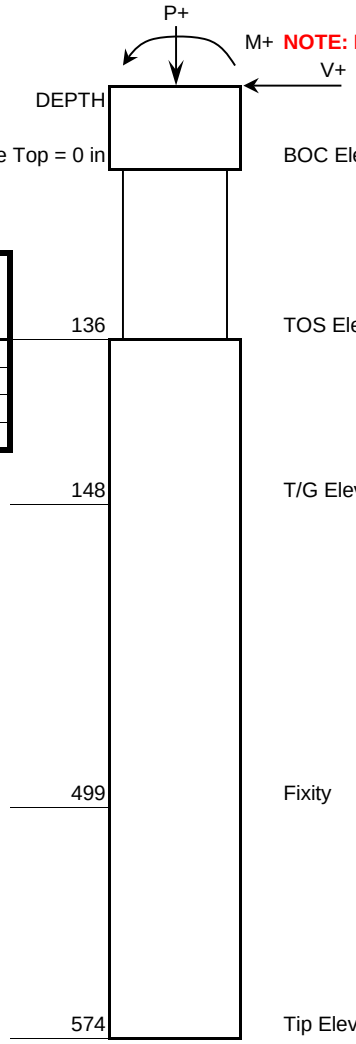
0041D1_P1_pat1
0001A0_P1_pat1

Designer: TRW Date: 3/4/13
Checker: XCB Date: 3/5/13

Project Title Haydock to Junker Bridge on NCRR/NS

TIP # P-5208G Bent # 2 Center
COUNTY: Mecklenburg

NOTE: LOADS GIVEN AT T/SHAFT



BOC Elev. =	Input Elevation 710.3	ft
TOS Elev. =	699.0	ft
T/G Elev. =	698.0	ft
Fixity	668.7	ft
Tip Elev. =	662.5	ft

Pile Properties

Total Pile Length	573.6	(inches)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	147.6	(inches)
Combined Ground Slope & Batter Angles	0	(degrees)

Drilled Shaft Sections

Section #	Depth (inches)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0	66	931419	3421	3600000
2	135.6	66	931419	3421	3600000
3	135.6	72	1319166	4072	3600000
4	573.6	72	1319166	4072	3600000

Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Moment	75820	38289600	3665810

Soil Layers

Layer #	Soil Type	Layer Top (inches)	Layer Bottom (inches)
1	4	147.6	273.6
2	4	273.6	465.6
3	2	465.6	488.4
4	6	488.4	675.6

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)

SOIL AND ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain e_{50}
4	0.0362	300		33	
4	0.0478	1000		40	
2	0.0478	1500	55.5		0.004

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	Young's Mod.* Er, (lbs/in^2)	Uniax. Comp. Str. (lbs/in^2)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6	0.0623	12,000

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}	First Neg.	Pile Length
1.09	470.35	573.6
	671.1	
Max. Neg. @	493.3	669.2

COMMENTS:

PT. OF FIXITY ELEV. = 668.7 ft

TIP NO HIGHER THAN EL. = 662.5 ft

File: B2, C

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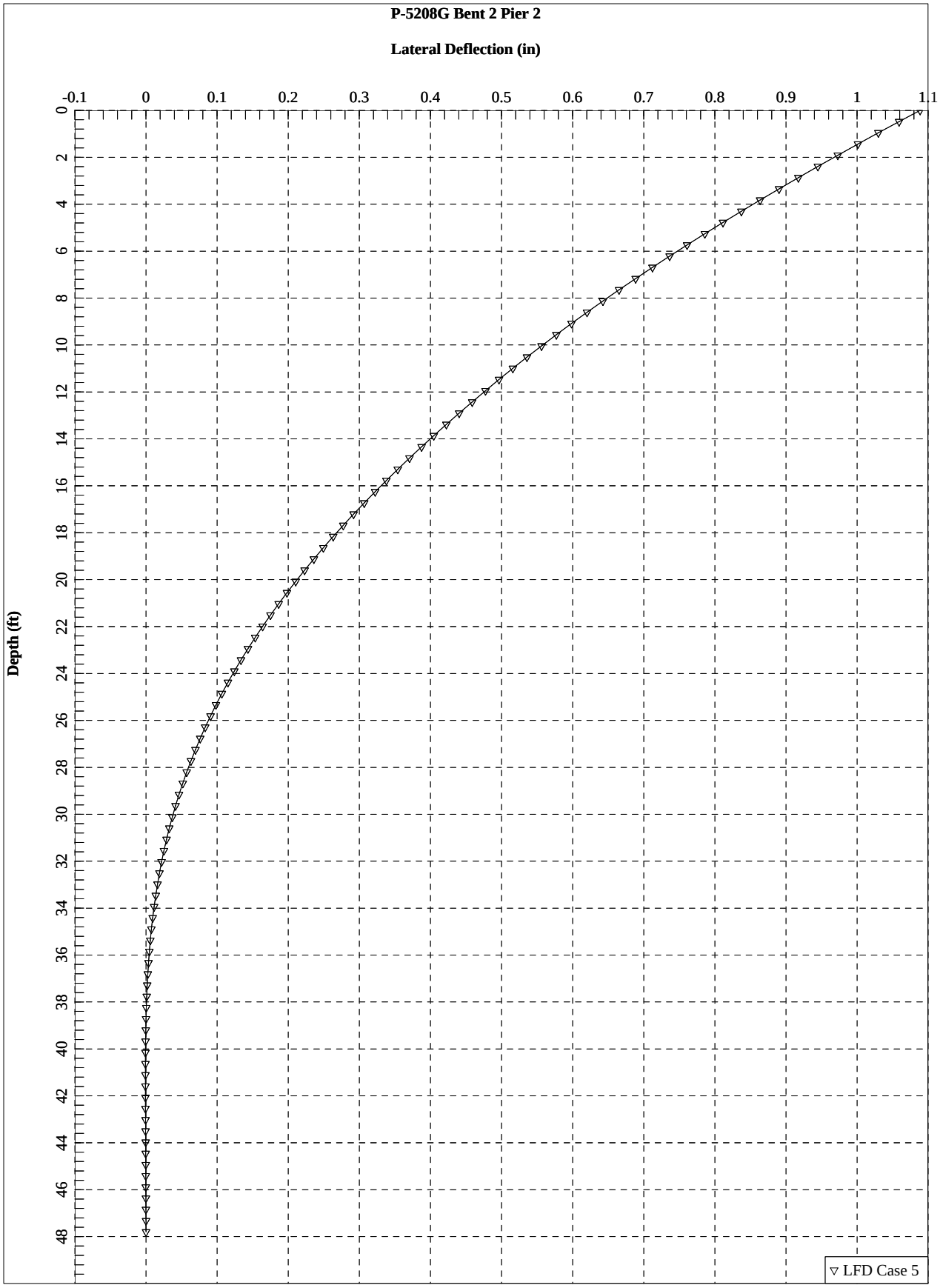

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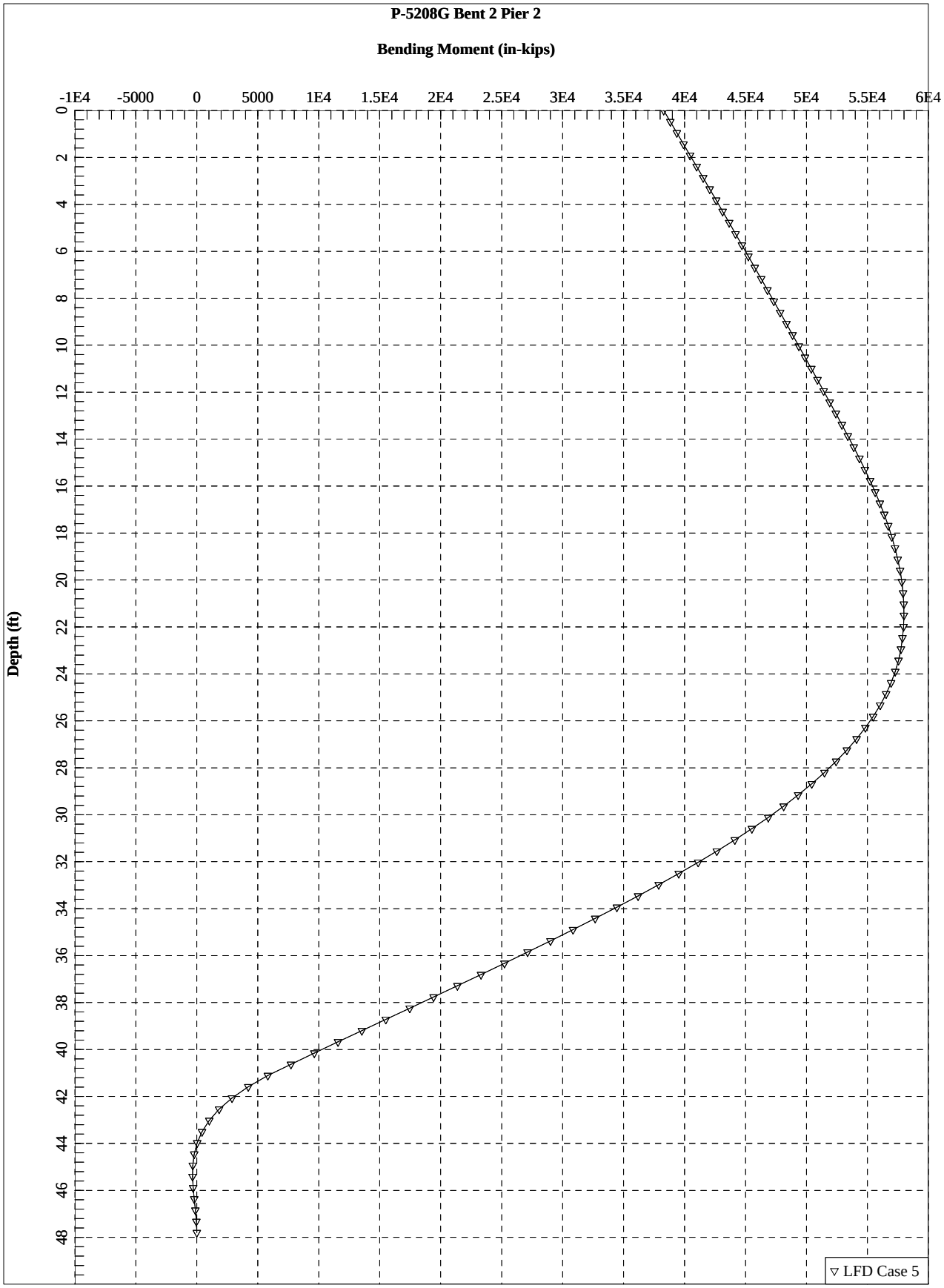

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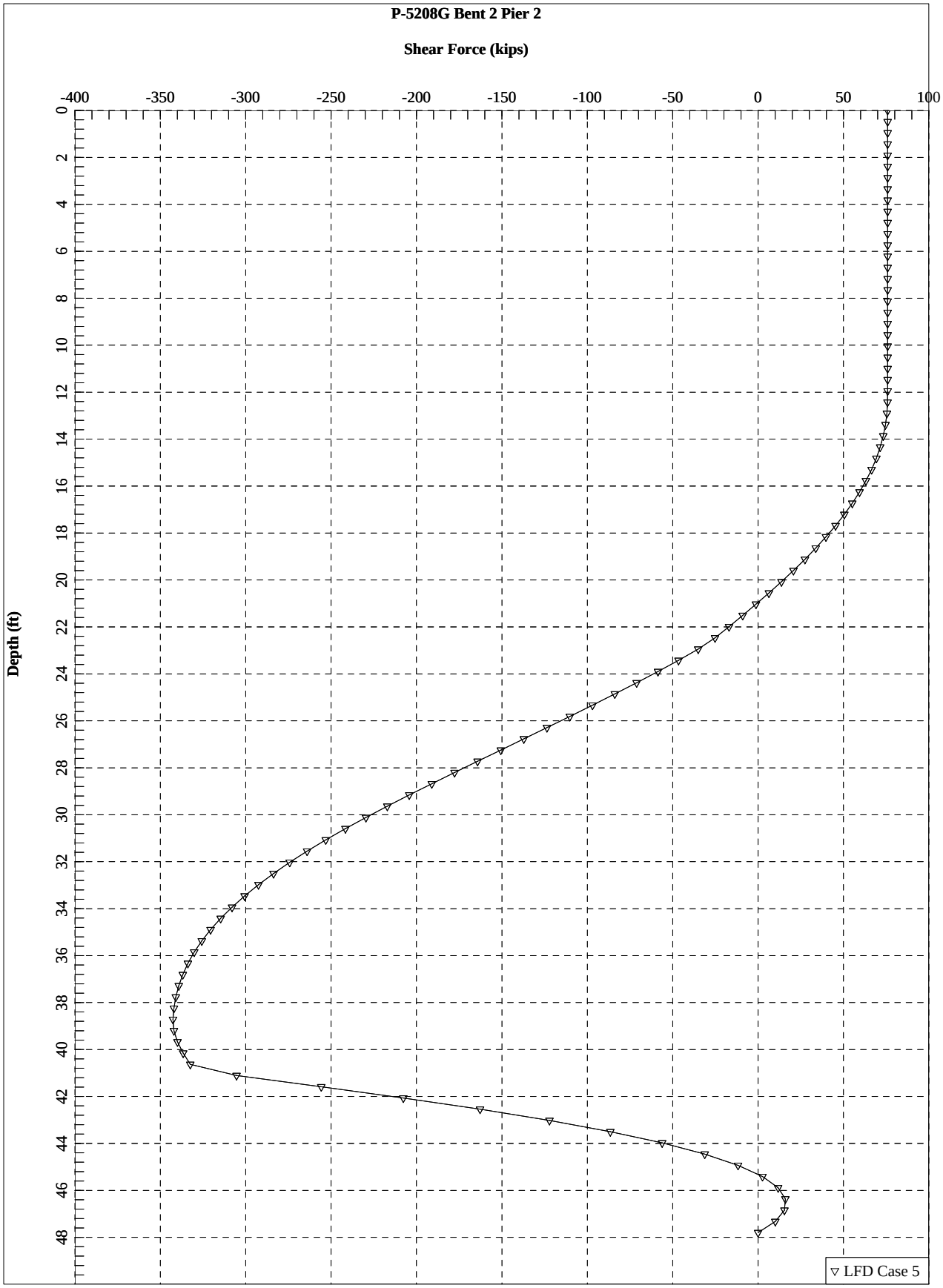

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```
==============================================================================

                  LPILE Plus for Windows, Version 5.0 (5.0.45)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method

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                               All Rights Reserved

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

This program is licensed to:

Thomas Wells
Kleinfelder Southeast, Inc.

------------------------------------------------------------------------------
                            Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:      W:\share\_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G
RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\
Name of input data file:     B2, Center.lpd
Name of output file:         B2, Center.lpo
Name of plot output file:    B2, Center.lpp
Name of runtime file:        B2, Center.lpr


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

               Date:  March  4, 2013     Time:  14:26:08


------------------------------------------------------------------------------
                                Problem Title
------------------------------------------------------------------------------

P-5208G Bent 2 Center Pier


------------------------------------------------------------------------------
                                Program Options
------------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          100
- Maximum number of iterations allowed =          100
- Deflection tolerance for convergence =   1.0000E-05 in
- Maximum allowable deflection         =   1.0000E+02 in
```



```
Printing Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) =  1


------------------------------------------------------------------------------
                      Pile Structural Properties and Geometry
------------------------------------------------------------------------------

Pile Length                                =     573.60 in

Depth of ground surface below top of pile =     147.60 in

Slope angle of ground surface              =       0.00 deg.

Structural properties of pile defined using  4 points

Point    Point         Pile      Moment of       Pile      Modulus of
 No.     Depth       Diameter     Inertia        Area      Elasticity
           in           in         in**4        Sq.in      lbs/Sq.in
-----  ---------   -----------   ----------   ----------   -----------
  1       0.0000   66.00000000  931419.0000    3421.0000      3600000.
  2     135.6000   66.00000000  931419.0000    3421.0000      3600000.
  3     135.6000   72.00000000     1319166.    4072.0000      3600000.
  4     573.6000   72.00000000     1319166.    4072.0000      3600000.


------------------------------------------------------------------------------
                        Soil and Rock Layering Information
------------------------------------------------------------------------------

The soil profile is modelled using  4 layers

Layer  1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      147.600 in
Distance from top of pile to bottom of layer =      273.600 in
p-y subgrade modulus k for top of soil layer =      300.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      300.000 lbs/in**3

Layer  2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      273.600 in
Distance from top of pile to bottom of layer =      465.600 in
p-y subgrade modulus k for top of soil layer =     1000.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1000.000 lbs/in**3

Layer  3 is stiff clay with water-induced erosion
Distance from top of pile to top of layer    =      465.600 in
Distance from top of pile to bottom of layer =      488.400 in
p-y subgrade modulus k for top of soil layer =     1500.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =     1500.000 lbs/in**3

Layer  4 is strong rock (vuggy limestone)
Distance from top of pile to top of layer    =      488.400 in
Distance from top of pile to bottom of layer =      675.600 in


(Depth of lowest layer extends  102.00 in below pile tip)


