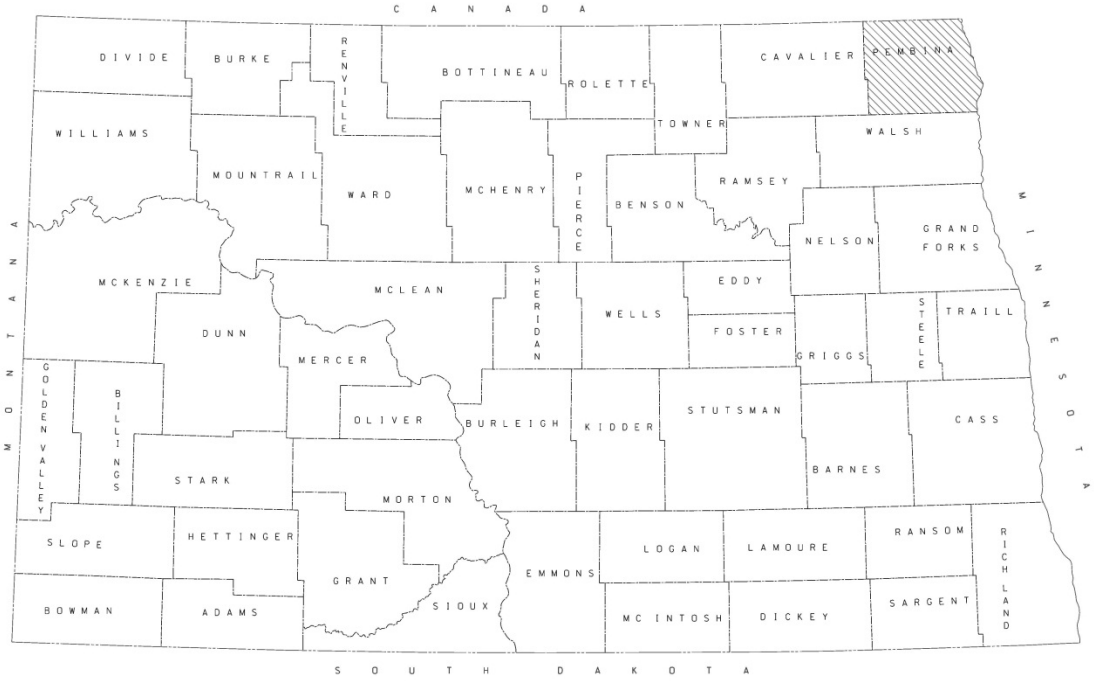
Deep Foundation Report and Analysis

PROJECT NO. BRI-6-029(124)214

PCN 20691

COUNTY Pembina

Bridge #: 0029-214.223 R



PREPARED BY: Colter Schwagler

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

April 2015

BRI-6-029(124)214

Bridge #0029-214.223 R

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of North Dakota. This document was originally issued and sealed by Jeff Jirava, Registration number PE-5950 on 4/16/2015 and the original document is stored at the North Dakota Department of Transportation.

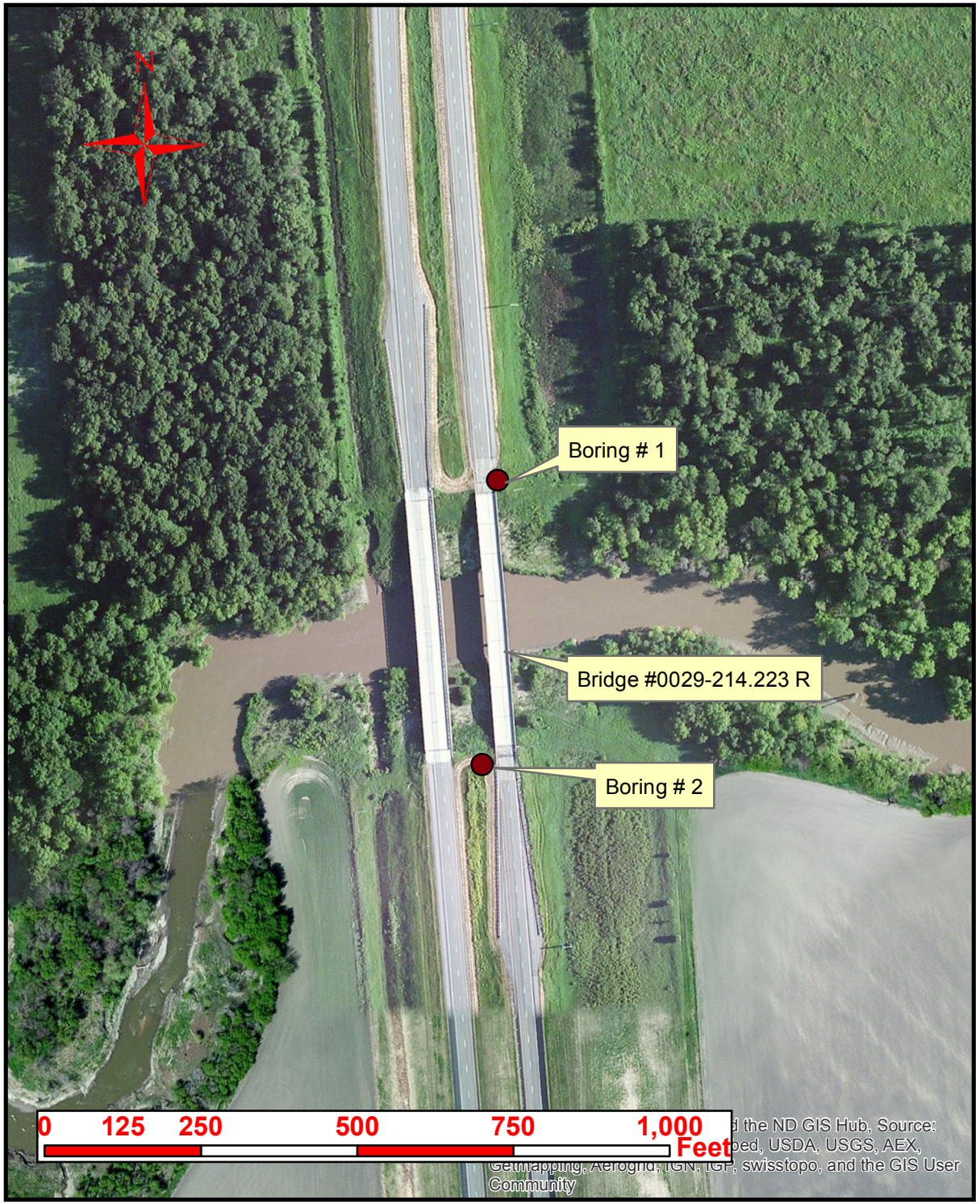
REGISTERED PROFESSIONAL ENGINEER
JEFF
JIRAVA
PE - 5950
DATE 4/16/15
NORTH DAKOTA