------------------------------------------------------------------------------
                      Effective Unit Weight of Soil vs. Depth
------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using  8 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ---------------
  1          147.60        0.03620
```

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2	273.60	0.03620
3	273.60	0.04490
4	465.60	0.04490
5	465.60	0.04780
6	488.40	0.04780
7	488.40	0.06230
8	675.60	0.06230

Shear Strength of Soils

Shear strength parameters with depth defined using 8 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	147.600	0.00000	33.00	------	------
2	273.600	0.00000	33.00	------	------
3	273.600	0.00000	40.00	------	------
4	465.600	0.00000	40.00	------	------
5	465.600	55.50000	0.00	0.00400	0.0
6	488.400	55.50000	0.00	0.00400	0.0
7	488.400	12000.00000	0.00	------	------
8	675.600	12000.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 75820.000 lbs
Bending moment at pile head = 38289600.000 in-lbs
Axial load at pile head = 3665810.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 75820.000 lbs
Specified moment at pile head = 38289600.000 in-lbs
Specified axial load at pile head = 3665810.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	1.089	3.8290E+07	75820.0000	-0.0051748	2428.1543	0.0000	0.0000
5.736	1.059	3.8833E+07	75820.0000	-0.0051089	2447.3936	0.0000	0.0000
11.472	1.030	3.9374E+07	75820.0000	-0.0050420	2466.5834	0.0000	0.0000
17.208	1.001	3.9914E+07	75820.0000	-0.0049742	2485.7231	0.0000	0.0000
22.944	0.972981	4.0453E+07	75820.0000	-0.0049054	2504.8119	0.0000	0.0000
28.680	0.945042	4.0991E+07	75820.0000	-0.0048358	2523.8491	0.0000	0.0000
34.416	0.917505	4.1526E+07	75820.0000	-0.0047652	2542.8341	0.0000	0.0000
40.152	0.890376	4.2061E+07	75820.0000	-0.0046937	2561.7662	0.0000	0.0000
45.888	0.863659	4.2594E+07	75820.0000	-0.0046213	2580.6447	0.0000	0.0000
51.624	0.837360	4.3125E+07	75820.0000	-0.0045480	2599.4689	0.0000	0.0000
57.360	0.811485	4.3655E+07	75820.0000	-0.0044737	2618.2381	0.0000	0.0000
63.096	0.786038	4.4183E+07	75820.0000	-0.0043986	2636.9517	0.0000	0.0000
68.832	0.761024	4.4709E+07	75820.0000	-0.0043226	2655.6090	0.0000	0.0000
74.568	0.736449	4.5234E+07	75820.0000	-0.0042456	2674.2093	0.0000	0.0000
80.304	0.712318	4.5758E+07	75820.0000	-0.0041678	2692.7520	0.0000	0.0000
86.040	0.688636	4.6280E+07	75820.0000	-0.0040891	2711.2363	0.0000	0.0000
91.776	0.665408	4.6800E+07	75820.0000	-0.0040095	2729.6617	0.0000	0.0000
97.512	0.642639	4.7318E+07	75820.0000	-0.0039290	2748.0274	0.0000	0.0000
103.248	0.620335	4.7835E+07	75820.0000	-0.0038476	2766.3329	0.0000	0.0000
108.984	0.598500	4.8350E+07	75820.0000	-0.0037653	2784.5773	0.0000	0.0000
114.720	0.577139	4.8863E+07	75820.0000	-0.0036822	2802.7602	0.0000	0.0000
120.456	0.556258	4.9374E+07	75820.0000	-0.0035981	2820.8808	0.0000	0.0000
126.192	0.535861	4.9884E+07	75820.0000	-0.0035132	2838.9384	0.0000	0.0000
131.928	0.515954	5.0392E+07	75820.0000	-0.0034275	2856.9325	0.0000	0.0000
137.664	0.496541	5.0898E+07	75820.0000	-0.0033536	2289.2489	0.0000	0.0000
143.400	0.477481	5.1403E+07	75820.0000	-0.0032919	2303.0242	0.0000	0.0000
149.136	0.458777	5.1906E+07	75760.0213	-0.0032295	2316.7639	-20.9131	261.4719
154.872	0.440433	5.2408E+07	75409.3813	-0.0031665	2330.4488	-101.3464	1319.8901
160.608	0.422451	5.2904E+07	74589.0763	-0.0031029	2344.0064	-184.6735	2507.4782
166.344	0.404836	5.3394E+07	73285.4745	-0.0030387	2357.3614	-269.8599	3823.5599
172.080	0.387592	5.3873E+07	71490.8316	-0.0029739	2370.4372	-355.8873	5266.8057
177.816	0.370720	5.4339E+07	69203.1914	-0.0029085	2383.1561	-441.7557	6835.1094
183.552	0.354225	5.4789E+07	66426.2741	-0.0028426	2395.4407	-526.4860	8525.4462
189.288	0.338109	5.5221E+07	63158.8192	-0.0027762	2407.2146	-612.7940	10396.0124
195.024	0.322376	5.5630E+07	59400.6950	-0.0027093	2418.4000	-697.5701	12411.7848
200.760	0.307028	5.6016E+07	55162.8838	-0.0026418	2428.9205	-780.0489	14573.1136
206.496	0.292069	5.6374E+07	50460.6076	-0.0025740	2438.7018	-859.5174	16880.2360
212.232	0.277500	5.6703E+07	45313.0947	-0.0025057	2447.6723	-935.2918	19332.7392
217.968	0.263324	5.7000E+07	39743.4099	-0.0024370	2455.7637	-1006.7182	21929.4076
223.704	0.249543	5.7261E+07	33771.4434	-0.0023680	2462.9116	-1075.5575	24722.8229
229.440	0.236158	5.7487E+07	27416.1113	-0.0022987	2469.0542	-1140.3882	27698.6742
235.176	0.223172	5.7673E+07	20704.3445	-0.0022292	2474.1329	-1199.8374	30838.4154
240.912	0.210585	5.7818E+07	13668.4132	-0.0021594	2478.0944	-1253.4162	34141.0268
246.648	0.198399	5.7920E+07	6343.2928	-0.0020895	2480.8904	-1300.6704	37604.2251
252.384	0.186614	5.7978E+07	-1233.5387	-0.0020195	2482.4783	-1341.1816	41224.1570
258.120	0.175231	5.7991E+07	-9033.1244	-0.0019495	2482.8219	-1378.3392	45118.4188
263.856	0.164250	5.7957E+07	-17040.3625	-0.0018795	2481.8877	-1413.5848	49365.7931
269.592	0.153670	5.7875E+07	-25230.4204	-0.0018095	2479.6440	-1442.0839	53828.2933
275.328	0.143491	5.7743E+07	-35042.4259	-0.0017397	2476.0655	-1979.1175	79114.4253
281.064	0.133712	5.7546E+07	-46621.2012	-0.0016701	2470.6699	-2058.1124	88289.0467
286.800	0.124332	5.7279E+07	-58645.5941	-0.0016007	2463.3864	-2134.4933	98473.7231
292.536	0.115349	5.6940E+07	-71083.9262	-0.0015317	2454.1467	-2202.4426	109522.
298.272	0.106760	5.6528E+07	-83876.6596	-0.0014632	2442.8900	-2258.0641	121321.
304.008	0.098563	5.6040E+07	-96951.2358	-0.0013952	2429.5667	-2300.7142	133893.
309.744	0.090754	5.5474E+07	-110232.	-0.0013279	2414.1387	-2329.8457	147255.
315.480	0.083329	5.4831E+07	-123639.	-0.0012613	2396.5803	-2345.0135	161420.
321.216	0.076285	5.4109E+07	-137121.	-0.0011955	2376.8784	-2355.6181	177124.
326.952	0.069615	5.3308E+07	-150657.	-0.0011306	2355.0239	-2364.2682	194807.
332.688	0.063314	5.2428E+07	-164208.	-0.0010668	2331.0096	-2360.3869	213841.
338.424	0.057377	5.1469E+07	-177699.	-0.0010040	2304.8397	-2343.8665	234317.
344.160	0.051796	5.0432E+07	-191060.	-0.0009425	2276.5295	-2314.6927	256332.

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349.896	0.046565	4.9317E+07	-204217.	-0.0008822	2246.1060	-2272.9494	279987.
355.632	0.041675	4.8126E+07	-217095.	-0.0008234	2213.6075	-2217.1268	305154.
361.368	0.037119	4.6861E+07	-229595.	-0.0007660	2179.0849	-2141.4884	330922.
367.104	0.032888	4.5524E+07	-241626.	-0.0007102	2142.6071	-2053.1530	358094.
372.840	0.028972	4.4119E+07	-253115.	-0.0006561	2104.2541	-1952.8756	386644.
378.576	0.025361	4.2648E+07	-263998.	-0.0006037	2064.1172	-1841.6007	416521.
384.312	0.022046	4.1116E+07	-274214.	-0.0005531	2022.2971	-1720.4703	447635.
390.048	0.019016	3.9526E+07	-283710.	-0.0005044	1978.9037	-1590.8301	479860.
395.784	0.016260	3.7882E+07	-292498.	-0.0004577	1934.0546	-1473.0623	519660.
401.520	0.013766	3.6189E+07	-300597.	-0.0004129	1887.8566	-1350.9701	562929.
407.256	0.011523	3.4451E+07	-307983.	-0.0003703	1840.4204	-1224.3362	609477.
412.992	0.009518	3.2672E+07	-314634.	-0.0003297	1791.8611	-1094.7713	659747.
418.728	0.007740	3.0856E+07	-320539.	-0.0002914	1742.2962	-963.9835	714384.
424.464	0.006176	2.9007E+07	-325695.	-0.0002552	1691.8443	-833.7447	774372.
430.200	0.004812	2.7130E+07	-330110.	-0.0002213	1640.6237	-705.8462	841308.
435.936	0.003637	2.5229E+07	-333804.	-0.0001897	1588.7505	-582.0372	917937.
441.672	0.002636	2.3309E+07	-336804.	-0.0001604	1536.3373	-463.9372	1009377.
447.408	0.001797	2.1372E+07	-339146.	-0.0001334	1483.4913	-352.8927	1126242.
453.144	0.001106	1.9423E+07	-340874.	-0.0001087	1430.3137	-249.6796	1294617.
458.880	0.000550	1.7466E+07	-342031.	-8.6468E-05	1376.8984	-153.5825	1602433.
464.616	0.000114	1.5503E+07	-342567.	-6.6558E-05	1323.3331	-33.1520	1663999.
470.352	-0.000214	1.3539E+07	-341990.	-4.9018E-05	1269.7273	234.0379	6279226.
476.088	-0.000448	1.1582E+07	-339901.	-3.3847E-05	1216.3222	494.3490	6328579.
481.824	-0.000602	9641087.	-336564.	-2.1030E-05	1163.3530	669.4691	6377931.
487.560	-0.000689	7721891.	-332428.	-1.0545E-05	1110.9782	772.3951	6427284.
493.296	-0.000723	5827913.	-305328.	-2.3616E-06	1059.2916	8676.6588	6.8832E+07
499.032	-0.000716	4219263.	-255788.	3.7061E-06	1015.3916	8596.9523	6.8832E+07
504.768	-0.000681	2893361.	-207710.	8.0015E-06	979.2078	8166.4664	6.8832E+07
510.504	-0.000625	1836075.	-162792.	1.0858E-05	950.3545	7495.4333	6.8832E+07
516.240	-0.000556	1025356.	-122160.	1.2586E-05	928.2300	6671.7534	6.8832E+07
521.976	-0.000480	434122.	-86498.0012	1.3467E-05	912.0952	5762.8277	6.8832E+07
527.712	-0.000401	32484.3057	-56152.7314	1.3749E-05	901.1345	4817.8103	6.8832E+07
533.448	-0.000323	-210640.	-31235.8275	1.3641E-05	905.9964	3870.0921	6.8832E+07
539.184	-0.000245	-326427.	-11704.8101	1.3317E-05	909.1562	2939.8861	6.8832E+07
544.920	-0.000170	-345478.	2568.3781	1.2911E-05	909.6761	2036.8184	6.8832E+07
550.656	-9.69E-05	-297505.	11743.9454	1.2523E-05	908.3669	1162.4729	6.8832E+07
556.392	-2.61E-05	-211278.	15975.2037	1.2216E-05	906.0138	312.8613	6.8832E+07
562.128	4.33E-05	-114752.	15383.4668	1.2019E-05	903.3796	-519.1852	6.8832E+07
567.864	0.000112	-35304.2375	10046.4725	1.1928E-05	901.2115	-1341.6915	6.8832E+07
573.600	0.000180	0.0000	0.0000	1.1907E-05	900.2480	-2161.2627	3.4416E+07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     1.08865327 in
Computed slope at pile head      =    -0.00517483
Maximum bending moment           =     57991046. lbs-in
Maximum shear force              =  -342566.53967 lbs
Depth of maximum bending moment  =      258.12000 in
Depth of maximum shear force     =      464.61600 in
Number of iterations             =             18
Number of zero deflection points =              2
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
```



```
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 75820.	M= 3.83E+07	3665810.	1.0887	5.7991E+07	-342567.

The analysis ended normally.

PILE+ 5.0 INPUT SHEET (ENGLISH)

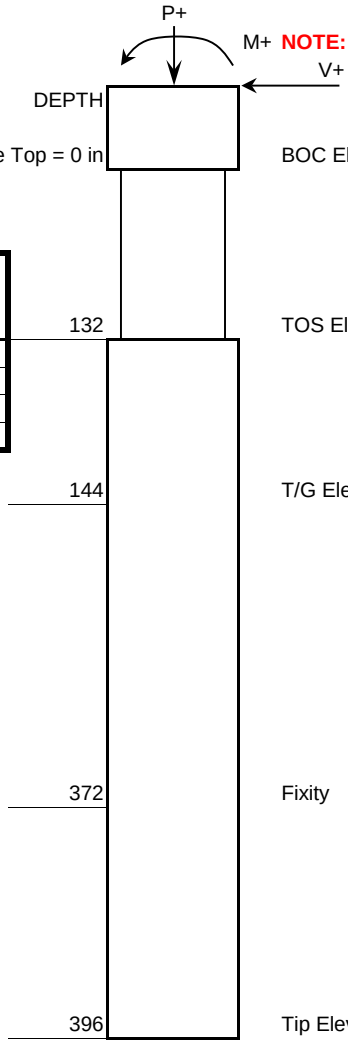
0041D1_P1_pa1
0001A0_P1_pa1

Designer: TRW Date: 3/4/13
Checker: XCB Date: 3/5/13

Project Title Haydock to Junker Bridge on NCRR/NS

TIP # P-5208G Bent # 2 Right
COUNTY: Mecklenburg

NOTE: LOADS GIVEN AT T/SHAFT



Input Elevation		
BOC Elev. =	710.3	ft
TOS Elev. =	699.3	ft
T/G Elev. =	698.3	ft
Fixity	679.3	ft
Tip Elev. =	677.3	ft

Pile Properties

Total Pile Length	396	(inches)
Increments (recommend 50 to 100)	100.0	
Distance from Top of Pile to Ground Surface	144.0	(inches)
Combined Ground Slope & Batter Angles	0	(degrees)

Drilled Shaft Sections

Section #	Depth (inches)	Diameter (inches)	Mom. of Inertia (in^4)	Area (in^2)	Modulus of Elasticity (lbs/in^2)
1	0	66	931419	3421	3600000
2	132	66	931419	3421	3600000
3	132	72	1319166	4072	3600000
4	396	72	1319166	4072	3600000

Pile-Head Boundary Conditions & Loading

Pile-Head Fixity Conditions	V=Shear (lbs)	M=Moment (lbs-in)	P=Axial load (lbs)
Shear & Moment	180260	37712400	1890330

Soil Layers

Layer #	Soil Type	Layer Top (inches)	Layer Bottom (inches)
1	4	144.0	291.6
2	4	291.6	306.0
3	6	306.0	445.2

#1 = Soft Clay Criteria (Matlock)
#2 = Stiff Clay with Free Water
#3 = Stiff Clay without Free Water
#4 = Sand (Reese, 1974)
#5 = Linear Interp. p-y curves
#6 = Strong Rock (Vuggy Limestone)
#7 = Silt (Cemented c-phi soil)
#8 = API Sand (O'Neill)
#9 = Weak Rock (Reese, 1977)

DEFLECTION @ PILE TOP = Δ_{TOP}

Δ_{TOP}	First Neg.	Pile Length
1	336.6	396.0
	682.3	
Max. Neg. @	368.28	679.6

SOIL AND ROCK PROPERTIES DATA

Non-rock Soil Types	Eff. Unit Wt. γ' (lbs/in^3)	p-y Modulus k, (lbs/in^3)	Cohesive Str. c, (lbs/in^2)	Friction Angle ϕ (degrees)	Soil Strain e_{50}
4	0.0362	400		32	
4	0.0438	750		38	

Weak Rock	Eff. Unit Wt. γ' (lbs/in^3)	Young's Mod.* Er, (lbs/in^2)	Uniax. Comp. Str. (lbs/in^2)	RQD (%)	k rm (.0005 to .00005)

Strong Rock Properties (Vuggy Limestone)	Eff. Unit Wt. γ' (lbs/in^3)	Uniax. Comp. Str. (lbs/in^2)
6	0.0623	12,000

COMMENTS:

PT. OF FIXITY ELEV. = **679.3** ft

TIP NO HIGHER THAN EL. = **677.3** ft

File: B2, R

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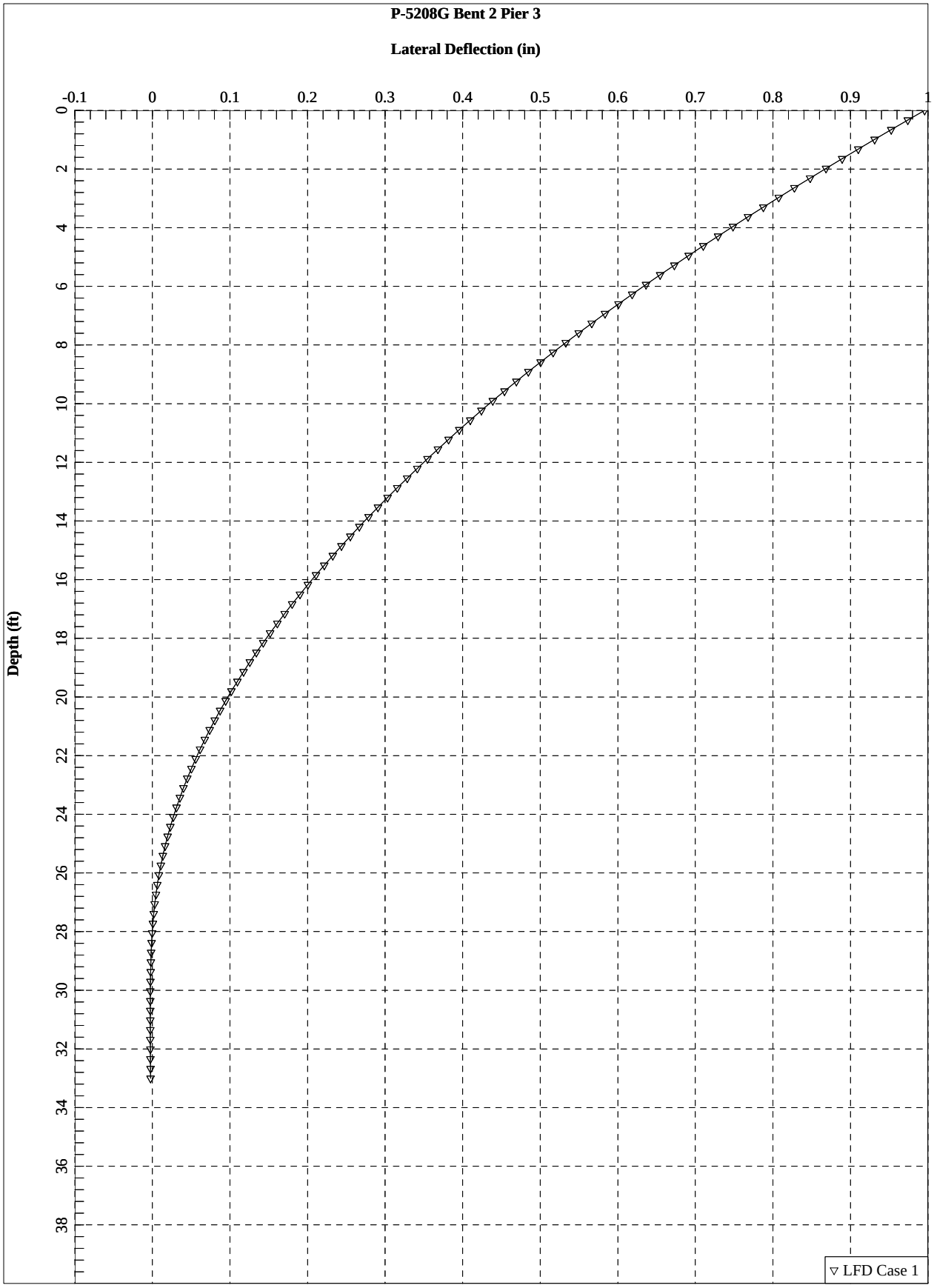

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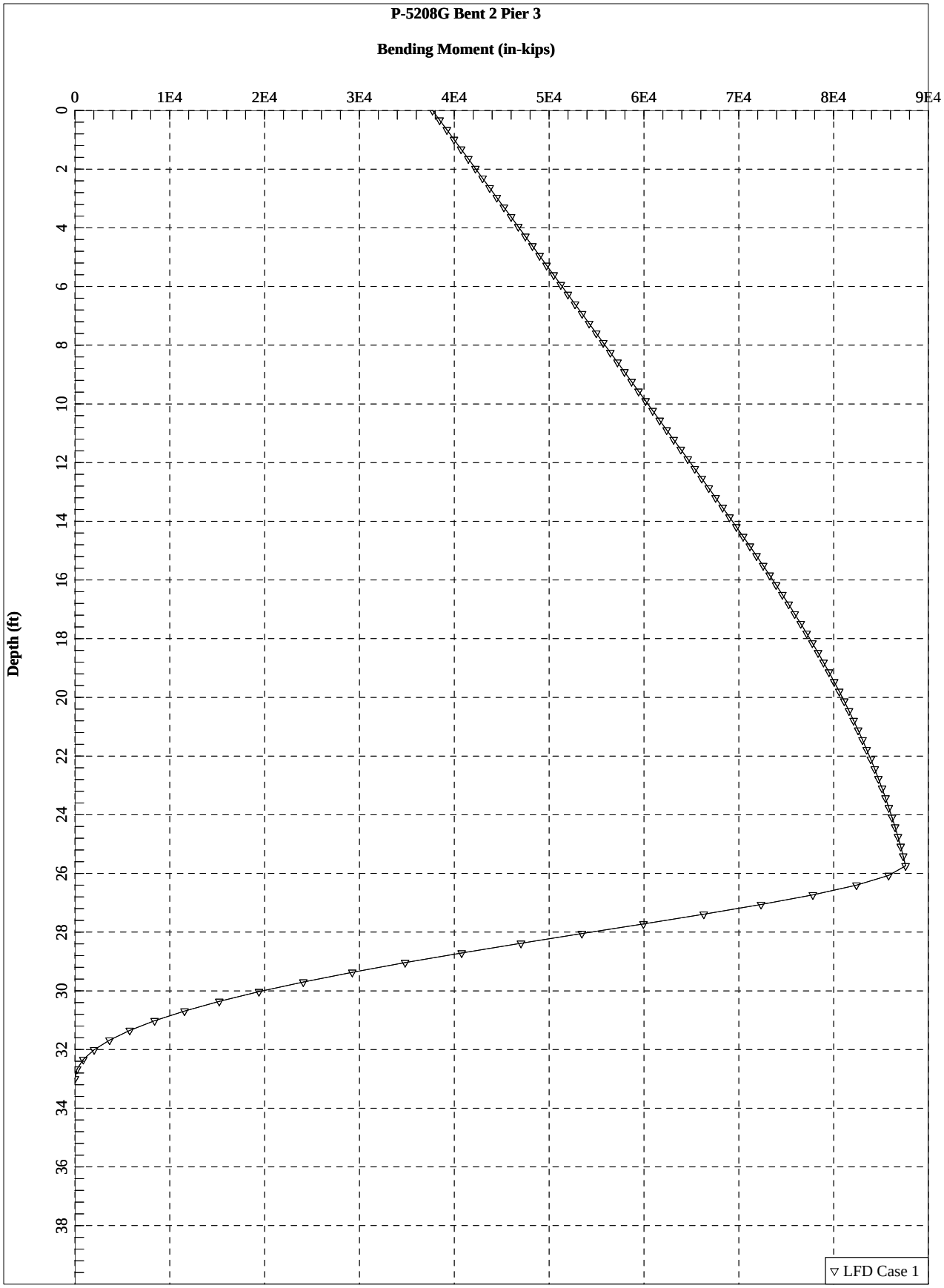

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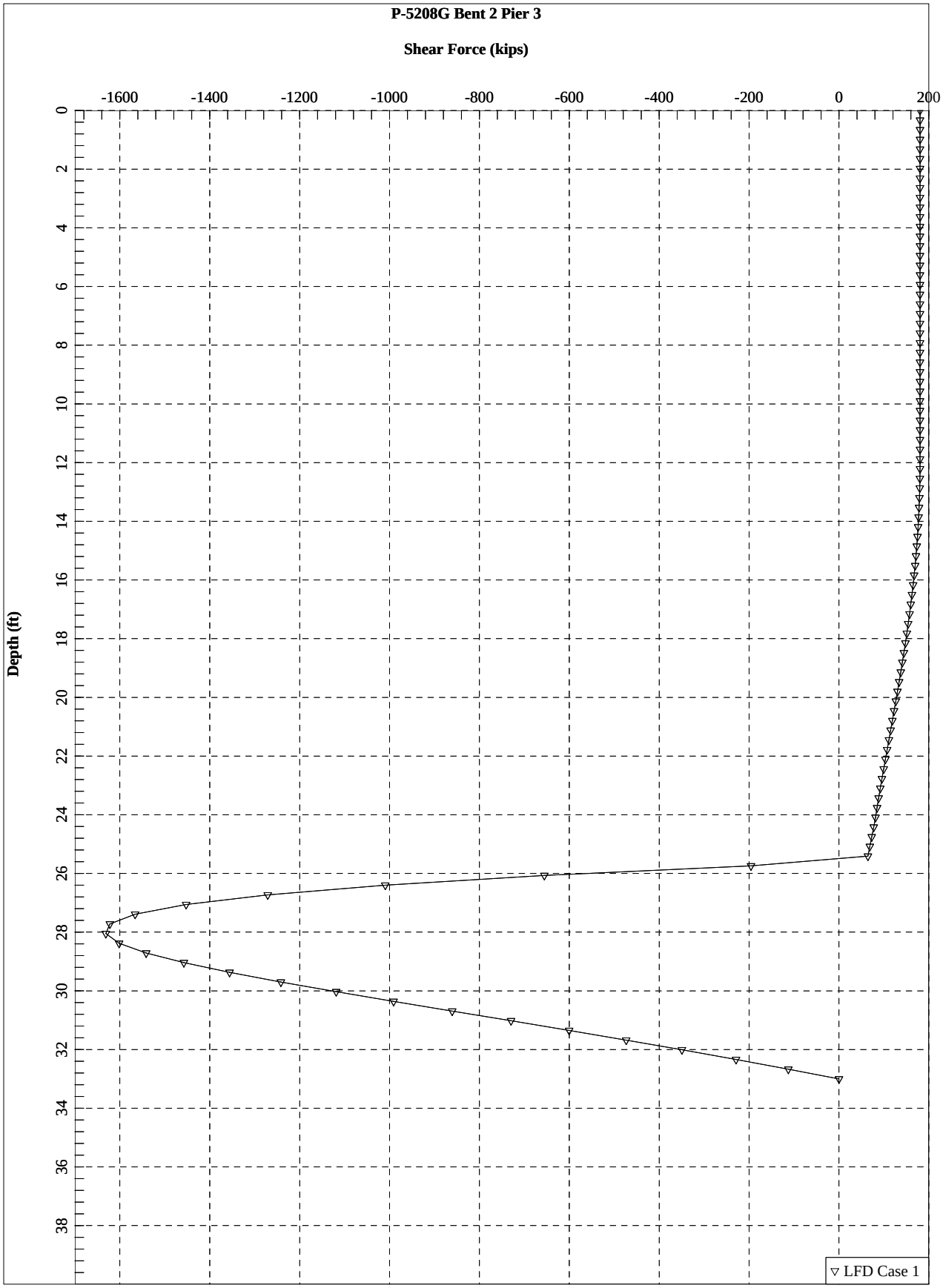

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```
==============================================================================

                  LPILE Plus for Windows, Version 5.0 (5.0.45)

                 Analysis of Individual Piles and Drilled Shafts
                Subjected to Lateral Loading Using the p-y Method

                          (c) 1985-2010 by Ensoft, Inc.
                               All Rights Reserved

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

This program is licensed to:

Thomas Wells
Kleinfelder Southeast, Inc.

------------------------------------------------------------------------------
                            Files Used for Analysis
------------------------------------------------------------------------------

Path to file locations:      W:\share\_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G
RailroadRoadbed Millbrook to CP Junker\Bridge\Foundations\
Name of input data file:     B2, Right.lpd
Name of output file:         B2, Right.lpo
Name of plot output file:    B2, Right.lpp
Name of runtime file:        B2, Right.lpr


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

               Date:  March  4, 2013     Time:  14:43:22


-----------------------------------------------------------------------------
                                Problem Title
-----------------------------------------------------------------------------

P-5208G Bent 2 Right Pier


-----------------------------------------------------------------------------
                                Program Options
-----------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- No additional p-y curves to be computed at user-specified depths

Solution Control Parameters:
- Number of pile increments            =          100
- Maximum number of iterations allowed =          100
- Deflection tolerance for convergence =   1.0000E-05 in
- Maximum allowable deflection         =   1.0000E+02 in
```



```
Printing Options:
- Values of pile-head deflection, bending moment, shear force, and
  soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) =  1


-----------------------------------------------------------------------------
                      Pile Structural Properties and Geometry
-----------------------------------------------------------------------------

Pile Length                                =     396.00 in

Depth of ground surface below top of pile =     144.00 in

Slope angle of ground surface              =       0.00 deg.

Structural properties of pile defined using  4 points

Point    Point         Pile      Moment of       Pile      Modulus of
 No.     Depth       Diameter     Inertia        Area      Elasticity
           in           in         in**4        Sq.in      lbs/Sq.in
-----  ---------   -----------   ----------   ----------   -----------
  1       0.0000   66.00000000  931419.0000    3421.0000      3600000.
  2     132.0000   66.00000000  931419.0000    3421.0000      3600000.
  3     132.0000   72.00000000     1319166.    4072.0000      3600000.
  4     396.0000   72.00000000     1319166.    4072.0000      3600000.


-----------------------------------------------------------------------------
                         Soil and Rock Layering Information
-----------------------------------------------------------------------------

The soil profile is modelled using  3 layers

Layer  1 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      144.000 in
Distance from top of pile to bottom of layer =      291.600 in
p-y subgrade modulus k for top of soil layer =      400.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      400.000 lbs/in**3

Layer  2 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      291.600 in
Distance from top of pile to bottom of layer =      306.000 in
p-y subgrade modulus k for top of soil layer =      750.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      750.000 lbs/in**3

Layer  3 is strong rock (vuggy limestone)
Distance from top of pile to top of layer    =      306.000 in
Distance from top of pile to bottom of layer =      445.200 in


(Depth of lowest layer extends   49.20 in below pile tip)


-----------------------------------------------------------------------------
                      Effective Unit Weight of Soil vs. Depth
-----------------------------------------------------------------------------

Effective unit weight of soil with depth defined using  6 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ----------------
  1          144.00        0.03620
  2          291.60        0.03620
  3          291.60        0.04380
  4          306.00        0.04380
  5          306.00        0.06230
  6          445.20        0.06230
```