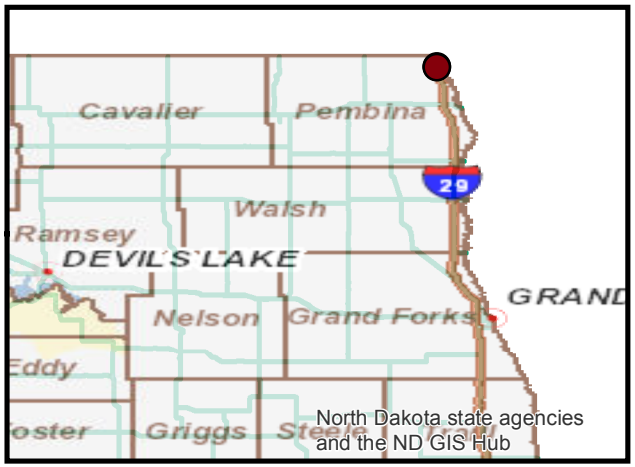
Jeff Jirava, P.E.

16 APRIL 2015
Date

Deep Foundation Report and Analysis

Project: BRI-6-029(124)214
PCN: 20691
Scope: Bridge Replacement
Location:1 Mile South of ND 59-NB
Bridge #: 0029-214.223 R





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Introduction

This report will provide foundation recommendations for the construction of the proposed permanent structure on Interstate 29 over the Pembina River (Bridge #0029-214.223 R).

Existing Structure Information

Main Structure Type: Steel Stinger
Length: 400'
Foundation Type: 14x73 Battered Pile and 14x89 Battered Pile
Year Constructed: 1959

Soil Borings

Two borings were drilled for this project.

Boring #1

Boring #1 has an elevation of 797 feet at the top of boring and is located 22 feet east of the existing centerline at station 170+82. This boring extends to a depth of 202 feet.

Boring #2

Boring #2 has an elevation of 796 feet at the top of boring and is located 39 feet west of the existing centerline at station 175+33. This boring extends to a depth of 197 feet.

Sampling and Testing Procedures:

Shelby tube sampling and split spoon sampling were used to extract the samples from a hollow stem auger.

Shelby tube sampling provides an "undisturbed" sample of fine grained soils for laboratory testing via a thin wall tube that is slowly pushed into the soils to be sampled. Unconfined compression testing equipment was used to determine UC shear strengths. Densities were calculated according to AASHTO test method T-296.

Split spoon samplers are utilized during advancement of the boring to perform the Standard Penetration Test (SPT). The samples are considered "disturbed", due to the driving nature in which they are obtained. The SPT results in an N-value, or number of blows required to drive the split spoon sampler 1 foot. This N-value is used to estimate

the shear strength and friction angle of the soil, define the consistency of cohesive soils and also the relative density of non-cohesive soils.

However, it should be noted that in cohesive soils, the shear strength values determined from the Unconfined Compression tests utilizing Shelby tubes samples are considered more reliable than those estimated from blow counts.

The samples from the split spoon and Shelby tubes are submitted to the laboratory for determination of AASHTO classification, moisture content, dry density, sieve analysis, and Atterberg limits.

Test Results

A summary of the lab analysis has been included in the Appendix B.

Proposed Structure

Length: 7 span – 400 feet

Foundation Recommendation

Steel Piling

Pile recommendations are given as termination elevations. The pile sizes that have been analyzed are HP10x42, HP12x53, HP14x73, and HP14x102.

The software “APile” (v2014) was used in conjunction with engineering judgment and past experience in pile driving in these types of soils, to estimate the pile lengths. The output from this analysis is in Appendix C.

The pile length estimations for the abutment #1 and piers #2-4 were based on boring #1 and abutment #8 and piers #5-7 were done with boring #2. The simplified soil profile used for analysis can be found in the tables below. The abutment and pile elevations were based off an estimate by the bridge hydraulics section. If the elevations change significantly from what is listed in the tables below the termination elevations may need to be readdressed.