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0001ADD_P10a1

Shear Strength of Soils

Shear strength parameters with depth defined using 6 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	144.000	0.00000	32.00	------	------
2	291.600	0.00000	32.00	------	------
3	291.600	0.00000	38.00	------	------
4	306.000	0.00000	38.00	------	------
5	306.000	12000.00000	0.00	------	------
6	445.200	12000.00000	0.00	------	------

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load Case Number 1

Pile-head boundary conditions are Shear and Moment (BC Type 1)
Shear force at pile head = 180260.000 lbs
Bending moment at pile head = 37712400.000 in-lbs
Axial load at pile head = 1890330.000 lbs

Non-zero moment at pile head for this load case indicates the pile-head may rotate under the applied pile-head loading, but is not a free-head (zero moment) condition.

Computed Values of Load Distribution and Deflection for Lateral Loading for Load Case Number 1

Pile-head boundary conditions are Shear and Moment (Pile-head Condition Type 1)
Specified shear force at pile head = 180260.000 lbs
Specified moment at pile head = 37712400.000 in-lbs
Specified axial load at pile head = 1890330.000 lbs

Depth X in	Deflect. y in	Moment M lbs-in	Shear V lbs	Slope S Rad.	Total Stress lbs/in**2	Soil Res. p lbs/in	Es*h F/L lbs/in
0.000	0.995518	3.7712E+07	180260.	-0.0054863	1888.7097	0.0000	0.0000

3.960	0.973880	3.8467E+07	180260.	-0.0054414	1915.4498	0.0000	0.0000
7.920	0.952422	3.9222E+07	180260.	-0.0053955	1942.1777	0.0000	0.0000
11.880	0.931148	3.9976E+07	180260.	-0.0053487	1968.8934	0.0000	0.0000
15.840	0.910060	4.0729E+07	180260.	-0.0053011	1995.5966	0.0000	0.0000
19.800	0.889163	4.1483E+07	180260.	-0.0052525	2022.2870	0.0000	0.0000
23.760	0.868460	4.2236E+07	180260.	-0.0052031	2048.9644	0.0000	0.0000
27.720	0.847955	4.2988E+07	180260.	-0.0051528	2075.6286	0.0000	0.0000
31.680	0.827650	4.3740E+07	180260.	-0.0051015	2102.2793	0.0000	0.0000
35.640	0.807551	4.4492E+07	180260.	-0.0050494	2128.9163	0.0000	0.0000
39.600	0.787659	4.5244E+07	180260.	-0.0049965	2155.5394	0.0000	0.0000
43.560	0.767979	4.5995E+07	180260.	-0.0049426	2182.1483	0.0000	0.0000
47.520	0.748514	4.6745E+07	180260.	-0.0048878	2208.7428	0.0000	0.0000
51.480	0.729267	4.7495E+07	180260.	-0.0048322	2235.3226	0.0000	0.0000
55.440	0.710243	4.8245E+07	180260.	-0.0047756	2261.8876	0.0000	0.0000
59.400	0.691444	4.8995E+07	180260.	-0.0047182	2288.4375	0.0000	0.0000
63.360	0.672875	4.9744E+07	180260.	-0.0046599	2314.9720	0.0000	0.0000
67.320	0.654538	5.0492E+07	180260.	-0.0046007	2341.4910	0.0000	0.0000
71.280	0.636437	5.1240E+07	180260.	-0.0045406	2367.9941	0.0000	0.0000
75.240	0.618576	5.1988E+07	180260.	-0.0044797	2394.4812	0.0000	0.0000
79.200	0.600958	5.2735E+07	180260.	-0.0044179	2420.9520	0.0000	0.0000
83.160	0.583586	5.3482E+07	180260.	-0.0043551	2447.4062	0.0000	0.0000
87.120	0.566465	5.4228E+07	180260.	-0.0042915	2473.8438	0.0000	0.0000
91.080	0.549598	5.4973E+07	180260.	-0.0042270	2500.2643	0.0000	0.0000
95.040	0.532987	5.5719E+07	180260.	-0.0041617	2526.6676	0.0000	0.0000
99.000	0.516637	5.6463E+07	180260.	-0.0040954	2553.0535	0.0000	0.0000
102.960	0.500551	5.7208E+07	180260.	-0.0040283	2579.4217	0.0000	0.0000
106.920	0.484733	5.7951E+07	180260.	-0.0039603	2605.7720	0.0000	0.0000
110.880	0.469185	5.8695E+07	180260.	-0.0038914	2632.1041	0.0000	0.0000
114.840	0.453913	5.9437E+07	180260.	-0.0038217	2658.4178	0.0000	0.0000
118.800	0.438918	6.0179E+07	180260.	-0.0037510	2684.7129	0.0000	0.0000
122.760	0.424204	6.0921E+07	180260.	-0.0036795	2710.9892	0.0000	0.0000
126.720	0.409776	6.1662E+07	180260.	-0.0036072	2737.2464	0.0000	0.0000
130.680	0.395636	6.2403E+07	180260.	-0.0035339	2763.4843	0.0000	0.0000
134.640	0.381787	6.3143E+07	180260.	-0.0034707	2187.3904	0.0000	0.0000
138.600	0.368147	6.3882E+07	180260.	-0.0034178	2207.5744	0.0000	0.0000
142.560	0.354719	6.4622E+07	180260.	-0.0033642	2227.7476	0.0000	0.0000
146.520	0.341503	6.5360E+07	180200.	-0.0033100	2247.9097	-30.3964	352.4704
150.480	0.328504	6.6098E+07	179983.	-0.0032552	2268.0477	-79.0266	952.6398
154.440	0.315722	6.6835E+07	179572.	-0.0031998	2288.1406	-128.4207	1610.7389
158.400	0.303161	6.7568E+07	178965.	-0.0031437	2308.1672	-178.2484	2328.3424
162.360	0.290824	6.8299E+07	178160.	-0.0030871	2328.1060	-228.1833	3107.0552
166.320	0.278712	6.9026E+07	177158.	-0.0030298	2347.9355	-277.9030	3948.5067
170.280	0.266828	6.9748E+07	175961.	-0.0029720	2367.6343	-327.0894	4854.3440
174.240	0.255174	7.0464E+07	174570.	-0.0029135	2387.1812	-375.4295	5826.2233
178.200	0.243753	7.1174E+07	172989.	-0.0028544	2406.5555	-422.6157	6865.7991
182.160	0.232567	7.1877E+07	171223.	-0.0027948	2425.7368	-469.6182	7996.3607
186.120	0.221618	7.2572E+07	169270.	-0.0027346	2444.7049	-516.4454	9228.1474
190.080	0.210909	7.3258E+07	167135.	-0.0026738	2463.4396	-561.9440	10550.9907
194.040	0.200442	7.3935E+07	164823.	-0.0026124	2481.9213	-605.8820	11970.0277
198.000	0.190219	7.4603E+07	162340.	-0.0025505	2500.1312	-648.0345	13490.8775
201.960	0.180242	7.5259E+07	159694.	-0.0024880	2518.0510	-688.1828	15119.7010
205.920	0.170514	7.5905E+07	156894.	-0.0024250	2535.6635	-726.1159	16863.2703
209.880	0.161036	7.6538E+07	153948.	-0.0023614	2552.9523	-761.6298	18729.0494
213.840	0.151811	7.7159E+07	150867.	-0.0022973	2569.9022	-794.5287	20725.2890
217.800	0.142841	7.7767E+07	147660.	-0.0022327	2586.4989	-825.5069	22885.5929
221.760	0.134128	7.8362E+07	144333.	-0.0021676	2602.7290	-854.7583	25235.9087
225.720	0.125674	7.8943E+07	140896.	-0.0021021	2618.5800	-881.1310	27764.6246
229.680	0.117480	7.9510E+07	137360.	-0.0020360	2634.0405	-904.4671	30487.7265
233.640	0.109548	8.0061E+07	133738.	-0.0019695	2649.1004	-924.6172	33423.4174
237.600	0.101882	8.0598E+07	130044.	-0.0019025	2663.7510	-941.4404	36592.5272
241.560	0.094481	8.1120E+07	126289.	-0.0018351	2677.9849	-954.8054	40019.0177
245.520	0.087348	8.1626E+07	122489.	-0.0017672	2691.7964	-964.5905	43730.6122
249.480	0.080485	8.2116E+07	118657.	-0.0016989	2705.1812	-970.6843	47759.5846
253.440	0.073892	8.2591E+07	114805.	-0.0016303	2718.1366	-974.4857	52224.1042
257.400	0.067573	8.3050E+07	110941.	-0.0015612	2730.6609	-977.1807	57266.0838
261.360	0.061528	8.3493E+07	107074.	-0.0014918	2742.7529	-976.1161	62824.0869
265.320	0.055758	8.3920E+07	103218.	-0.0014220	2754.4129	-971.1951	68975.2701
269.280	0.050266	8.4332E+07	99389.5209	-0.0013518	2765.6430	-962.3306	75813.6864
273.240	0.045052	8.4728E+07	95604.2037	-0.0012813	2776.4469	-949.4457	83455.2167
277.200	0.040118	8.5108E+07	91878.0022	-0.0012105	2786.8301	-932.4742	92044.3372

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281.160	0.035464	8.5474E+07	88227.2082	-0.0011394	2796.7997	-911.3612	101764.
285.120	0.031094	8.5824E+07	84668.3063	-0.0010680	2806.3647	-886.0640	112847.
289.080	0.027006	8.6160E+07	81214.6391	-0.0009963	2815.5360	-858.2123	125843.
293.040	0.023203	8.6482E+07	77258.5756	-0.0009243	2824.3252	-1139.7996	194526.
297.000	0.019686	8.6786E+07	72796.2319	-0.0008521	2832.6120	-1113.9093	224076.
300.960	0.016455	8.7072E+07	68452.1982	-0.0007796	2840.4073	-1080.0471	259923.
304.920	0.013512	8.7340E+07	64258.6284	-0.0007068	2847.7255	-1037.9174	304196.
308.880	0.010857	8.7591E+07	-195749.	-0.0006339	2854.5847	-130279.	4.7520E+07
312.840	0.008491	8.5799E+07	-655446.	-0.0005616	2805.6760	-101891.	4.7520E+07
316.800	0.006409	8.2408E+07	-1009456.	-0.0004915	2713.1484	-76902.4439	4.7520E+07
320.760	0.004598	7.7811E+07	-1270979.	-0.0004247	2587.6964	-55179.4389	4.7520E+07
324.720	0.003045	7.2349E+07	-1452583.	-0.0003621	2438.6170	-36539.7122	4.7520E+07
328.680	0.001731	6.6312E+07	-1566049.	-0.0003043	2273.8881	-20766.8006	4.7520E+07
332.640	0.000635	5.9950E+07	-1622258.	-0.0002516	2100.2608	-7621.5178	4.7520E+07
336.600	-0.000262	5.3468E+07	-1631115.	-0.0002043	1923.3616	3148.2431	4.7520E+07
340.560	-0.000983	4.7035E+07	-1601519.	-0.0001624	1747.8006	11799.3396	4.7520E+07
344.520	-0.001549	4.0786E+07	-1541355.	-0.0001258	1577.2811	18586.6865	4.7520E+07
348.480	-0.001980	3.4829E+07	-1457513.	-9.4300E-05	1414.7089	23757.8779	4.7520E+07
352.440	-0.002296	2.9244E+07	-1355925.	-6.7586E-05	1262.2979	27548.9687	4.7520E+07
356.400	-0.002515	2.4091E+07	-1241619.	-4.5349E-05	1121.6716	30181.2597	4.7520E+07
360.360	-0.002655	1.9411E+07	-1118780.	-2.7212E-05	993.9572	31858.9404	4.7520E+07
364.320	-0.002731	1.5231E+07	-990819.	-1.2768E-05	879.8735	32767.4520	4.7520E+07
368.280	-0.002756	1.1564E+07	-860456.	-1.5968E-06	779.8101	33072.4441	4.7520E+07
372.240	-0.002743	8415974.	-729793.	6.7335E-06	693.8981	32919.2087	4.7520E+07
376.200	-0.002703	5784030.	-600396.	1.2654E-05	622.0724	32432.4900	4.7520E+07
380.160	-0.002643	3660644.	-473381.	1.6592E-05	564.1253	31716.5789	4.7520E+07
384.120	-0.002571	2034602.	-349488.	1.8966E-05	519.7506	30855.6147	4.7520E+07
388.080	-0.002493	892412.	-229164.	2.0187E-05	488.5803	29914.0293	4.7520E+07
392.040	-0.002411	219317.	-112639.	2.0650E-05	470.2116	28937.0820	4.7520E+07
396.000	-0.002329	0.0000	0.0000	2.0742E-05	464.2264	27951.4443	2.3760E+07

Output Verification:

Computed forces and moments are within specified convergence limits.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     0.99551755 in
Computed slope at pile head      =    -0.00548634
Maximum bending moment           =      87591095. lbs-in
Maximum shear force              =      -1631115. lbs
Depth of maximum bending moment  =      308.88000 in
Depth of maximum shear force     =      336.60000 in
Number of iterations             =              6
Number of zero deflection points =              1
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
1	V= 1.80E+05	M= 3.77E+07	1890330.	0.9955175	8.7591E+07	-1631115.

The analysis ended normally.

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END BENT SLOPE STABILITY

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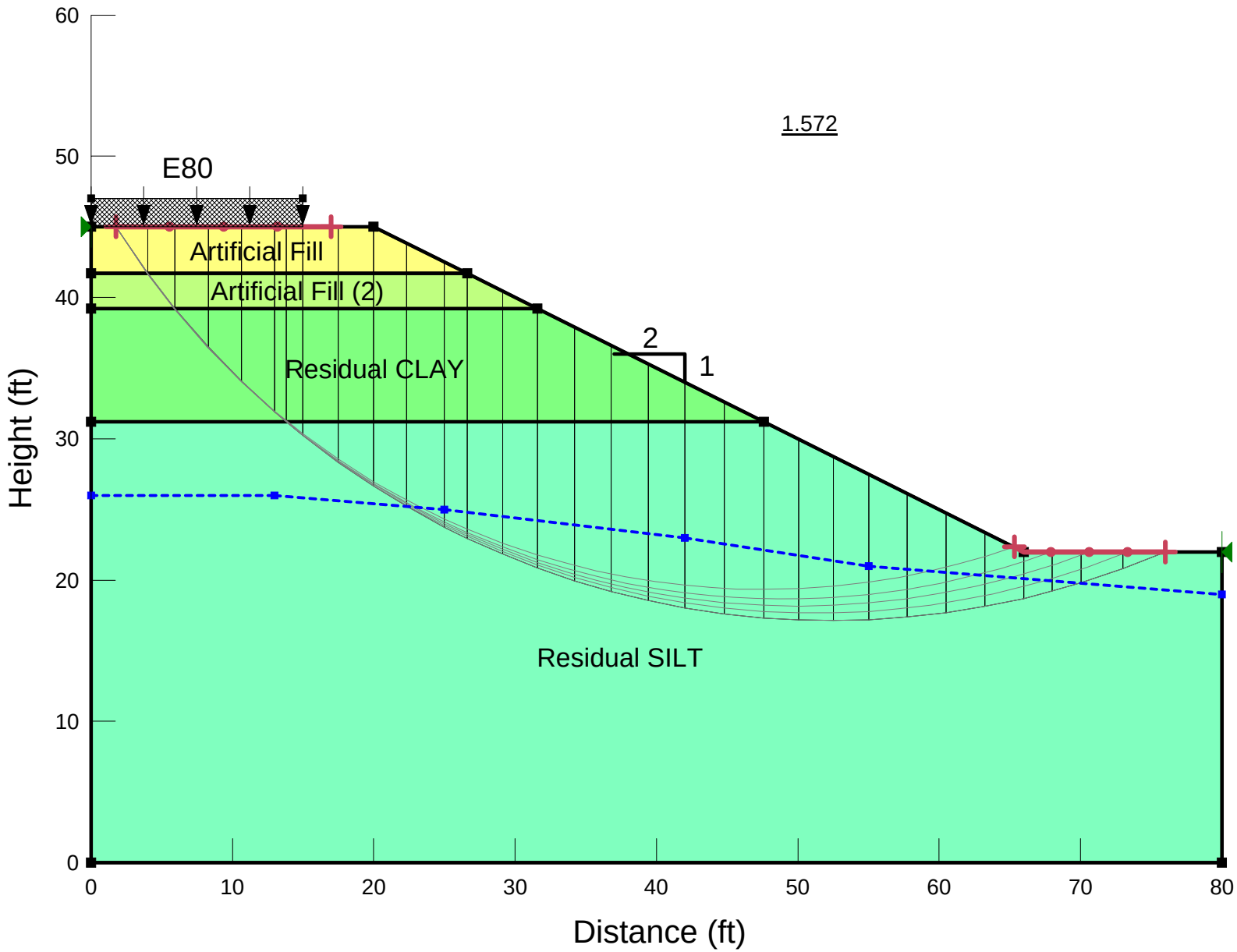
P-5208G
NCRR/NS Bridge over Mallard Creek Church Road
End Bent Slope Stability
Last Solved Date: 3/8/2013
Method: Morgenstern-Price



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File Information

Created By: Thomas Wells
Last Edited By: Thomas Wells
Revision Number: 6
File Version: 8.0
Tool Version: 8.0.10.6504
Date: 3/8/2013
Time: 11:29:56 AM
File Name: P5208G_End_Bent_Slope_Stabilitya.gsz
Directory: W:\share_GEOTECHNICAL\Projects\Active Projects\127855 AECOM P5208G RailroadRoadbed Millbrook to CP Junker\Bridge\
Last Solved Date: 3/8/2013
Last Solved Time: 11:30:02 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

Slope Stability

Description: P-5208G End Bent Slope Stability
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- Lambda
  - Lambda 1: -1
  - Lambda 2: -0.8
  - Lambda 3: -0.6
  - Lambda 4: -0.4
  - Lambda 5: -0.2
  - Lambda 6: 0
  - Lambda 7: 0.2
  - Lambda 8: 0.4
  - Lambda 9: 0.6
  - Lambda 10: 0.8
  - Lambda 11: 1
- PWP Conditions Source: Piezometric Line
- Apply Phreatic Correction: No
- Use Staged Rapid Drawdown: No

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Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 1
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

F of S Distribution
- F of S Calculation Option: Constant

Advanced
- Number of Slices: 30
- F of S Tolerance: 0.001
- Minimum Slip Surface Depth: 0.1 ft
- Optimization Maximum Iterations: 2,000
- Optimization Convergence Tolerance: 1e-007
- Starting Optimization Points: 8
- Ending Optimization Points: 16
- Complete Passes per Insertion: 1
- Driving Side Maximum Convex Angle: 5 °
- Resisting Side Maximum Convex Angle: 1 °

Materials

Artificial Fill
- Model: Mohr-Coulomb
- Unit Weight: 105 pcf
- Cohesion': 1,000 psf
- Phi': 0 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Artificial Fill (2)
- Model: Mohr-Coulomb
- Unit Weight: 104 pcf
- Cohesion': 900 psf
- Phi': 0 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Residual CLAY
- Model: Mohr-Coulomb
- Unit Weight: 106 pcf
- Cohesion': 1,100 psf
- Phi': 0 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1

Residual SILT

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 100 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (1.76378, 45) ft
Left-Zone Right Coordinate: (17, 45) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (65.31024, 22.34488) ft
Right-Zone Right Coordinate: (76, 22) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 45) ft
Right Coordinate: (80, 22) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	26
Coordinate 2	13	26
Coordinate 3	25	25
Coordinate 4	42	23
Coordinate 5	55	21
Coordinate 6	80	19

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 940 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)

	0	47
	15	47

Points

	X (ft)	Y (ft)
Point 1	0	0
Point 2	0	31.2
Point 3	47.6	31.2
Point 4	66	22
Point 5	80	22
Point 6	80	0
Point 7	0	39.2
Point 8	31.6	39.2
Point 9	0	41.7
Point 10	26.6	41.7
Point 11	0	45
Point 12	20	45

Regions

	Material	Points	Area (ft^2)
Region 1	Residual SILT	1,2,3,4,5,6	2,282.6
Region 2	Residual CLAY	2,7,8,3	316.8
Region 3	Artificial Fill (2)	7,9,10,8	72.75
Region 4	Artificial Fill	9,11,12,10	76.89

Current Slip Surface

Slip Surface: 23
F of S: 1.572
Volume: 855.50148 ft^3
Weight: 92,448.029 lbs
Resisting Moment: 4,386,448.2 lbs-ft
Activating Moment: 2,790,061.1 lbs-ft
Resisting Force: 63,339.563 lbs
Activating Force: 40,319.76 lbs
F of S Rank: 1
Exit: (76, 22) ft
Entry: (1.76378, 45) ft
Radius: 59.880797 ft
Center: (52.36505, 77.019078) ft

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Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	2.8865708	43.35	-1,082.64	1,075.4651	0	1,000
Slice 2	4.9739164	40.45	-901.68	1,459.7464	0	900
Slice 3	7.1153927	37.840697	-738.85949	1,581.1426	0	1,100
Slice 4	9.4692356	35.272085	-578.57812	1,832.3078	0	1,100
Slice 5	11.823079	32.97933	-435.51018	2,050.6845	0	1,100
Slice 6	13.406102	31.547942	-348.30329	2,188.302	0	1,100
Slice 7	14.406102	30.713156	-301.41268	2,167.4363	1,354.3645	100
Slice 8	16.25	29.280663	-221.61337	985.85173	616.02853	100
Slice 9	18.75	27.486703	-122.67029	1,173.67	733.39042	100
Slice 10	21.158002	25.93103	-38.11787	1,310.2108	818.71057	100
Slice 11	23.658002	24.490263	38.785974	1,400.0738	850.62705	100
Slice 12	25.8	23.360797	96.413315	1,475.2533	861.59487	100
Slice 13	27.85	22.403651	141.08982	1,541.0635	874.80065	100
Slice 14	30.35	21.348255	188.59362	1,616.9673	892.54695	100
Slice 15	32.9	20.40696	228.61039	1,685.7757	910.53793	100
Slice 16	35.5	19.578289	261.23241	1,745.5008	927.47381	100
Slice 17	38.1	18.877643	285.86566	1,793.0605	941.79983	100
Slice 18	40.7	18.300429	302.79676	1,824.9403	951.14084	100
Slice 19	43.4	17.83012	309.16051	1,836.9762	954.68521	100
Slice 20	46.2	17.473121	304.55724	1,821.9639	948.18097	100
Slice 21	48.833333	17.25529	292.86992	1,774.1138	925.5839	100
Slice 22	51.3	17.160462	275.10717	1,693.7499	886.46637	100
Slice 23	53.766667	17.1674	250.99423	1,579.7257	830.28362	100
Slice 24	56.375	17.288592	224.72787	1,419.744	746.72891	100
Slice 25	59.125	17.537166	195.48884	1,209.9614	633.91285	100
Slice 26	61.875	17.91467	158.20462	963.51118	503.21139	100
Slice 27	64.625	18.4236	112.71936	688.14569	359.56628	100
Slice 28	67.003912	18.964435	67.09574	504.04972	273.03915	100
Slice 29	69.011737	19.508163	23.144039	418.4559	247.01827	100
Slice 30	71.511737	20.303817	-38.984779	290.11048	181.28115	100
Slice 31	74.503912	21.404443	-122.60078	119.41703	74.620043	100

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STRUCTURAL LOADS

Loads at top of pile for HP12x53

End Bent 1, Estimated top of pile Elevation: 716.486 ft

Service Load Design

Maximum compression:	88.12	kip
Maximum tension:	22.23	kip
Maximum lateral:	7.00	kip

Load Factor Design

Maximum compression:	148.10	kip
Maximum tension:	33.10	kip
Maximum lateral:	9.00	kip

End Bent 2, Estimated top of pile Elevation: 717.236 ft

Service Load Design

Maximum compression:	86.67	kip
Maximum tension:	27.94	kip
Maximum lateral:	6.00	kip

Load Factor Design

Maximum compression:	153.30	kip
Maximum tension:	41.43	kip
Maximum lateral:	7.00	kip

Pier 1 Estimated top of Column Elevation: 711.409 ft

Column 1 (left Column, looking upstation)

	Load Case	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip·ft)	My (kip·ft)	Mz (kip·ft)
Service	**1**	(kip)	(kip)	(kip)	(kip·ft)	(kip·ft)	(kip·ft)
Load	**2**	52.82	1056.70	85.10	-763.89	-27.47	-600.54
Design	**3**	-39.30	1517.53	-104.23	-294.41	55.80	834.02
	4	-8.53	1275.82	-112.37	-625.37	82.70	387.23
	5	-0.14	1249.48	89.14	-1233.71	13.77	283.09
	6	-8.53	1275.82	-112.37	-625.37	82.70	387.23
Load	**1**	-51.18	1036.61	-101.97	-281.42	42.72	1118.40
Factor	**2**	73.95	1479.37	119.14	-1122.94	-38.46	-854.92
Design	**3**	-38.44	2944.40	-15.16	-1205.60	51.47	1162.06
	4	-11.94	1786.15	-157.32	-929.61	115.78	553.23
	5	-29.44	2581.06	-19.26	-2248.05	109.04	970.20
	6	-11.94	1786.15	-157.32	-929.61	115.78	553.23

Column 2 (Center Column, looking upstation)

	Load Case	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip·ft)	My (kip·ft)	Mz (kip·ft)
Service	**1**	(kip)	(kip)	(kip)	(kip·ft)	(kip·ft)	(kip·ft)
Load	**2**	102.63	1780.29	90.82	-683.73	26.03	-1672.47
Design	**3**	56.24	2060.84	-106.14	-880.14	9.40	-912.27
	4	44.18	1880.46	-112.90	-563.15	-16.95	-691.66
	5	54.87	1880.99	89.93	-1223.34	16.95	-878.49
	6	20.55	1630.37	-105.72	-620.37	48.53	-453.76
Load	**1**	102.63	1780.29	90.82	-683.73	26.03	-1672.47
Factor	**2**	143.68	2492.41	127.15	-1044.32	36.44	-2409.61
Design	**3**	80.82	4050.70	-15.13	-1421.14	21.03	-1445.38
	4	61.85	2632.64	-158.06	-865.03	-23.74	-998.20
	5	77.61	3627.85	-21.93	-2347.26	38.66	-1353.39
	6	96.55	3046.27	-14.15	-2029.98	112.34	-1839.56

Column 3 (Right Column, looking upstation)

	Load Case	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip·ft)	My (kip·ft)	Mz (kip·ft)
Service Load Design	**1**	126.23	1294.14	86.70	-746.41	21.02	-2145.36
	2	114.34	1775.05	84.45	-771.67	7.94	-1868.69
	3	75.19	1507.00	-112.44	-632.39	-83.44	-1310.11
	4	81.77	1532.82	89.22	-1253.04	-13.03	-1408.58
	5	75.19	1507.00	-112.44	-632.39	-83.44	-1310.11
	6	126.23	1294.14	86.70	-746.41	21.02	-2145.36
Load Factor Design	**1**	176.72	1811.79	121.39	-1110.58	29.42	-3065.98
	2	142.24	3304.56	-15.16	-1242.07	-51.47	-2684.04
	3	105.26	2109.80	-157.42	-951.55	-116.81	-1878.92
	4	133.23	2941.22	-19.26	-2314.05	-109.04	-2476.35
	5	105.26	2109.80	-157.42	-951.55	-116.81	-1878.92
	6	169.98	2182.43	-9.89	-1120.52	-20.95	-3313.21

Pier 2 Estimated top of Column Elevation: 711.409 ft

Column 1 (left Column, looking upstation)

	Load Case	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip·ft)	My (kip·ft)	Mz (kip·ft)
Service	**1**	(kip)	(kip)	(kip)	(kip·ft)	(kip·ft)	(kip·ft)
Load	**2**	58.91	943.77	84.04	849.57	-27.13	-673.17
Design	**3**	-42.32	1549.67	-102.50	998.43	16.60	859.07
	4	6.58	433.24	-117.70	1107.47	87.32	129.25
	5	-9.55	1296.12	-108.32	1491.47	-5.18	402.30
	6	6.58	433.24	-117.70	1107.47	87.32	129.25
Load	**1**	-54.77	1061.07	-104.70	969.89	29.28	1156.63
Factor	**2**	82.47	1321.28	117.66	1241.93	-37.98	-956.56
Design	**3**	-37.45	2990.40	-11.75	1593.70	-37.44	1134.37
	4	9.21	606.53	-164.78	1580.35	122.25	182.17
	5	-27.34	2600.96	-7.52	2646.71	-96.39	924.94
	6	9.21	606.53	-164.78	1580.35	122.25	182.17

Column 2 (Center Column, looking upstation)

	Load Case	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip·ft)	My (kip·ft)	Mz (kip·ft)
Service	**1**	(kip)	(kip)	(kip)	(kip·ft)	(kip·ft)	(kip·ft)
Load	**2**	99.99	1775.57	94.21	808.17	-25.78	-1631.04
Design	**3**	94.28	2075.10	-102.31	1307.08	-7.49	-1454.86
	4	34.82	1213.85	-108.23	1456.70	-0.30	-486.95
	5	40.23	1875.75	-98.73	1726.43	-16.66	-632.85
	6	48.71	1628.70	-102.04	1628.38	-48.26	-842.04
Load	**1**	99.99	1775.57	94.21	808.17	-25.78	-1631.04
Factor	**2**	139.99	2485.80	131.89	1234.06	-36.10	-2349.72
Design	**3**	85.18	4076.77	0.61	2035.51	-17.19	-1519.47
	4	48.74	1699.39	-151.52	2158.48	-0.41	-695.00
	5	77.10	3616.60	8.98	3162.67	-38.86	-1344.42
	6	96.32	3038.82	1.25	2809.96	-112.59	-1833.32

Column 3 (Right Column, looking upstation)

	Load Case	Fx (kip)	Fy (kip)	Fz (kip)	Mx (kip·ft)	My (kip·ft)	Mz (kip·ft)
Service Load Design	**1**	128.36	1317.49	81.60	537.77	31.63	-2172.36
	2	115.88	1805.16	83.79	554.82	44.23	-1881.57
	3	54.97	646.86	-117.70	1119.95	-87.35	-960.01
	4	71.04	1509.49	-108.31	1507.92	5.17	-1245.89
	5	54.97	646.86	-117.70	1119.95	-87.35	-960.01
	6	128.36	1317.49	81.60	537.77	31.63	-2172.36
Load Factor Design	**1**	179.71	1844.49	114.25	801.12	44.28	-3105.76
	2	140.43	3348.09	-11.77	1641.06	37.33	-2643.76
	3	76.96	905.61	-164.79	1614.01	-122.29	-1357.69
	4	131.09	2960.92	-7.51	2723.67	96.38	-2428.91
	5	76.96	905.61	-164.79	1614.01	-122.29	-1357.69
	6	169.53	2209.34	-16.88	1489.79	7.84	-3307.01