Table 1 - Boring #1 Simplified Soil Profile

Layer	Depth	Cohesion	Friction Angle	Graph Label
Clay	796.7-789	3,000	0	A
Clay	789-755	450	0	B
Clay	755-661	1,100	0	C
Clay Loam	661-621	4,000	0	D
Sandy Loam	621-611	5,125	0	E
Clay Loam	611-596	12,500	0	F

Table 2 - Boring #2 Simplified Soil Profile

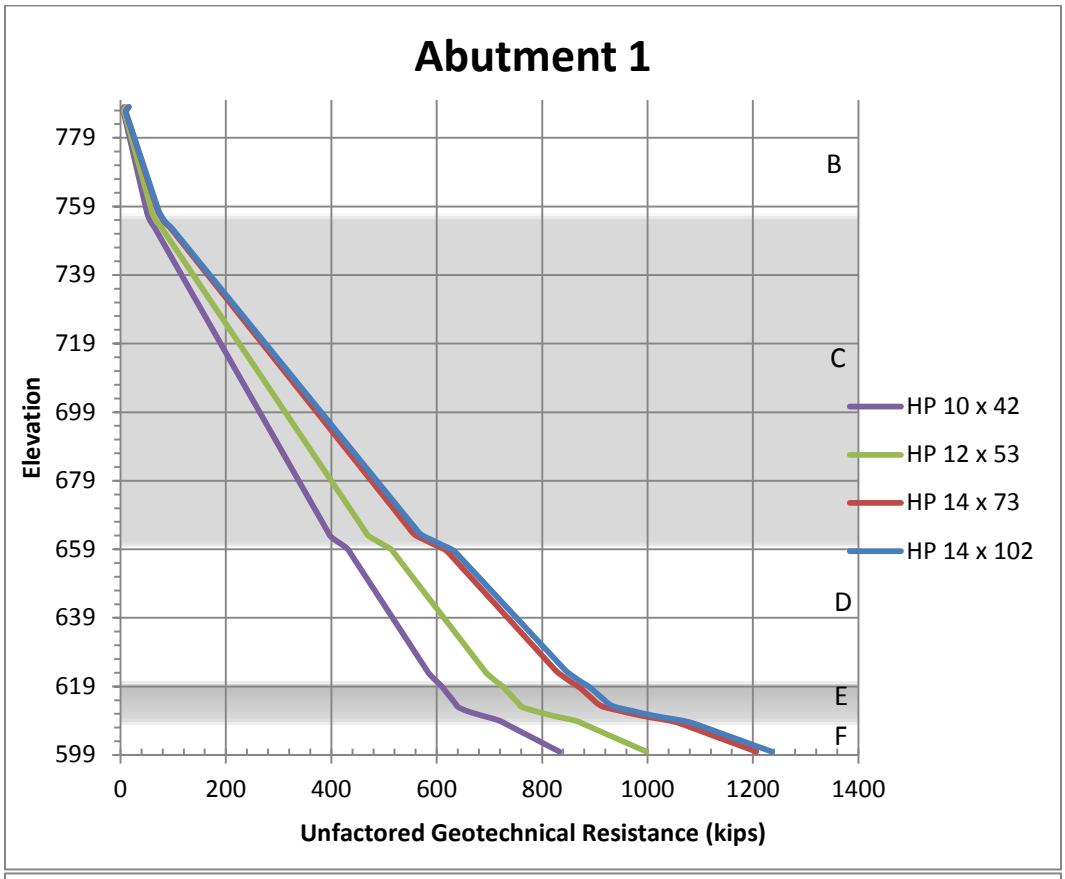
Layer	Depth	Cohesion	Friction Angle	Graph Label
Clay	795.9-761	750	0	G
Clay	761-659	1,000	0	H
Clay	659-644	2,000	0	I
Clay Loam	644-615	3,500	0	J
Clay	615-600	5,125	0	K