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STRUCTURE PLANS

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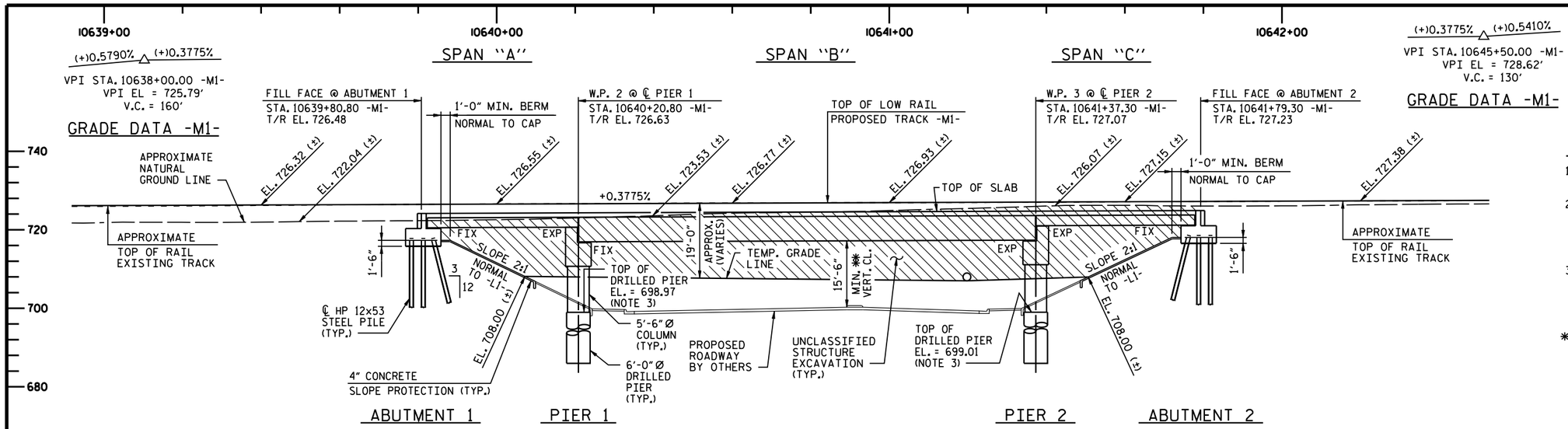


SECTION ALONG ℄ -M1-

(ABUTMENT AND PIER SECTIONS AT RIGHT ANGLES TO ABUTMENTS AND PIERS)

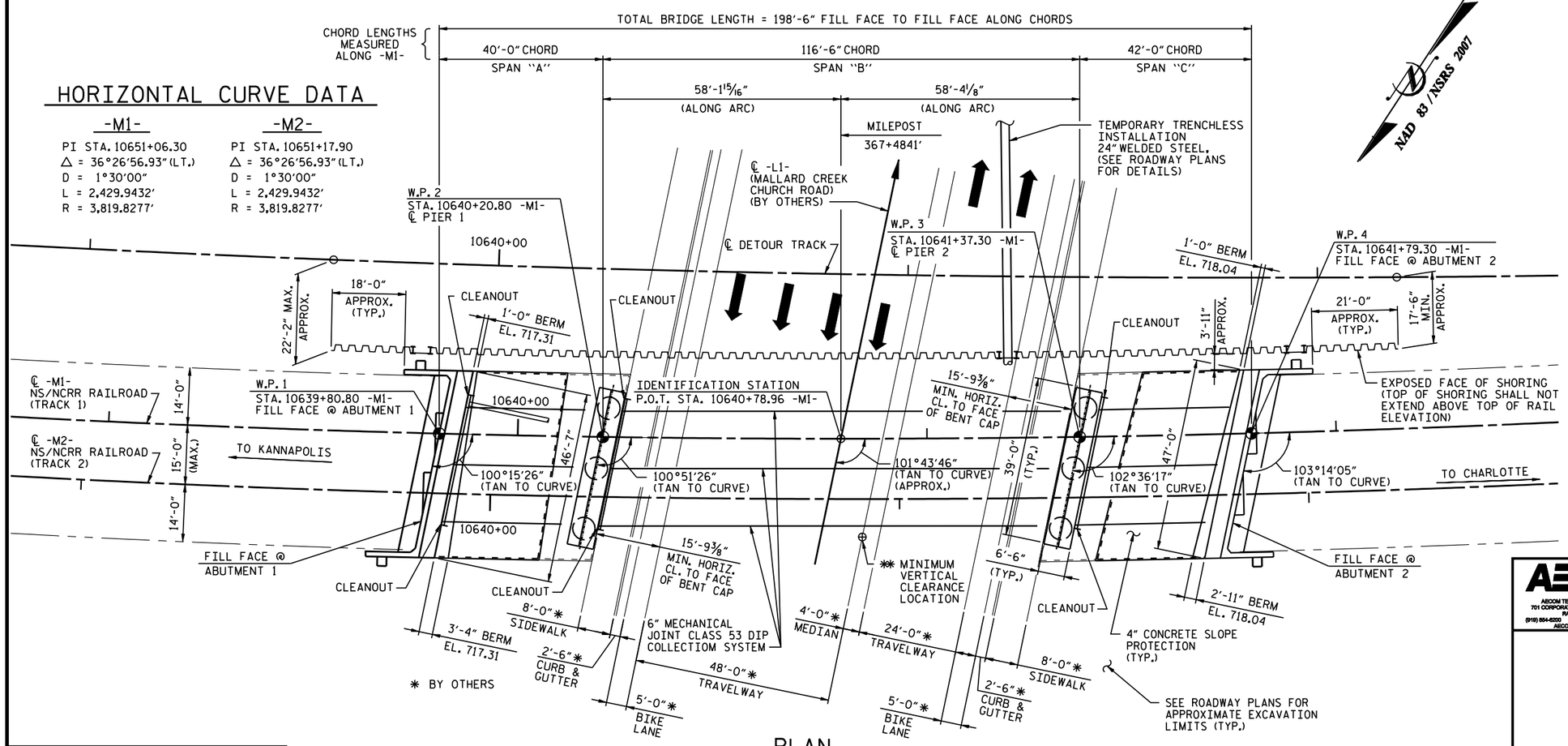
NOTES:

1. SEE "GENERAL DRAWING - LONG CHORD LAYOUT (SHEET 3 OF 4)" FOR GENERAL NOTES.
2. DESIGN SPEED:
   - 50 MPH FOR FREIGHT
   - 60 MPH FOR INTERMODAL
   - 80 MPH FOR PASSENGER
   - 90 MPH FOR FUTURE PASSENGER
3. THESE ELEVATIONS ARE AT THE CENTER DRILLED PIERS. FOR ELEVATIONS AT OTHER DRILLED PIERS, SEE SHEETS "SUBSTRUCTURE - PIER 1" AND "SUBSTRUCTURE - PIER 2".

** CONTROL POINT FOR ULTIMATE MINIMUM VERTICAL CLEARANCE OF 15'-6" OCCURS AT EXTERIOR GIRDER ON NORTH SIDE.

HORIZONTAL CURVE DATA

-M1-	-M2-
PI STA. 10651+06.30	PI STA. 10651+17.90
Δ = 36°26'56.93" (LT.)	Δ = 36°26'56.93" (LT.)
D = 1°30'00"	D = 1°30'00"
L = 2,429.9432'	L = 2,429.9432'
R = 3,819.8277'	R = 3,819.8277'



PLAN

(ABUTMENT PILES NOT SHOWN FOR CLARITY)

PRELIMINARY PLANS
DO NOT USE FOR CONSTRUCTION

MILEPOST 367+4841'

PROJECT NO. P-5208G
MECKLENBURG COUNTY
STATION: P.O.T. 10640+78.96 -M1-

SHEET 1 OF 5

AECOM
AECOM TECHNICAL SERVICES, INC.
701 CORPORATE CENTER DRIVE, SUITE 475
RALEIGH, NC 27607
(919) 854-6200 www.aecom.com
AECOM License No. F-0342

STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION
RALEIGH

GENERAL DRAWING
FOR NS/NCRR RAILROAD
BRIDGE OVER MALLARD
CREEK CHURCH ROAD

REVISIONS							SHEET NO.
NO.	BY:	DATE:	NO.	BY:	DATE:		S-01
1			3				TOTAL SHEETS
2			4				

DRAWN BY : MTB DATE : 01/13
CHECKED BY : JL DATE : 01/13

DATE: 1/25/2013
TIME: 10:38:49 AM

USER: lowerjw
DGN: G:\60258594\400_Tech_Info_Dsc_Files\450_NCDOT Staff Inh Dsc Files\Structures\V12_PlanEle.dgn

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STRUCTURE SUBSURFACE INVESTIGATION

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PROJECT: 50000.1.STR11T1B ID: P-5208G

STATE	STATE PROJECT REFERENCE NO.	SHEET NO.	TOTAL SHEETS
N.C.	50000.1.STR11T1B (P-5208G)	1	21

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

STRUCTURE SUBSURFACE INVESTIGATION

PROJ. REFERENCE NO. 50000.1.STR11T1B (P-5208G) F.A. PROJ. N/A

COUNTY MECKLENBERG

PROJECT DESCRIPTION MILLBROOK (MP 365.5) TO JUNKER (MP 372.2) ON THE NCRR/NS MAINLINE

SITE DESCRIPTION BRIDGE ON NCRR/NS MAINLINE OVER FUTURE MALLARD CREEK CHURCH ROAD

CONTENTS

SHEET	DESCRIPTION
1	TITLE SHEET
2	LEGEND
3	SITE PLANS
4	PROFILE
5-8	CROSS SECTIONS
9-18	BORE LOG, CORE REPORTS & CORE PHOTOGRAPHS
19	ROCK CORE TEST RESULTS
20	LABORATORY SUMMARY SHEET
21	SITE PHOTOGRAPHS

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) 250-4088. NEITHER THE SUBSURFACE PLANS AND REPORTS, NOR THE FIELD BORING LOGS, ROCK CORES, OR SOIL TEST DATA ARE PART OF THE CONTRACT.

GENERAL SOIL AND ROCK STRATA DESCRIPTIONS AND INDICATED BOUNDARIES ARE BASED ON A GEOTECHNICAL INTERPRETATION OF ALL AVAILABLE SUBSURFACE DATA AND MAY NOT NECESSARILY REFLECT THE ACTUAL SUBSURFACE CONDITIONS BETWEEN BORINGS OR BETWEEN SAMPLED STRATA WITHIN THE BOREHOLE. THE LABORATORY SAMPLE DATA AND THE IN SITU (IN-PLACE) TEST DATA CAN BE RELIED ON ONLY TO THE DEGREE OF RELIABILITY INHERENT IN THE STANDARD TEST METHOD. THE OBSERVED WATER LEVELS OR SOIL MOISTURE CONDITIONS INDICATED IN THE SUBSURFACE INVESTIGATIONS ARE AS RECORDED AT THE TIME OF THE INVESTIGATION. THESE WATER LEVELS OR SOIL MOISTURE CONDITIONS MAY VARY CONSIDERABLY WITH TIME ACCORDING TO CLIMATIC CONDITIONS INCLUDING TEMPERATURES, PRECIPITATION, AND WIND, AS WELL AS OTHER NON-CLIMATIC FACTORS.

THE BIDDER OR CONTRACTOR IS CAUTIONED THAT DETAILS SHOWN ON THE SUBSURFACE PLANS ARE PRELIMINARY ONLY AND IN MANY CASES THE FINAL DESIGN DETAILS ARE DIFFERENT. FOR BIDDING AND CONSTRUCTION PURPOSES, REFER TO THE CONSTRUCTION PLANS AND DOCUMENTS FOR FINAL DESIGN INFORMATION ON THIS PROJECT. THE DEPARTMENT DOES NOT WARRANT OR GUARANTEE THE SUFFICIENCY OR ACCURACY OF THE INVESTIGATION MADE, NOR THE INTERPRETATIONS MADE, OR OPINION OF THE DEPARTMENT AS TO THE TYPE OF MATERIALS AND CONDITIONS TO BE ENCOUNTERED. THE BIDDER OR CONTRACTOR IS CAUTIONED TO MAKE SUCH INDEPENDENT SUBSURFACE INVESTIGATIONS AS HE DEEMS NECESSARY TO SATISFY HIMSELF AS TO CONDITIONS TO BE ENCOUNTERED ON THIS PROJECT. THE CONTRACTOR SHALL HAVE NO CLAIM FOR ADDITIONAL COMPENSATION OR FOR AN EXTENSION OF TIME FOR ANY REASON RESULTING FROM THE ACTUAL CONDITIONS ENCOUNTERED AT THE SITE DIFFERING FROM THOSE INDICATED IN THE SUBSURFACE INFORMATION.

PERSONNEL

R. TOOTHMAN
G. LOWDERMILK
J. FREGOSI
W. FELDER
M. FIORA
S. GOWER

INVESTIGATED BY T. WELLS
CHECKED BY R. WELLS
SUBMITTED BY KLEINFELDER
DATE APRIL 2013

NORTH CAROLINA PROFESSIONAL SEAL 37998 ENGINEER THOMAS R. WELLS
4/29/13

DRAWN BY: W. FELDER

NOTE - THE INFORMATION CONTAINED HEREIN IS NOT IMPLIED OR GUARANTEED BY THE N.C. DEPARTMENT OF TRANSPORTATION AS BEING ACCURATE NOR IT IS CONSIDERED TO BE PART OF THE PLANS, SPECIFICATIONS, OR CONTRACT FOR THE PROJECT.

NOTE - BY HAVING REQUESTED THIS INFORMATION THE CONTRACTOR SPECIFICALLY WAIVES ANY CLAIMS FOR INCREASED COMPENSATION OR EXTENSION OF TIME BASED ON DIFFERENCES BETWEEN THE CONDITIONS INDICATED HEREIN AND THE ACTUAL CONDITIONS AT THE PROJECT SITE.

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PROJECT REFERENCE NO.	SHEET NO.
50000.1.STRI1TIB (P-5208G)	2 OF 20

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
GEOTECHNICAL ENGINEERING UNIT

SUBSURFACE INVESTIGATION

SOIL AND ROCK LEGEND, TERMS, SYMBOLS, AND ABBREVIATIONS

SOIL DESCRIPTION

SOIL IS CONSIDERED TO BE THE 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 STANDARD PENETRATION TEST (AASHTO T206, ASTM D-1586). SOIL CLASSIFICATION IS BASED ON THE AASHTO SYSTEM. BASIC DESCRIPTIONS GENERALLY SHALL INCLUDE: CONSISTENCY, COLOR, TEXTURE, MOISTURE, AASHTO CLASSIFICATION, AND OTHER PERTINENT FACTORS SUCH AS MINERALOGICAL COMPOSITION, ANGULARITY, STRUCTURE, PLASTICITY, ETC. 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	50 MX											GRANULAR SOILS	SILT-CLAY SOILS	MUCK, PEAT
# 40	30 MX	50 MX	51 MN											
# 200	15 MX	25 MX	10 MX	35 MX	35 MX	35 MX	35 MX	36 MN	36 MN	36 MN	36 MN			
LIQUID LIMIT	6 MX		NP	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	40 MX	41 MN	SOILS WITH LITTLE OR MODERATE AMOUNTS OF ORGANIC MATTER		HIGHLY ORGANIC SOILS
PLASTIC INDEX				10 MX	10 MX	11 MN	11 MN	10 MX	10 MX	11 MN	11 MN			
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 A 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 RESISTENCE (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 0.50 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
GRAIN SIZE 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	- MOIST - (M)	SOLID; AT OR NEAR OPTIMUM MOISTURE
SL — SHRINKAGE LIMIT	- DRY - (D)	REQUIRES ADDITIONAL WATER TO ATTAIN OPTIMUM MOISTURE

PLASTICITY

	PLASTICITY INDEX (PI)	DRY STRENGTH
NONPLASTIC	0-5	VERY LOW
LOW PLASTICITY	6-15	SLIGHT
MED. PLASTICITY	16-25	MEDIUM
HIGH PLASTICITY	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.
UNIFORM - INDICATES THAT SOIL PARTICLES ARE ALL APPROXIMATELY THE SAME SIZE. (ALSO POORLY GRADED)
GAP-GRADED - INDICATES A MIXTURE OF UNIFORM PARTICLES 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 WHENEVER THEY ARE CONSIDERED OF SIGNIFICANCE.

COMPRESSIBILITY

SLIGHTLY COMPRESSIBLE	LIQUID LIMIT LESS THAN 31
MODERATELY COMPRESSIBLE	LIQUID LIMIT EQUAL TO 31-50
HIGHLY COMPRESSIBLE	LIQUID LIMIT GREATER THAN 50

PERCENTAGE OF MATERIAL

ORGANIC MATERIAL	GRANULAR SOILS	SILT - CLAY SOILS
TRACE OF ORGANIC MATTER	2 - 3%	3 - 5%
LITTLE ORGANIC MATTER	3 - 5%	5 - 12%
MODERATELY ORGANIC	5 - 10%	12 - 20%
HIGHLY ORGANIC	>10%	>20%

OTHER MATERIAL	
TRACE	1 - 10%
LITTLE	10 - 20%
SOME	20 - 35%
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 W/ CORE
- SPT N-VALUE
- REF SPT REFUSAL

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] MOBILE B-57
- [ ] BK-51
- [ ] CME-45C
- [ ] CME-550
- [ ] PORTABLE HOIST
- [X] CME-55
- [ ] _____

ADVANCING TOOLS:
- [ ] CLAY BITS
- [ ] 6" CONTINUOUS FLIGHT AUGER
- [X] 8" HOLLOW AUGERS
- [ ] HARD FACED FINGER BITS
- [ ] TUNG.-CARBIDE INSERTS
- [X] CASING [ ] W/ ADVANCER
- [ ] TRICONE ____" STEEL TEETH
- [X] TRICONE 3 7/8" " TUNG.-CARB.
- [X] CORE BIT
- [ ] _____

HAMMER TYPE:
- [X] AUTOMATIC [ ] MANUAL

CORE SIZE:
- [ ] -B_____
- [X] -N 0
- [ ] -H_____

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

ROCK DESCRIPTION

HARD ROCK IS NON-COASTAL PLAIN MATERIAL THAT IF TESTED, WOULD YIELD SPT REFUSAL. 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, YIELDS SPT N VALUES > 100 BPF*
VERY SEVERE (V SEV.)	ALL ROCK EXCEPT QUARTZ DISCOLORED OR STAINED. ROCK FABRIC ELEMENTS ARE DISCERNIBLE BUT THE MASS IS EFFECTIVELY REDUCED TO SOIL STATUS, WITH ONLY FRAGMENTS OF STRONG ROCK REMAINING. SAPROLITE IS AN EXAMPLE OF ROCK WEATHERED TO A DEGREE SUCH THAT ONLY MINOR VESTIGES OF THE ORIGINAL ROCK FABRIC REMAIN. *IF TESTED, YIELDS 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 FEET
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 THE 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. 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: BM-107 (571705 FT N, 1487615 FT E)