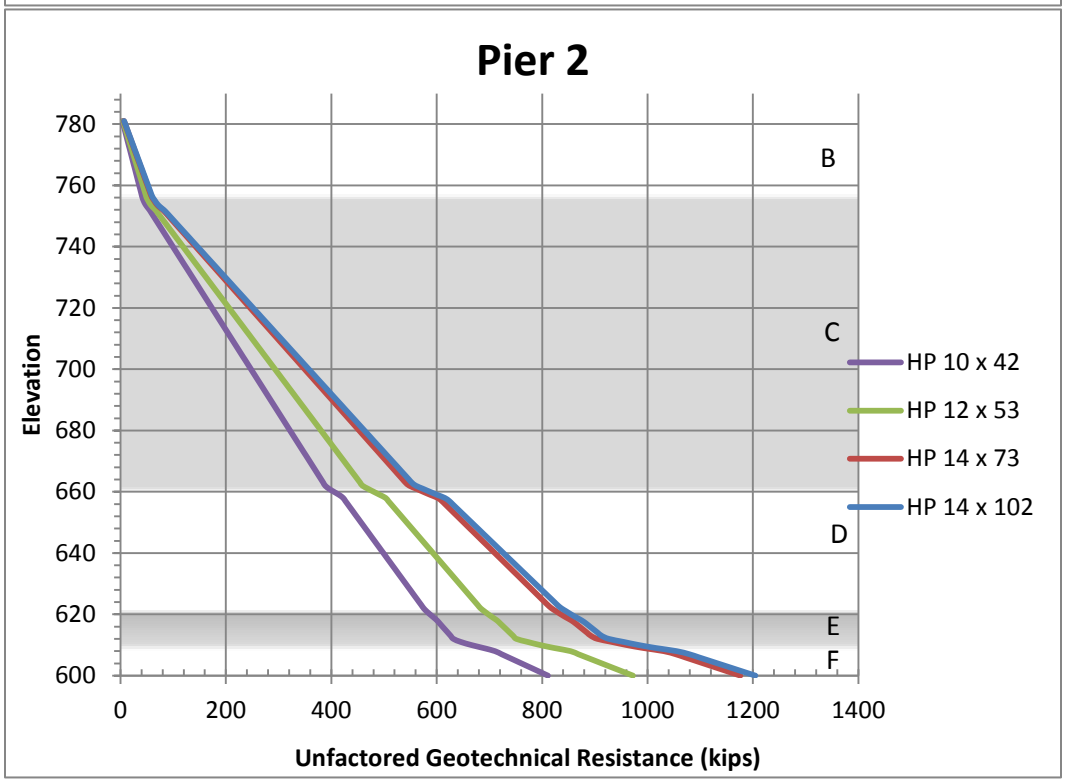
Table 3 - Pile Length Information (Boring #1)

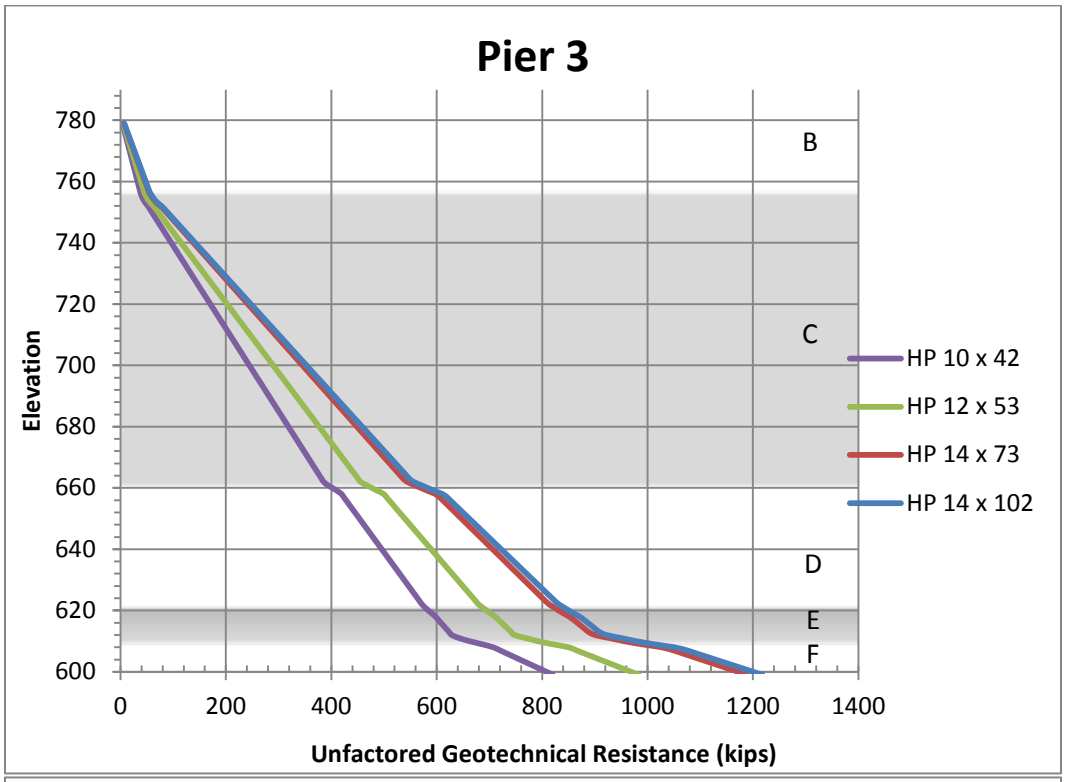
Pile Type	90% Ultimate Axial Capacity	Abutment #1 elev. 788.53 (Boring #1)	Pier #2 elev. 781.76 (Boring #1)	Pier #3 elev. 779.72 (Boring #1)	Pier #4 elev. 745.9 (Boring #1)
	kips	Termination Elevation	Termination Elevation	Termination Elevation	Termination Elevation
HP10x42	558	629	626	625	612
HP12x53	698	623	619	619	610
HP14x73	963	611	609	609	606
HP14x102	1355	600	600	600	600

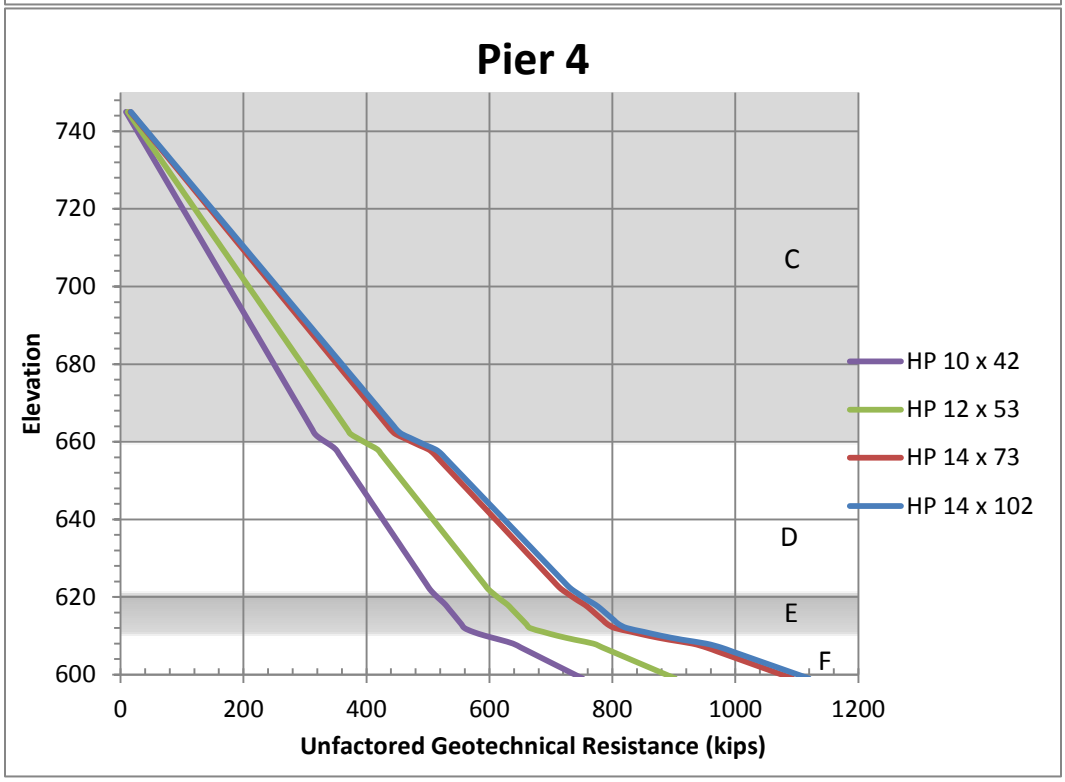
Table 4 - Pile Length Information (Boring #2)

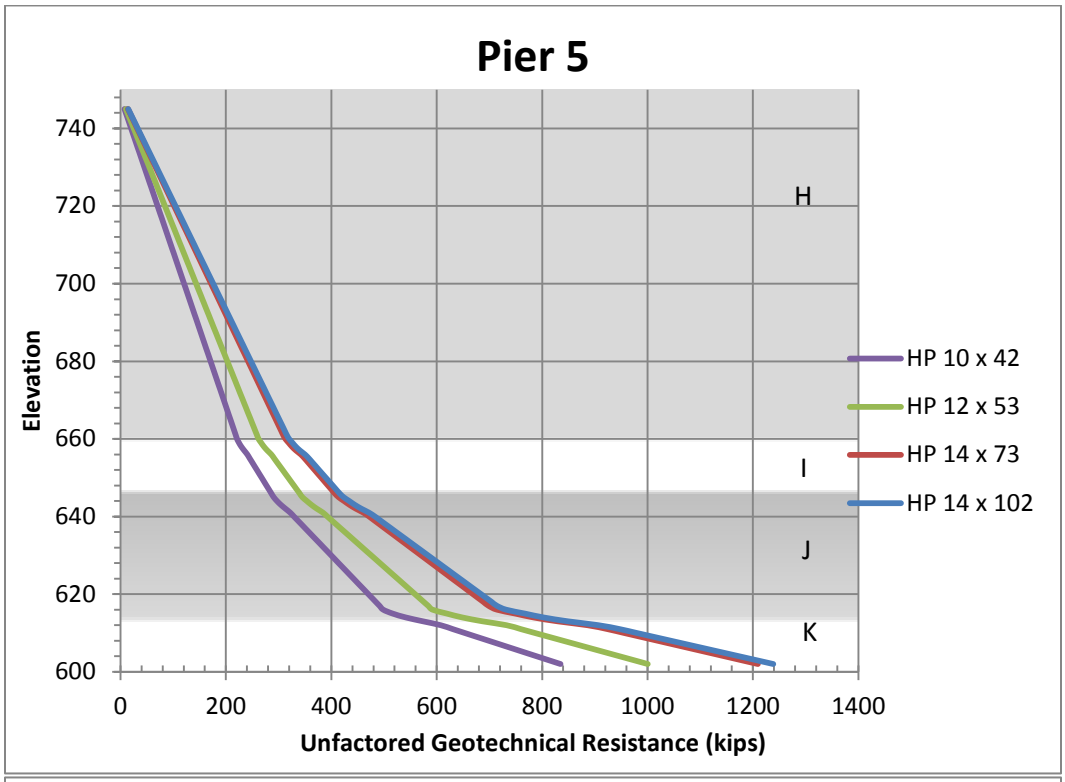
Pile Type	90% Ultimate Axial Capacity	Abutment #8 elev. 788.53 (Boring #2)	Pier #7 elev. 783.14 (Boring #2)	Pier #6 elev. 781.81 (Boring #2)	Pier #5 elev. 745.9 (Boring #2)
	kips	Termination Elevation	Termination Elevation	Termination Elevation	Termination Elevation
HP10x42	558	621	620	619	613
HP12x53	698	617	616	616	612
HP14x73	963	613	613	613	609
HP14x102	1355	603	600	600	600