ELEVATION: 729.21

NOTES: FIAD - FILLED IN AFTER DRILLING

REVISED 09/23/09

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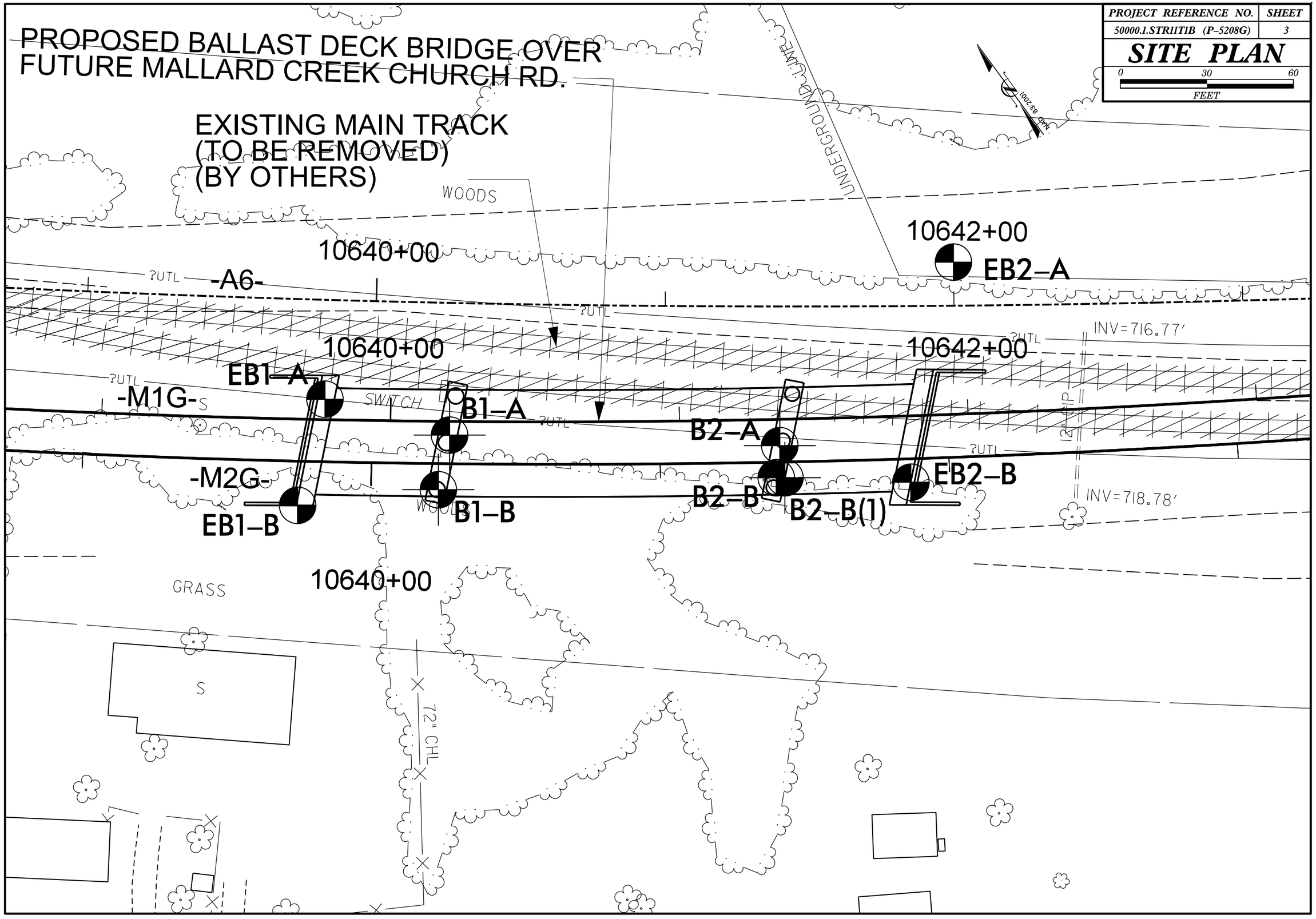

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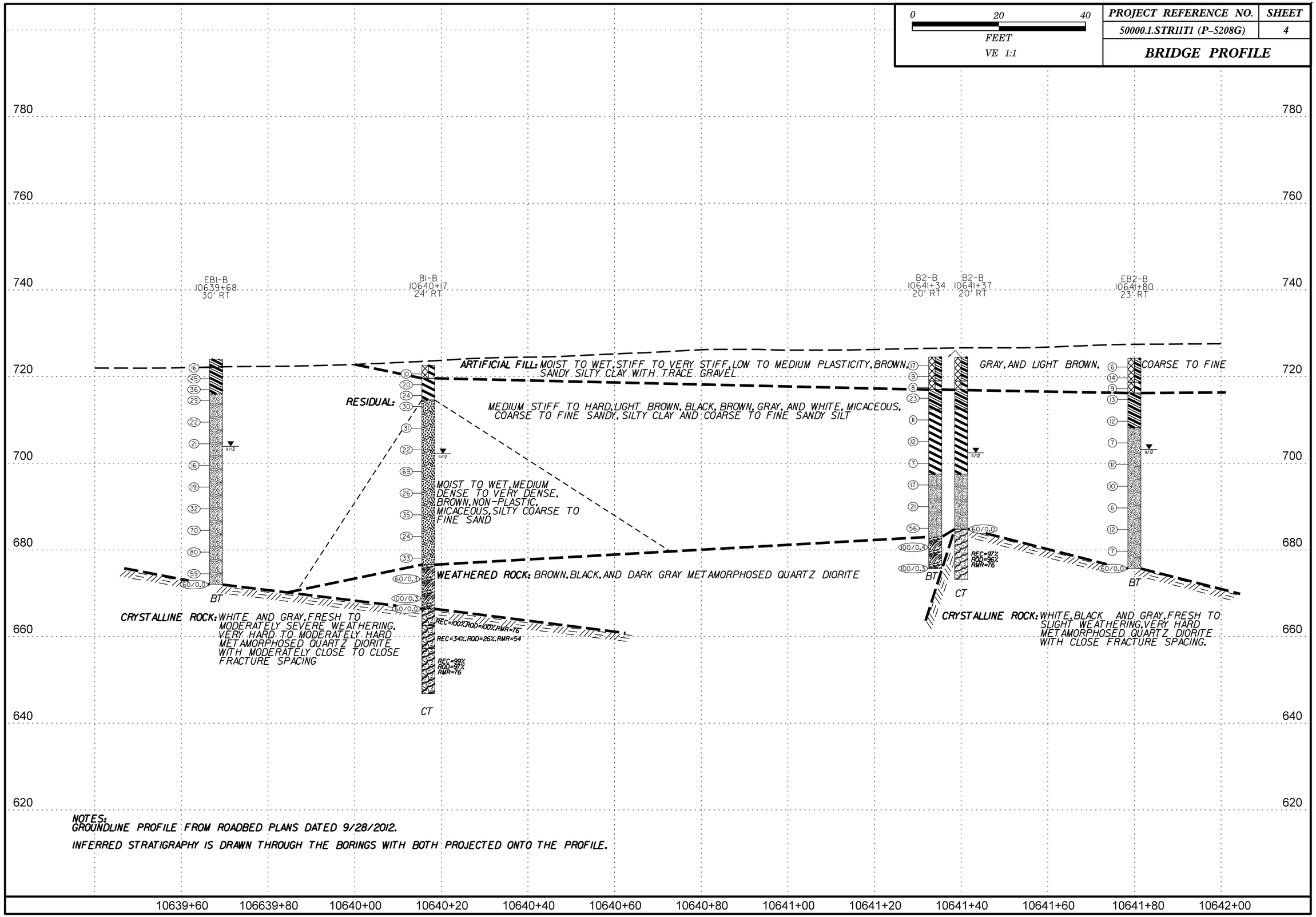
PROJECT REFERENCE NO.	SHEET
50000.1.STR11T1 (P-5208G)	4

BRIDGE PROFILE



NOTES:
GROUNDLINE PROFILE FROM ROADBED PLANS DATED 9/28/2012.
INFERRED STRATIGRAPHY IS DRAWN THROUGH THE BORINGS WITH BOTH PROJECTED ONTO THE PROFILE.

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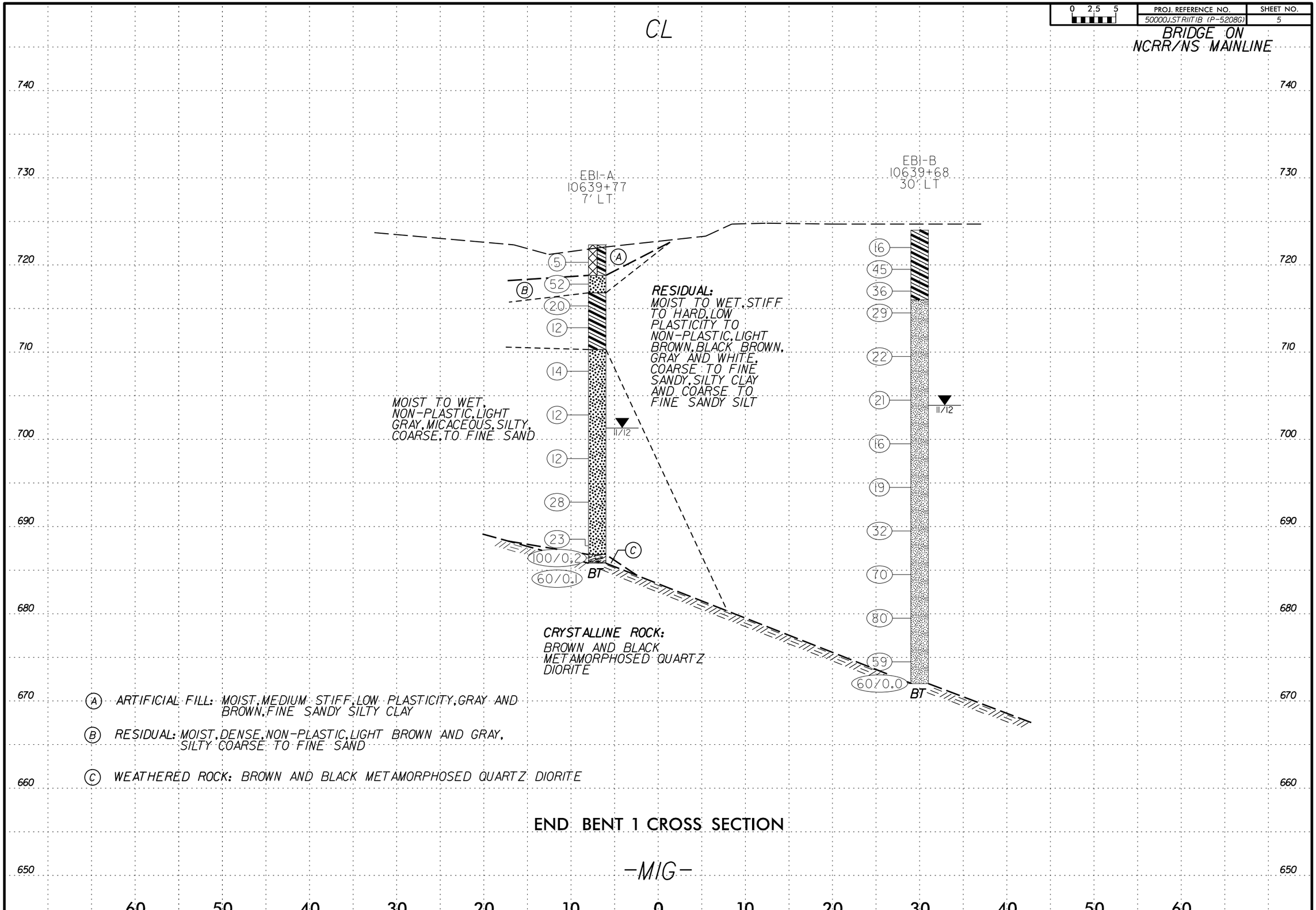
PROJ. REFERENCE NO.	SHEET NO.
50000J.STRUTIB (P-5208G)	5

BRIDGE ON
NCRR/NS MAINLINE



(A) ARTIFICIAL FILL: MOIST, MEDIUM STIFF, LOW PLASTICITY, GRAY AND BROWN, FINE SANDY SILTY CLAY

(B) RESIDUAL: MOIST, DENSE, NON-PLASTIC, LIGHT BROWN AND GRAY, SILTY COARSE TO FINE SAND

(C) WEATHERED ROCK: BROWN AND BLACK METAMORPHOSED QUARTZ DIORITE

END BENT 1 CROSS SECTION

-MIG-

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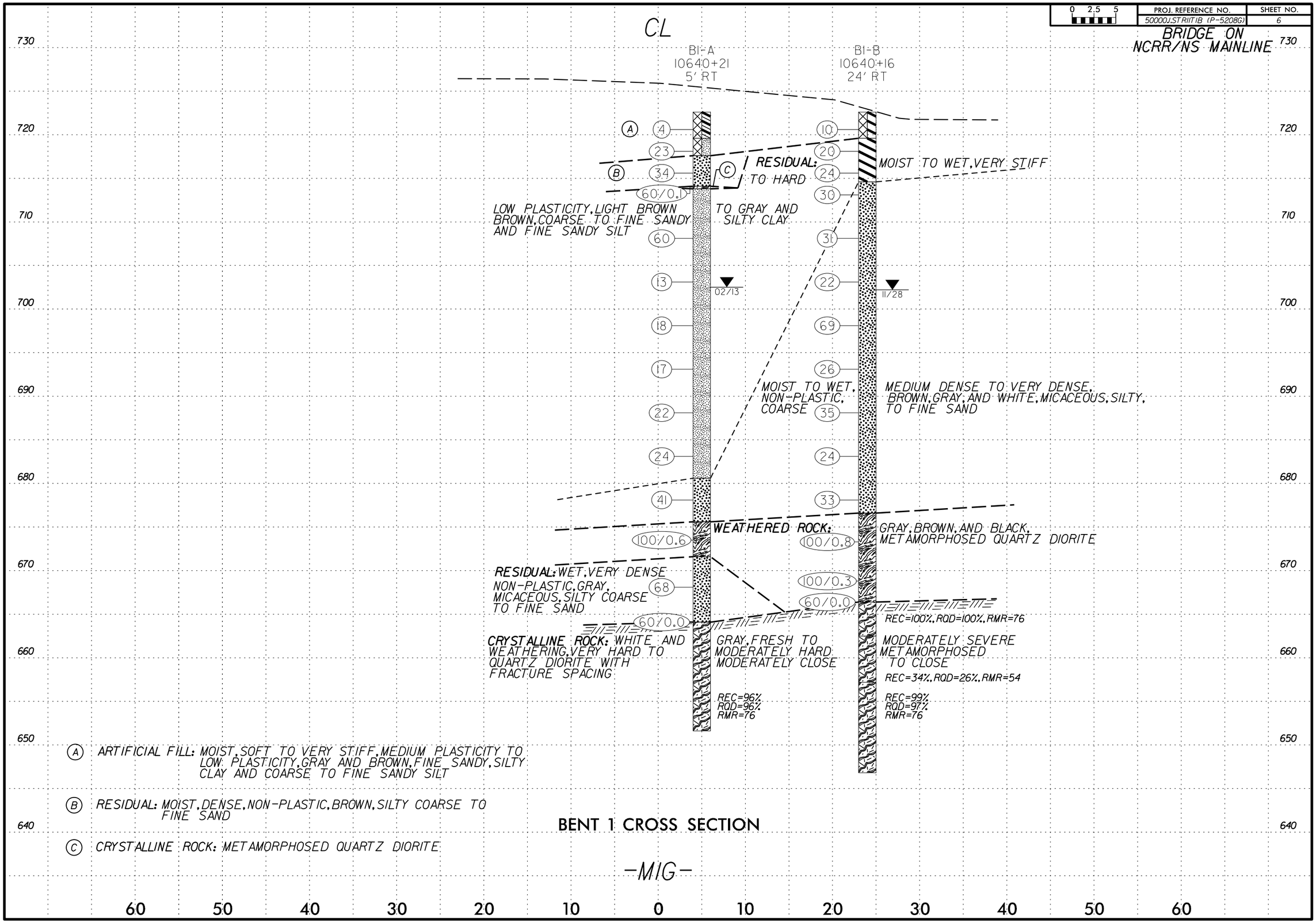
PROJ. REFERENCE NO.	SHEET NO.
50000J.STRIITIB (P-5208G)	6

0 2.5 5

BRIDGE ON NCRR/NS MAINLINE



(A) ARTIFICIAL FILL: MOIST, SOFT TO VERY STIFF, MEDIUM PLASTICITY TO LOW PLASTICITY, GRAY AND BROWN, FINE SANDY, SILTY CLAY AND COARSE TO FINE SANDY SILT

(B) RESIDUAL: MOIST, DENSE, NON-PLASTIC, BROWN, SILTY COARSE TO FINE SAND

(C) CRYSTALLINE ROCK: METAMORPHOSED QUARTZ DIORITE

BENT 1 CROSS SECTION

-MIG-

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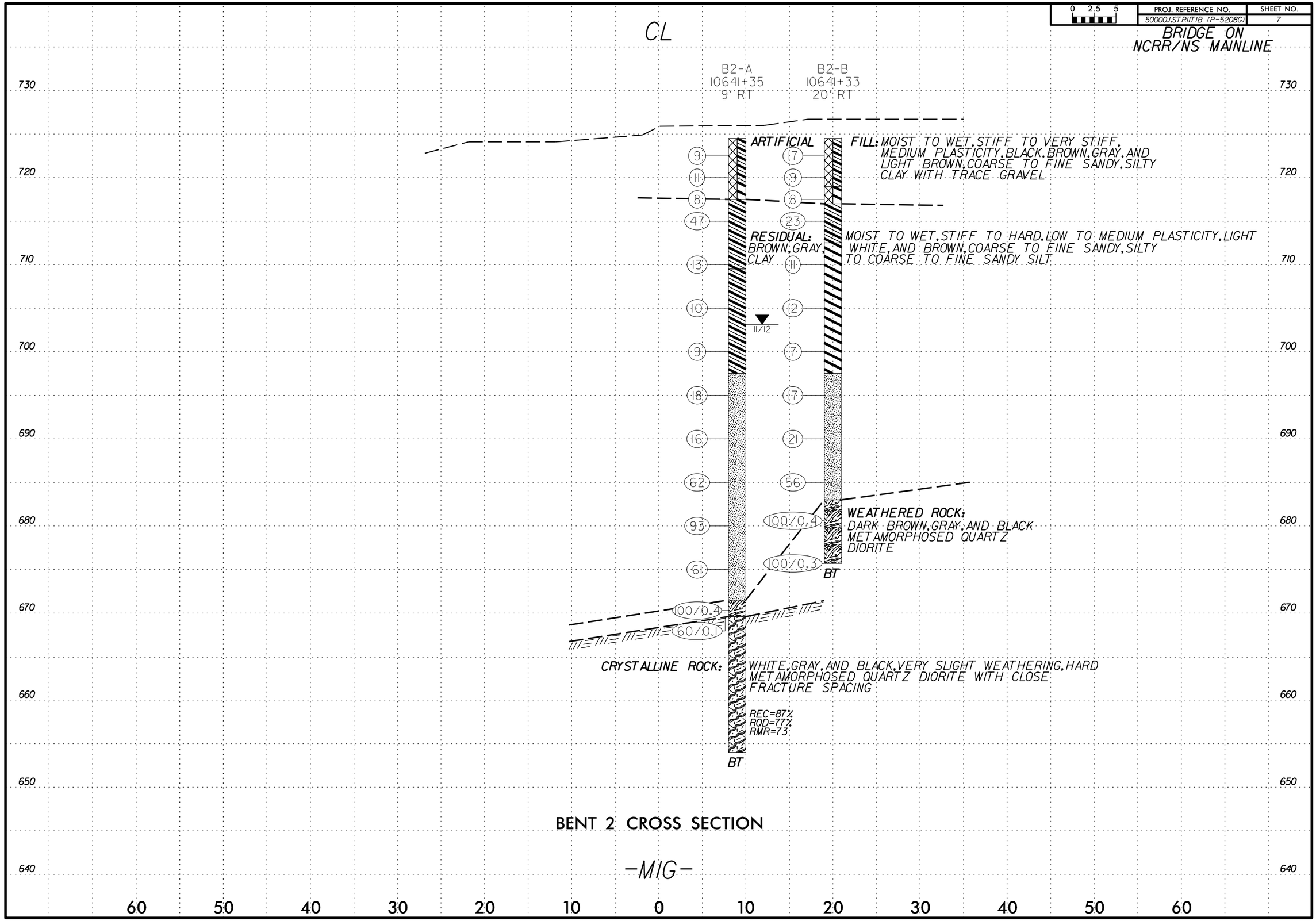
0 2.5 5	PROJ. REFERENCE NO.	SHEET NO.
	50000J.STRUTIB (P-5208G)	7