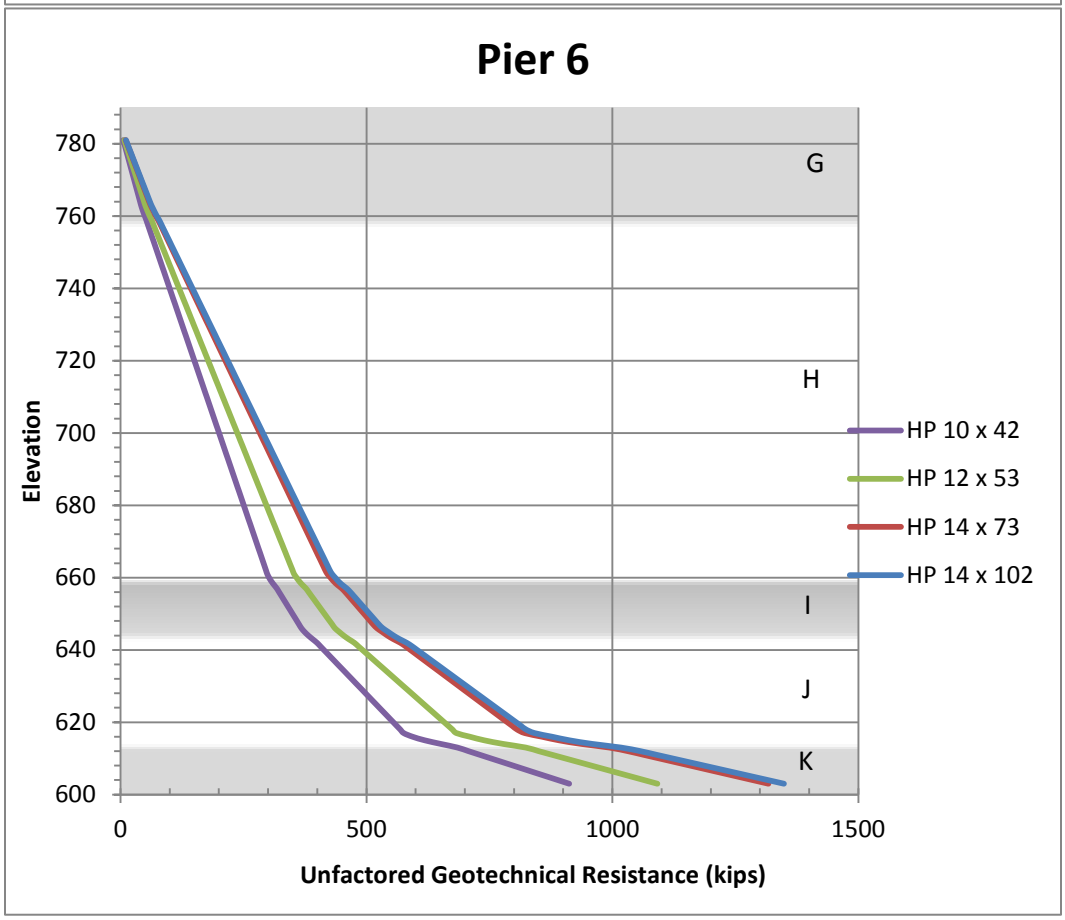

Abutment 1
Elevation
779
759
739
719
699
679
659
639
619
599
0
200
400
600
800
1000
1200
1400
Unfactored Geotechnical Resistance (kips)
B
C
D
E
F
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102