BRIDGE ON
NCRR/NS MAINLINE



BENT 2 CROSS SECTION

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0 2.5 5	PROJ. REFERENCE NO.	SHEET NO.
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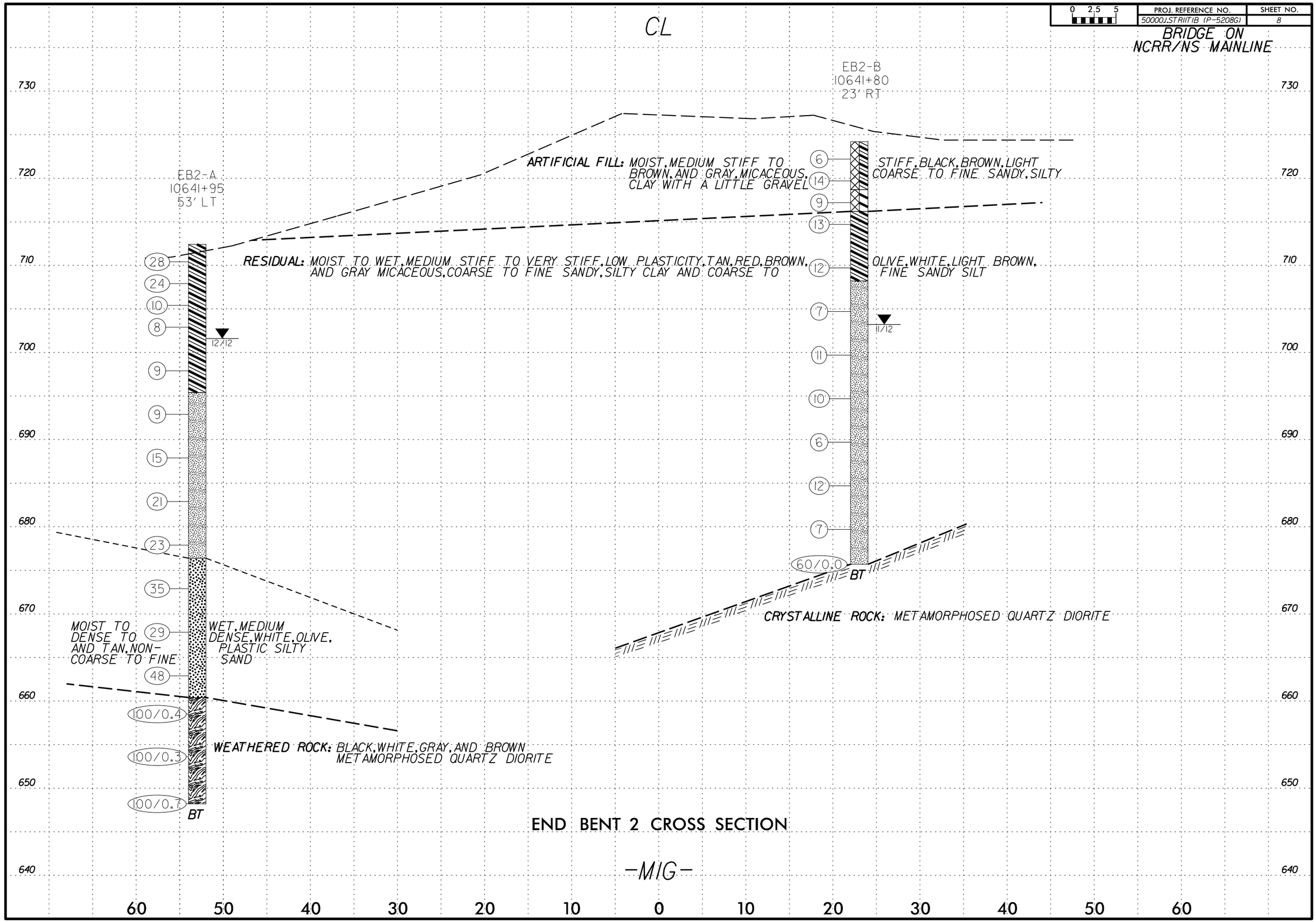
BRIDGE ON
NCRR/NS MAINLINE



END BENT 2 CROSS SECTION

-MIG-

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR11T1B	TIP P-5208G	COUNTY MECKLENBURG	GEOLOGIST Fiora, M. E.	
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road				GROUND WTR (ft)
BORING NO. EB1-A	STATION 10639+77	OFFSET 7 ft LT	ALIGNMENT M1G	0 HR. 21.3
COLLAR ELEV. 722.3 ft	TOTAL DEPTH 36.5 ft	NORTHING 571,537	EASTING 1,487,542	24 HR. 21.0
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic	
DRILLER Toothman, R. E.	START DATE 11/14/12	COMP. DATE 11/14/12	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)
725											
										722.3 GROUND SURFACE	0.0
720	721.3	1.0	1	2	3	5	SS-1	23%		**ARTIFICIAL FILL (ENGINEERED)** Gray and Brown, Fine Sandy, Silty CLAY	
	718.8	3.5	7	17	35	52		M		718.8 **RESIDUAL**	3.5
715	716.3	6.0	7	9	11	20		M		716.8 Light Brown and Gray, Silty, Coarse to Fine SAND	5.5
	713.8	8.5	4	5	7	12		M		Light Brown, Coarse to Fine Sandy, Silty CLAY	
710	708.8	13.5	4	6	8	14		M		710.3 Light Gray, Micaceous, Silty Coarse to Fine SAND	12.0
705	703.8	18.5	3	5	7	12					
700	698.8	23.5	4	5	7	12		W			
695	693.8	28.5	5	6	22	28		W			
690	688.8	33.5	7	10	13	23		W		686.8 **WEATHERED ROCK** Brown and Black METAMORPHOSED QUARTZ DIORITE	35.5
	686.6	35.7	100/0.2			100/0.2				685.9 **CRYSTALLINE ROCK** Brown and Black METAMORPHOSED QUARTZ DIORITE	36.4
	685.9	36.4	60/0.1			60/0.1				685.8 Boring Terminated with Standard Penetration Test Refusal at Elevation 685.8 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	36.5

WBS 50000.1.STR11T1B	TIP P-5208G	COUNTY MECKLENBURG	GEOLOGIST Wells, T. R.	
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road				GROUND WTR (ft)
BORING NO. EB1-B	STATION 10639+68	OFFSET 30 ft RT	ALIGNMENT M1G	0 HR. 20.6
COLLAR ELEV. 724.0 ft	TOTAL DEPTH 52.0 ft	NORTHING 571,573	EASTING 1,487,530	24 HR. 20.1
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic	
DRILLER Toothman, R. E.	START DATE 11/26/12	COMP. DATE 11/26/12	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
725										
										724.0 GROUND SURFACE 0.0
	723.0	1.0	5	8	8	16		M		**RESIDUAL** Brown to Light Brown, Coarse to Fine Sandy, Silty CLAY
720	720.5	3.5	5	14	31	45	SS-2	18%		
	718.0	6.0	12	14	22	36		M		716.0 8.0
715	715.5	8.5	8	19	10	29		M		Light Brown and Black to Brown, Gray, and White, Micaceous, Coarse to Fine Sandy SILT
710	710.5	13.5	8	10	12	22		M		
705	705.5	18.5	5	10	11	21				
700	700.5	23.5	14	8	8	16	SS-3	19%		
695	695.5	28.5	5	8	11	19		W		
690	690.5	33.5	11	13	19	32		W		
685	685.5	38.5	20	30	40	70		W		
680	680.5	43.5	9	32	48	80		W		
675	675.5	48.5	24	26	33	59		W		
	672.0	52.0	60/0.0			60/0.0				672.0 52.0 Boring Terminated with Standard Penetration Test Refusal at Elevation 672.0 ft on Crystalline Rock: METAMORPHOSED QUARTZ DIORITE

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NCDOT BORE DOUBLE 127855.GPJ NC_DOT.GDT 4/26/13

NCDOT GEOTECHNICAL ENGINEERING UNIT BORELOG REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B1-A	**STATION** 10640+21	**OFFSET** 5 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 722.6 ft	**TOTAL DEPTH** 71.0 ft	**NORTHING** 571,524	**EASTING** 1,487,499 — **24 HR.** 20.1
DRILL RIG/HAMMER EFF./DATE TRI8016 MOBILE B-57 94% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Gower, S. D.	**START DATE** 02/07/13	**COMP. DATE** 02/08/13	**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)
725											
										722.6 GROUND SURFACE	0.0
	721.6	1.0								**ARTIFICIAL FILL (ENGINEERED)** Gray, Fine Sandy, Silty CLAY	
720			2	2	2	4	SS-4	21%		719.6	3.0
	719.1	3.5	4	11	12	23		M		Brown, Coarse to Fine Sandy SILT	
										717.6	5.0
	716.6	6.0	12	16	18	34		M		**RESIDUAL** Brown, Silty Coarse to Fine SAND	
715										714.1	8.5
	714.1	8.5	60/0.1			60/0.1		M		713.8 **CRYSTALLINE ROCK** METAMORPHOSED QUARTZ DIORITE	8.8
710										**RESIDUAL** Brown, White, and Gray, Coarse to Fine Sandy SILT	
	709.1	13.5	5	7	53	60	SS-5	12%			
705											
	704.1	18.5	3	6	7	13					
700											
	699.1	23.5	5	8	10	18		W			
695											
	694.1	28.5	6	7	10	17		W			
690											
	689.1	33.5	6	10	12	22		W			
685											
	684.1	38.5	7	11	13	24		W			
680										680.6 Gray, Micaceous, Silty Coarse to Fine SAND	42.0
	679.1	43.5	12	20	21	41	SS-6	16%			
675										675.6 **WEATHERED ROCK** Gray METAMORPHOSED QUARTZ DIORITE	47.0
	674.1	48.5	31	69/0.1		100/0.6				671.6	51.0
670										**RESIDUAL** Gray, Micaceous, Silty Coarse to Fine SAND	
	669.1	53.5	21	30	38	68		W			
665										664.1	58.5
	664.1	58.5	60/0.0			60/0.0				**CRYSTALLINE ROCK** White, Black, and Gray METAMORPHOSED QUARTZ DIORITE	
660											
655											
										651.6	71.0
										Boring Terminated at Elevation 651.6 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	

NCDOT BORE DOUBLE 127855.GPJ NC_DOT.GDT 4/26/13

NCDOT GEOTECHNICAL ENGINEERING UNIT CORE BORING REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B1-A	**STATION** 10640+21	**OFFSET** 5 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 722.6 ft	**TOTAL DEPTH** 71.0 ft	**NORTHING** 571,524	**EASTING** 1,487,499 — **24 HR.** 20.1
DRILL RIG/HAMMER EFF./DATE TRI8016 MOBILE B-57 94% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Gower, S. D.	**START DATE** 02/07/13	**COMP. DATE** 02/08/13	**SURFACE WATER DEPTH** N/A
CORE SIZE NQ	**TOTAL RUN** 12.8 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS — ELEV. (ft)	DEPTH (ft)
714.1											Begin Coring @ 8.5 ft	
	714.1 / 713.8	8.5 / 8.8	0.3	0:43/0.3 N=60/0.1 0:43/0.3	(0.0) 0%	(0.0) 0%		(0.0) 0%	(0.0) 0%		714.1 / 713.8 **CRYSTALLINE ROCK** METAMORPHOSED QUARTZ DIORITE	8.5 / 8.8
710											**RESIDUAL** Brown, White, and Gray, Coarse to Fine Sandy SILT	
				N=60			SS-5					
705												
				N=13								
700												
				N=18								
695												
				N=17								
690												
				N=22								
685												
				N=24								
680											680.6 Gray, Micaceous, Silty Coarse to Fine SAND	42.0
				N=41			SS-6					
675											675.6 **WEATHERED ROCK** Gray METAMORPHOSED QUARTZ DIORITE	47.0
				N=100/0.6							671.6	51.0
670											**RESIDUAL** Gray, Micaceous, Silty Coarse to Fine SAND	
				N=68								
665											664.1	58.5
	664.1	58.5	2.5	N=60/0.0 7:40/1.0 5:02/1.0	(2.0) 80%	(2.0) 80%		(12.0) 96%	(12.0) 96%		**CRYSTALLINE ROCK** White, Black, and Gray, Very Slight Weathering, Hard METAMORPHOSED QUARTZ DIORITE with Moderately Close Fracture Sacing	
	661.6	61.0	5.0	2:41/0.5 5:21/1.0 5:06/1.0 4:22/1.0 4:13/1.0 4:52/1.0	(5.0) 100%	(5.0) 100%					2 Fractures at 60 Degrees 1 Fracture at 45 Degrees 2 Fractures at 30 Degrees	
660												
	656.6	66.0	5.0	3:26/1.0 4:02/1.0 3:47/1.0 3:36/1.0 3:49/1.0	(5.0) 100%	(5.0) 100%						
655												
	651.6	71.0									651.6	71.0
											Boring Terminated at Elevation 651.6 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	

NCDOT CORE SINGLE 127855.GPJ NC_DOT.GDT 4/26/13

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CORE PHOTOGRAPHS

B1-A

BOXES 1 and 2: 58.5 - 71.0 FEET

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 10640+17	**OFFSET** 24 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 722.6 ft	**TOTAL DEPTH** 75.8 ft	**NORTHING** 571,542	**EASTING** 1,487,492 — **24 HR.** 20.4
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/26/12	**COMP. DATE** 11/27/12	**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)
730											
725										722.6 GROUND SURFACE	0.0
	721.6	1.0	6	4	6	10		M		**ARTIFICIAL FILL (ENGINEERED)** Brown, Fine Sandy, Silty CLAY	
720	719.1	3.5	7	7	13	20		M		719.6 **RESIDUAL** Light Brown to Gray, Coarse to Fine Sandy, Silty CLAY	3.0
	716.6	6.0	5	11	13	24	SS-7	36%			
715	714.1	8.5	10	13	17	30		M		714.6 Brown, Gray, and White, Micaceous, Silty Coarse to Fine SAND	8.0
710	709.1	13.5	17	15	16	31		M			
705	704.1	18.5	9	10	12	22					
700	699.1	23.5	7	9	60	69		M			
695	694.1	28.5	10	12	14	26		W			
690	689.1	33.5	13	15	20	35		W			
685	684.1	38.5	10	11	13	24		W			
680	679.1	43.5	10	15	18	33		W			
675	674.1	48.5	71	39/0.3						676.6 **WEATHERED ROCK** Brown and Black METAMORPHOSED QUARTZ DIORITE	46.0
670	669.1	53.5	100/0.3				100/0.8				
	666.4	56.2	60/0.0				100/0.3			666.4 **CRYSTALLINE ROCK** Gray and White METAMORPHOSED QUARTZ DIORITE	56.2
665							60/0.0				
660							RS-1			662.5 Gray and White METAMORPHOSED QUARTZ DIORITE	60.1
655										657.2 Gray and White METAMORPHOSED QUARTZ DIORITE	65.4
650											

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 10640+17	**OFFSET** 24 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 722.6 ft	**TOTAL DEPTH** 75.8 ft	**NORTHING** 571,542	**EASTING** 1,487,492 — **24 HR.** 20.4
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/26/12	**COMP. DATE** 11/27/12	**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	
650						Match Line				Gray and White METAMORPHOSED QUARTZ DIORITE *(continued)*	
										646.8 Boring Terminated at Elevation 646.8 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	75.8

NCDOT BORE DOUBLE 127855.GPJ NC_DOT.GDT 4/26/13

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NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B1-B	**STATION** 10640+17	**OFFSET** 24 ft RT	**ALIGNMENT** M1G	**0 HR.** N/A
COLLAR ELEV. 722.6 ft	**TOTAL DEPTH** 75.8 ft	**NORTHING** 571,542	**EASTING** 1,487,492	**24 HR.** 20.4
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/26/12	**COMP. DATE** 11/27/12	**SURFACE WATER DEPTH** N/A
CORE SIZE NQ	**TOTAL RUN** 19.6 ft		

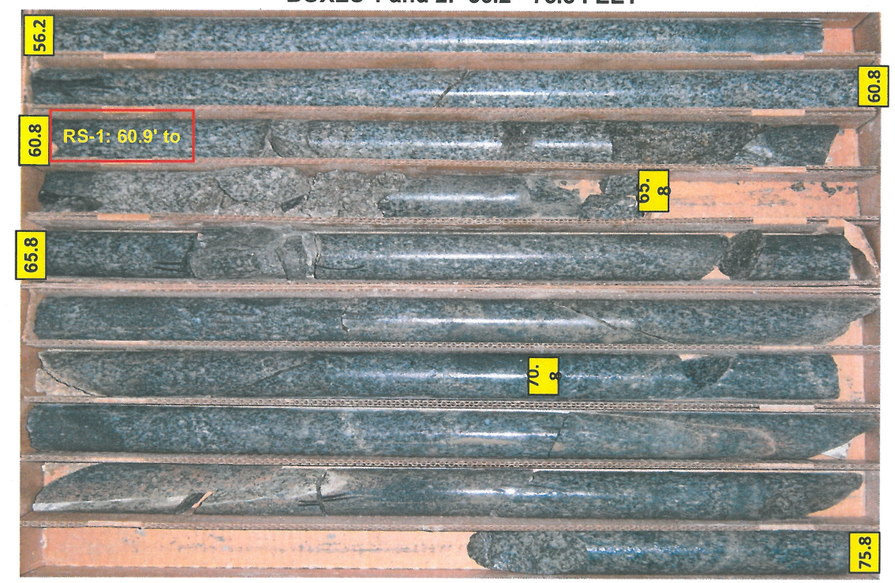
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS (ELEV. (ft) / DEPTH (ft))
666.4											Begin Coring @ 56.2 ft
665	666.4	56.2	4.6	N=60/0.0 4:10/0.6 8:30/1.0 10:32/1.0 5:19/1.0 3:10/1.0	(3.9) 85%	(3.9) 85%		(3.9) 100%	(3.9) 100%		666.4 / 56.2 **CRYSTALLINE ROCK** White and Gray, Fresh to Very Slight Weathering, Very Hard to Moderately Hard METAMORPHOSED QUARTZ DIORITE with Moderately Close Fracture Sacing
	661.8	60.8									662.5 / 60.1
660			5.0	4:15/1.0 2:50/1.0 4:09/1.0 2:55/1.0 6:25/1.0	(3.0) 60%	(1.3) 26%	RS-1	(1.8) 34%	(1.4) 26%		1 Fracture at 60 Degrees White and Gray, Moderate to Moderately Severe Weathering, Hard to Moderately Hard METAMORPHOSED QUARTZ DIORITE with Close Fracture Spacing
	656.8	65.8									657.2 / 65.4
655			5.0	5:25/1.0 4:24/1.0 5:50/1.0 4:15/1.0 5:25/1.0	(4.9) 98%	(4.7) 94%		(10.3) 99%	(10.1) 97%		3 Fracture at 75 Degrees 2 Fracture at 60 Degrees 1 Fracture at 45 Degrees
	651.8	70.8									R1=12, R2=8, R3=10, R4=20, R5=4, RMR = 54 ROCK CLASS III, ROCK TYPE E
650			5.0	4:35/1.0 5:43/1.0 5:50/1.0 5:49/1.0 7:15/1.0	(5.0) 100%	(5.0) 100%					White and Gray, Very Slight Weathering, Very Hard METAMORPHOSED QUARTZ DIORITE with Moderately Close Fracture Spacing
	646.8	75.8									646.8 / 75.8
											6 Fracture at 60 Degrees to 80 Degrees 1 Fracture at 45 Degrees 2 Fractures at 10 Degrees Some Soil Infilling in the Fracture at 69.9 feet Boring Terminated at Elevation 646.8 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE

NCDOT CORE DOUBLE 127855.GPJ NC_DOT.GDT 7/9/13

CORE PHOTOGRAPHS

B1-B

BOXES 1 and 2: 56.2 - 75.8 FEET



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FEET

NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fregosi, J. D.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B2-A	**STATION** 10641+35	**OFFSET** 9 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 724.5 ft	**TOTAL DEPTH** 70.5 ft	**NORTHING** 571,465	**EASTING** 1,487,401 — **24 HR.** 21.4
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/20/12	**COMP. DATE** 11/21/12	**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)
725										724.5 GROUND SURFACE	0.0
	723.5	1.0	6	5	4	9		M		**ARTIFICIAL FILL (ENGINEERED)** Brown and Brown, Coarse to Fine Sandy, Silty CLAY with Trace Gravel	
720	721.0	3.5	8	6	5	11		M		719.5	5.0
	718.5	6.0	3	3	5	8		M		717.5 Gray and Light Brown, Fine Sandy, Silty CLAY	7.0
715	716.0	8.5	9	22	25	47		M		**RESIDUAL** Light Brown, Coarse to Fine Sandy, Silty CLAY	
710	711.0	13.5	4	4	9	13		M		709.5	15.0
										Light Brown, Gray and White, Coarse to Fine Sandy, Silty CLAY	
705	706.0	18.5	4	4	6	10					
700	701.0	23.5	3	4	5	9	SS-8	31%		697.5	27.0
										Gray and White, Coarse to Fine Sandy SILT	
695	696.0	28.5	7	7	11	18		M			
690	691.0	33.5	6	7	9	16		M			
685	686.0	38.5	15	26	36	62		M			
680	681.0	43.5	35	40	53	93	SS-9	16%			
675	676.0	48.5	25	27	34	61		M			
	671.0	53.5								671.5	53.0
670	669.6	54.9	47 / 60/0.1	53/0.1		100/0.6 / 60/0.1				669.6 **WEATHERED ROCK** Dark Brown, Gray, and Black METAMORPHOSED QUARTZ DIORITE	54.9
										CRYSTALLINE ROCK White, Black, and Gray METAMORPHOSED QUARTZ DIORITE	
665											
660											
655										654.0	70.5
										Boring Terminated at Elevation 654.0 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	

NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fregosi, J. D.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B2-A	**STATION** 10641+35	**OFFSET** 9 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 724.5 ft	**TOTAL DEPTH** 70.5 ft	**NORTHING** 571,465	**EASTING** 1,487,401 — **24 HR.** 21.4
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/20/12	**COMP. DATE** 11/21/12	**SURFACE WATER DEPTH** N/A
CORE SIZE NQ	**TOTAL RUN** 15.7 ft		

ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS — ELEV. (ft)	DEPTH (ft)
669.6											Begin Coring @ 54.9 ft	
	669.0	55.5	5.0	N=60/0.1 4:49/1.0 4:12/1.0 4:38/1.0 6:45/1.0 7:30/1.0	(3.4) 68%	(2.1) 42%		(13.5) 87%	(12.0) 77%		669.6 **CRYSTALLINE ROCK** White, Gray, and Black, Very Slight Weathering, Hard METAMORPHOSED QUARTZ DIORITE with Close Fracture Spacing	54.9
665	664.0	60.5	5.0	4:34/1.0 3:51/1.0 4:28/1.0 4:22/1.0 4:03/1.0	(4.8) 96%	(4.8) 96%					1 Fracture at 60 Degrees 2 Fractures at 90 Degrees	
660	659.0	65.5	5.0	4:56/1.0 4:32/1.0 4:50/1.0 5:08/1.0 5:41/1.0	(5.0) 100%	(5.0) 100%						
655	654.0	70.5									654.0 Boring Terminated at Elevation 654.0 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	70.5

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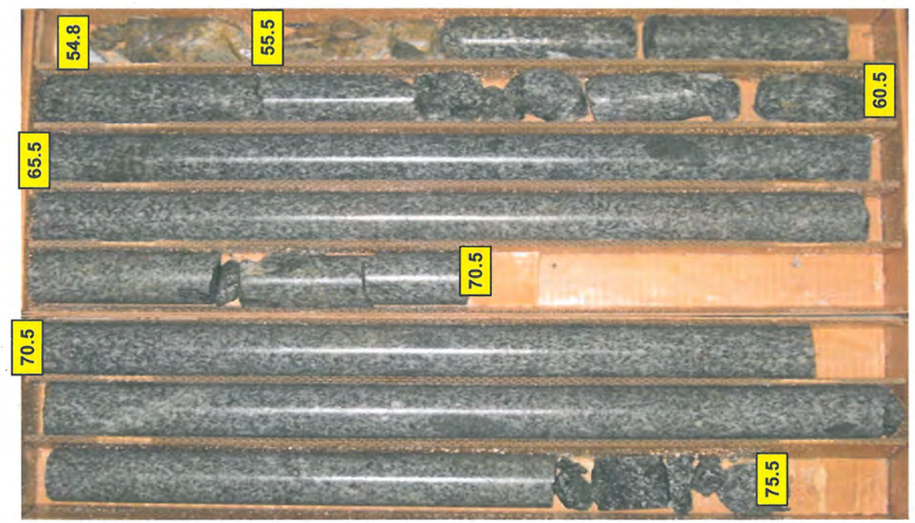
CORE PHOTOGRAPHS

B2-A

BOXES 1 and 2: 54.8 - 75.5 FEET



NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Wells, T. R.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B2-B	**STATION** 10641+34	**OFFSET** 20 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 724.5 ft	**TOTAL DEPTH** 48.8 ft	**NORTHING** 571,475	**EASTING** 1,487,396 — **24 HR.** FIAD
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** Mud Rotary	**HAMMER TYPE** Automatic
DRILLER Gower, S. D.	**START DATE** 11/15/12	**COMP. DATE** 11/15/12	**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)
725										724.5 GROUND SURFACE	0.0
	723.5	1.0	6	9	8	17	SS-10	13%		**ARTIFICIAL FILL (ENGINEERED)** Black and Brown, Coarse to Fine Sandy, Silty CLAY with Trace Gravel	
720	721.0	3.5	3	4	5	9		W		719.0 Gray and Brown, Fine Sandy, Silty CLAY	5.5
	718.5	6.0	3	4	4	8		M		717.0 **RESIDUAL** Light Brown, Coarse to Fine Sandy, Silty CLAY	7.5
715	716.0	8.5	8	8	15	23		M		712.5 Light Brown, Silty, Coarse to Fine Sandy CLAY	12.0
710	711.0	13.5	3	5	6	11		M			
705	706.0	18.5	4	5	7	12	SS-11	40%			
700	701.0	23.5	2	3	4	7		W		697.5 Gray and Brown, Coarse to Fine Sandy SILT	27.0
695	696.0	28.5	3	6	11	17		W			
690	691.0	33.5	10	9	12	21		W			
685	686.0	38.5	16	25	31	56		W		683.0 **WEATHERED ROCK** Dark Gray and Brown METAMORPHOSED QUARTZ DIORITE	41.5
680	681.0	43.5	100/0.4			100/0.4					
	676.0	48.5	100/0.3			100/0.3				675.7 Boring Terminated at Elevation 675.7 ft in Weathered Rock: METAMORPHOSED QUARTZ DIORITE	48.8

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B2-B(1)	**STATION** 10641+37	**OFFSET** 20 ft RT	**ALIGNMENT** M1G — **0 HR.** N/A
COLLAR ELEV. 724.5 ft	**TOTAL DEPTH** 51.3 ft	**NORTHING** 571,476	**EASTING** 1,487,392 — **24 HR.** 22.1
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/16/12	**COMP. DATE** 11/20/12	**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	
725										724.5 GROUND SURFACE	0.0
720										**ARTIFICIAL FILL (ENGINEERED)** Black and Brown, Coarse to Fine Sandy, Silty CLAY with Trace Gravel	
										719.0 Gray and Brown, Fine Sandy, Silty CLAY	5.5
										717.0 **RESIDUAL** Light Brown, Coarse to Fine Sandy, Silty CLAY	7.5
715										712.5 Light Brown, Silty, Coarse to Fine Sandy CLAY	12.0
710											
705											
700										697.5 Gray and Brown, Coarse to Fine Sandy SILT	27.0
695											
690											
685	684.8	39.7	60/0.0			60/0.0	RS-2			684.8 **CRYSTALLINE ROCK** White, Black, and Gray METAMORPHOSED QUARTZ DIORITE	39.7
680											
675										673.2 Boring Terminated at Elevation 673.2 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE	51.3

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NCDOT GEOTECHNICAL ENGINEERING UNIT
CORE BORING REPORT

WBS 50000.1.STR11T1B	**TIP** P-5208G	**COUNTY** MECKLENBURG	**GEOLOGIST** Fiora, M. E.
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road			**GROUND WTR (ft)**
BORING NO. B2-B(1)	**STATION** 10641+37	**OFFSET** 20 ft RT	**ALIGNMENT** M1G	**0 HR.** N/A
COLLAR ELEV. 724.5 ft	**TOTAL DEPTH** 51.3 ft	**NORTHING** 571,476	**EASTING** 1,487,392	**24 HR.** 22.1
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		**DRILL METHOD** NQ Casing W/SPT & Core	**HAMMER TYPE** Automatic
DRILLER Toothman, R. E.	**START DATE** 11/16/12	**COMP. DATE** 11/20/12	**SURFACE WATER DEPTH** N/A
CORE SIZE NQ	**TOTAL RUN** 11.6 ft		

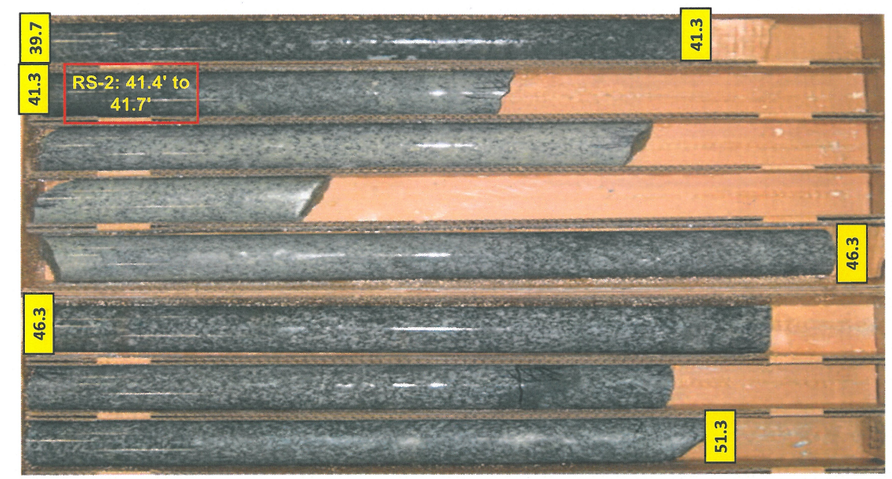
ELEV (ft)	RUN ELEV (ft)	DEPTH (ft)	RUN (ft)	DRILL RATE (Min/ft)	RUN REC. (ft) %	RUN RQD (ft) %	SAMP. NO.	STRATA REC. (ft) %	STRATA RQD (ft) %	LOG	DESCRIPTION AND REMARKS (ELEV. (ft) / DEPTH (ft))
684.8											Begin Coring @ 39.7 ft
	684.8	39.7	1.6	N=60/0.0	(1.5)	(1.5)		(11.3)	(11.1)		684.8 **CRYSTALLINE ROCK** 39.7
	683.2	41.3		3:45/0.6	94%	94%		97%	96%		White, Black, and Gray, Fresh to Very Slight Weathering, Hard
			5.0	5:25/1.0			RS-2				METAMORPHOSED QUARTZ DIORITE with Close Fracture Spacing
				7:24/1.0	(4.9)	(4.9)					
				5:49/1.0	98%	98%					
680				6:55/1.0							1 Fracture at 45 Degrees
				6:30/1.0							2 Fractures at 30 Degrees
	678.2	46.3		7:30/1.0							
			5.0	9:39/1.0	(4.8)	(4.6)					R1=7, R2=20, R3=20, R4=20, R5=4, RMR = 71
				8:21/1.0	96%	92%					ROCK CLASS II, ROCK TYPE E
675				8:08/1.0							
				7:35/1.0							
	673.2	51.3		7:31/1.0							673.2 51.3
											Boring Terminated at Elevation 673.2 ft in Crystalline Rock: METAMORPHOSED QUARTZ DIORITE

NCDOT CORE DOUBLE 127855.GPJ NC_DOT.GDT 7/9/13

CORE PHOTOGRAPHS

B2-B(1)

BOXES 1 and 2: 39.7 - 51.3 FEET



NCDOT GEOTECHNICAL ENGINEERING UNIT
BORELOG REPORT

WBS 50000.1.STR11T1B	TIP P-5208G	COUNTY MECKLENBURG	GEOLOGIST Fiora, M. E.	
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road				GROUND WTR (ft)
BORING NO. EB2-A	STATION 10641+95	OFFSET 53 ft LT	ALIGNMENT M1G	0 HR. 11.0
COLLAR ELEV. 712.4 ft	TOTAL DEPTH 64.2 ft	NORTHING 571,379	EASTING 1,487,385	24 HR. 10.8
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic	
DRILLER Toothman, R. E.	START DATE 12/03/12	COMP. DATE 12/03/12	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)
715											
										712.4 GROUND SURFACE	0.0
	711.4	1.0	4	8	20	28		M		**RESIDUAL** Tan, Red, Brown, and Olive, Coarse to Fine Sandy, Silty CLAY	
710	708.9	3.5	8	11	13	24		W			
	706.4	6.0	4	4	6	10		M			
705	703.9	8.5	3	4	4	8					
700	698.9	13.5	3	4	5	9	SS-12	31%			
695										695.4 White, Olive, and Tan, Coarse to Fine Sandy SILT	17.0
	693.9	18.5	3	3	6	9		W			
690	688.9	23.5	3	6	9	15	SS-13	24%			
685	683.9	28.5	6	8	13	21		W			
680	678.9	33.5	7	10	13	23		W			
675	673.9	38.5	10	16	19	35	SS-14	14%			
670	668.9	43.5	6	11	18	29		W			
665	663.9	48.5	10	18	30	48		W			
660	658.9	53.5	100/0.4			100/0.4				676.4 White, Olive and Tan, Silty Coarse to Fine SAND	36.0
										660.4 **WEATHERED ROCK** Black, White, Gray, and Brown METAMORPHOSED QUARTZ DIORITE	52.0
655	653.9	58.5	100/0.3			100/0.3					
650	648.9	63.5	100/0.7			100/0.7				648.2 Boring Terminated at Elevation 648.2 ft in Weathered Rock: METAMORPHOSED QUARTZ DIORITE	64.2

WBS 50000.1.STR11T1B	TIP P-5208G	COUNTY MECKLENBURG	GEOLOGIST Wells, T. R.	
SITE DESCRIPTION Millbrook to Junker on the NCRR/NS Mainline: Bridge over Mallard Creek Church Road				GROUND WTR (ft)
BORING NO. EB2-B	STATION 10641+80	OFFSET 23 ft RT	ALIGNMENT M1G	0 HR. 20.1
COLLAR ELEV. 724.2 ft	TOTAL DEPTH 48.5 ft	NORTHING 571,451	EASTING 1,487,356	24 HR. 21.0
DRILL RIG/HAMMER EFF./DATE TRI0055 CME-55 74% 02/15/2013		DRILL METHOD H.S. Augers	HAMMER TYPE Automatic	
DRILLER Toothman, R. E.	START DATE 11/14/12	COMP. DATE 11/14/12	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
725										
										724.2 GROUND SURFACE 0.0
	723.2	1.0	2	3	3	6		M		**ARTIFICIAL FILL (ENGINEERED)** Black and Brown, Coarse to Fine Sandy, Silty CLAY with a Little Gravel
720	720.7	3.5	6	8	6	14		M		
	718.2	6.0	3	4	5	9		W		718.7 Light Brown and Gray, Micaceous, Coarse to Fine Sandy, Silty CLAY 5.5
715	715.7	8.5	3	6	7	13		M		716.2 **RESIDUAL** Light Brown and Gray, Coarse to Fine Sandy, Silty CLAY 8.0
710	710.7	13.5	4	5	7	12		M		
										708.2 Light Brown and Gray, Micaceous, Coarse to Fine Sandy SILT 16.0
705	705.7	18.5	2	3	4	7	SS-15	25%		
700	700.7	23.5	3	4	7	11		W		
695	695.7	28.5	4	5	5	10		W		
690	690.7	33.5	3	3	3	6		W		
685	685.7	38.5	2	4	8	12		W		
680	680.7	43.5	3	3	4	7		W		
	675.7	48.5	60/0.0			60/0.0				675.7 Boring Terminated with Standard Penetration Test Refusal at Elevation 675.7 ft on Crystalline Rock: METAMORPHOSED QUARTZ DIORITE 48.5

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NCDOT BORE DOUBLE 127855.GPJ NC_DOT.GDT 4/26/13

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LABORATORY SUMMARY SHEET FOR ROCK CORE SAMPLES

SHEET 19

PROJECT NO.: 50000.1.STR11T1B (P-5208G)
F.A. NO.: N/A
COUNTY: MECKLENBURG
BRIDGE ON NCRR/NS MAINLINE OVER MALLARD CREEK CHURCH ROAD

Sample #	Boring #	Depth (ft)	Rock Type	Geologic Map Unit	Run RQD	Length (in)	Diameter (in)	Unit Weight (PCF)	Unconfined Compressive Strength (PSI)	Young's Modulus (PSI)	Splitting Tensile Strength (PSI)	Remarks
RS-1	B1-B	60.9-61.2	MET. QUARTZ DIORITE	PzZa	26	3.977	1.988	173.9	16,971	N/M	N/M	RMR=54
RS-2	B2-B	41.4-41.7	MET. QUARTZ DIORITE	PzZa	98	4.100	1.985	188.2	14,288	N/M	N/M	RMR=71

SUMMARY OF LABORATORY TEST DATA

PROJECT NO. 50000.1.STR11T1B (P-5208G)
FA NO. N/A
COUNTY: MECKLENBURG
BRIDGE ON NCRR/NS MAINLINE OVER MALLARD CREEK CHURCH ROAD

						Atterberg Limits			Gradation Results							
Boring Number	Sample Depth (ft.)	Sample No.*	Natural Moisture Content (%)	AASHTO Class (Group Index)	N-Value (blows/ ft.)	L.L.	P.L.	P.I.	Pass #10 Sieve	Pass #40 Sieve	Pass #200 Sieve	Retained #270 Sieve	Coarse Sand (%)	Fine Sand (%)	Silt (%)	Clay (%)
EB1-A	1.0 – 2.5	SS-1	23.2	A-6 (5)	5	36	22	14	99.9	83.3	56.2	46.1	25.6	20.4	32.0	21.9
EB1-B	3.5 – 5.0	SS-2	17.9	A-6 (4)	45	39	26	13	99.8	84.3	55.2	49.4	25.6	23.7	30.7	19.9
EB1-B	23.5 – 25.0	SS-3	19.4	A-4 (0)	16	25	NP	NP	100.0	78.8	39.2	66.4	34.2	32.2	23.9	9.7
B1-A	1.0 – 2.5	SS-4	21.4	A-6 (7)	4	31	15	16	98.8	85.6	62.9	37.4	20.7	15.5	26.5	36.1
B1-A	13.5 – 15.0	SS-5	11.7	A-4 (0)	60	27	18	9	89.8	66.2	40.6	63.1	32.8	20.0	26.5	10.4
B1-A	43.5 – 45.0	SS-6	16.4	A-2-4(0)	41	21	NP	NP	99.7	77.5	33.8	67.4	36.3	30.8	22.0	10.6
B1-B	6.0 – 7.5	SS-7	35.5	A-7-5 (12)	24	46	35	11	99.8	95.4	88.2	15.7	5.6	9.9	66.3	18.0
B2-A	23.5 – 25.0	SS-8	30.8	A-6 (7)	9	40	29	11	99.1	91.2	73.1	31.5	11.3	19.3	58.9	9.6
B2-A	43.5 – 45.0	SS-9	16.3	A-4 (0)	93	26	NP	NP	99.4	84.4	46.4	59.6	23.7	35.4	34.8	5.6
B2-B	1.0 – 2.5	SS-10	15.1	A-6 (7)	17	36	17	19	99.1	81.5	57.6	45.6	27.9	16.9	21.2	33.2
B2-B	18.5 – 20.0	SS-11	39.9	A-7-6 (6)	12	44	27	17	93.8	74.3	53.6	49.9	27.3	16.4	33.1	17.0
EB2-A	13.5 – 15.0	SS-12	31.1	A-6 (4)	9	36	23	13	99.4	77.8	53.1	50.5	29.1	20.9	35.8	13.7
EB2-A	23.5 – 25.0	SS-13	24.4	A-4 (3)	15	36	26	10	99.7	84.5	56.2	48.2	23.5	24.4	40.3	11.5
EB2-A	38.5 – 40.0	SS-14	13.6	A-2-4 (0)	35	23	NP	NP	99.5	72.5	33.9	70.6	39.2	30.9	23.9	5.5
EB2-B	18.5 – 20.0	SS-15	25.3	A-4 (0)	7	33	28	5	99.0	74.7	42.9	62.1	34.5	26.6	31.4	6.5

SS = Split-Barrel Sample (ASTM-D-1586) ST = Shelby Tube (Undisturbed) Sample
S = Grab Sample
NP -- Non Plastic NA-- Non Applicable

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Lab Technician: Joshua D. Fregosi

NCDOT Certification No.: 111-05-1203

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SITE PHOTOGRAPHS

View Looking Upstation along -M1G- from End Bent 1

View Looking Downstation along -M1G- from End Bent 2