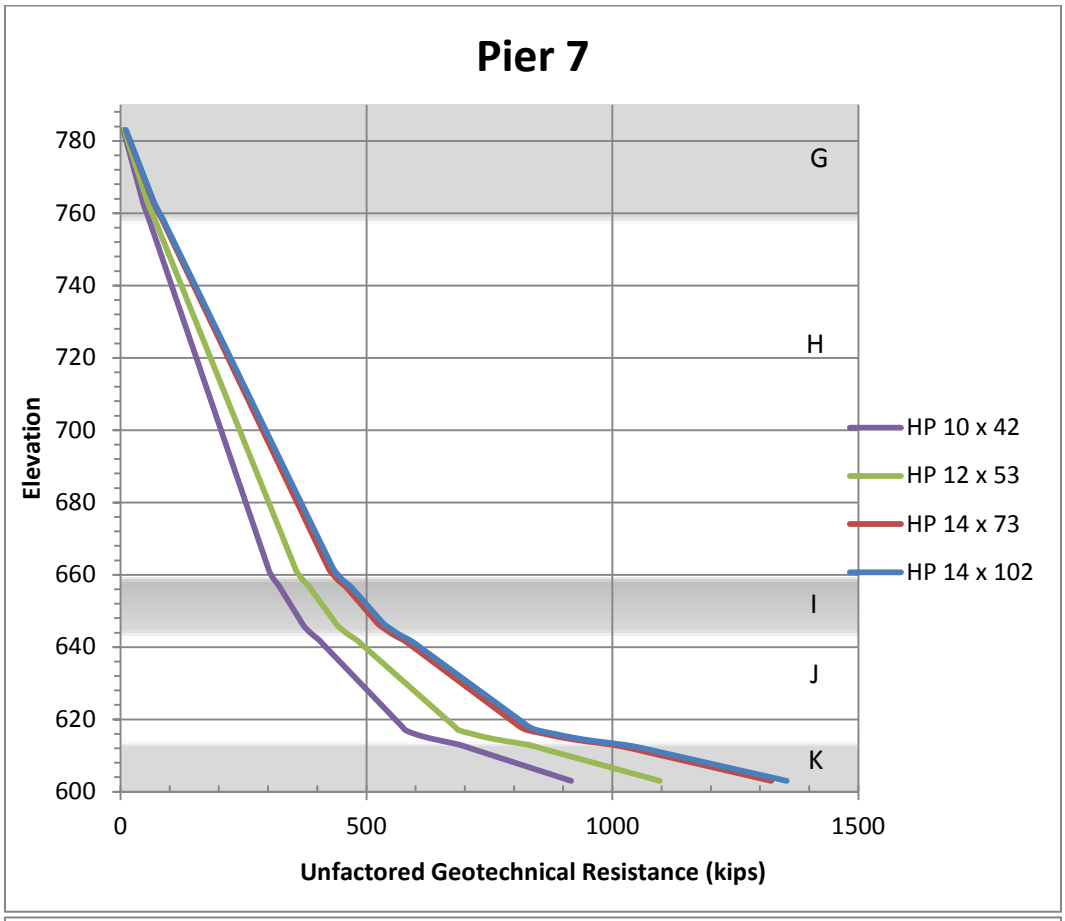

Pier 2
Elevation
780
760
740
720
700
680
660
640
620
600
0
200
400
600
800
1000
1200
1400
Unfactored Geotechnical Resistance (kips)
B
C
D
E
F
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102

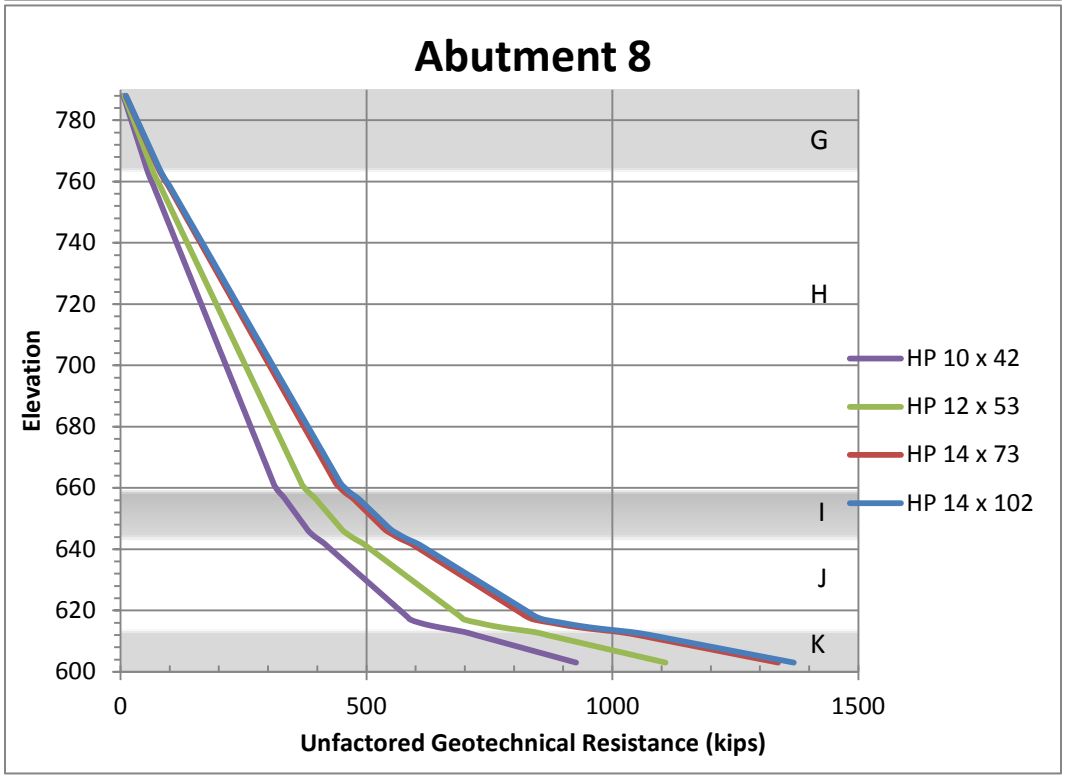

Pier 3
Elevation
780
760
740
720
700
680
660
640
620
600
0
200
400
600
800
1000
1200
1400
Unfactored Geotechnical Resistance (kips)
B
C
D
E
F
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102


Pier 4
Elevation
740
720
700
680
660
640
620
600
0
200
400
600
800
1000
1200
Unfactored Geotechnical Resistance (kips)
C
D
E
F
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102


Pier 5
Elevation
740
720
700
680
660
640
620
600
0
200
400
600
800
1000
1200
1400
Unfactored Geotechnical Resistance (kips)
H
I
J
K
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102


Pier 6
Elevation
780
760
740
720
700
680
660
640
620
600
0
500
1000
1500
Unfactored Geotechnical Resistance (kips)
G
H
I
J
K
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102


Pier 7
Elevation
780
760
740
720
700
680
660
640
620
600
0
500
1000
1500
Unfactored Geotechnical Resistance (kips)
G
H
I
J
K
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102


Abutment 8
Elevation
780
760
740
720
700
680
660
640
620
600
0
500
1000
1500
Unfactored Geotechnical Resistance (kips)
G
H
I
J
K
HP 10 x 42
HP 12 x 53
HP 14 x 73
HP 14 x 102

Pile Tips

It is not anticipated that pile tips will be required on this project.

Downdrag

As the grade is not changing at the embankment locations downdrag should not be an issue on this project.

Scour

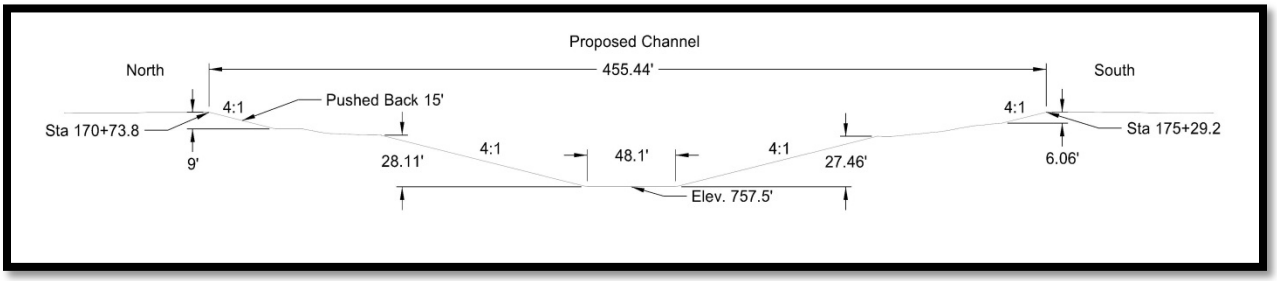
Scour depths were not used in the analysis of the pile termination elevation calculations. If significant amounts of scour are expected at this location the termination elevations need to be reevaluated.

Compaction Recommendation

The roadway embankment shall be compacted to 90% of the maximum dry density as determined by AASHTO T-180 and the moisture contents shall comply with section 203.02 G. The aggregate transitions at the bridge ends shall be compacted to 90% of the maximum dry density as determined by AASHTO T-180 and the moisture contents shall comply with section 714.03 A.

End Slope Recommendation

The stability analysis was conducted with Slope/W developed by Geo-Slope International. The analysis was a two-dimensional limit equilibrium method.
Using the existing survey data and the spot shot elevations in the survey folder an existing stream profile was created. To be conservative a soil profile was created using both boring #1 and Boring #2. The slope configuration at this bridge was evaluated with two separate slopes on each side of the river. The first slope extends from the bottom of the river channel to wherever it ties on the bench where piers 2 and 3 on the north side and 6 and 7 on the south side currently sit. The second slope extends from the bench up to the abutment. To achieve the desired factor of safety of 1.5 the slope beginning at the perceived existing toe and tying to the bench will need to be 4:1. On the south side of the river the second slope of 4:1 up to the abutment achieves the desired factor of safety. On the north side the second slope of 4:1 needed to be shifted north an additional 15 feet to achieve the desired factor of safety of 1.5.



Drainage Recommendation

The drainage off the bridge should be controlled so that water does not drain directly off the bridge ends and causes erosion around the wing-wall. A combination of inlets, downdrains, and/or deckdrains should be used to control water runoff. Water should not be allowed to drain off the bridge as to allow the in slopes and end slopes to become saturated, which is a common cause of slope failure.

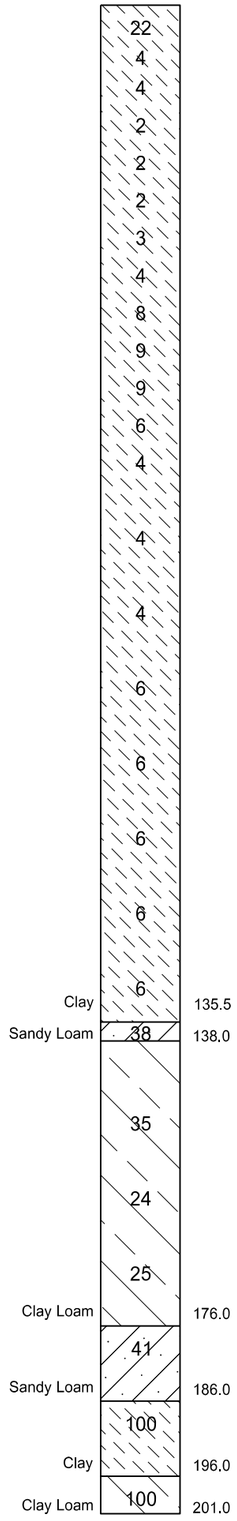
Settlement

It is understood that this project will not include any significant grade increase therefore settlement of the approach embankments will not be an issue.

APPENDIX A

Boring Logs

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	BRI-6-029(124)214	175	1



Project Number: BRI-6-029(124)214
PCN: 20691
Bridge Number: 0029-214.223 R
Location: 1 S of ND 59 - NB
Boring Number: 1
Dates Drilled: 7/21/14 - 7/24/14

RP + Feet: 213 + 4872.19'
Station: 170+81.96
Offset: 21.71 Right
Orientation: Northeast Quadrant
Elevation of Boring: 796.74

Depth (ft.)	Textural Class	Soil Class	Sample Type	Test Type	Comp. Strength (psf)	Friction Angle (degr.)	Cohesion (Shear Strength) (psf)	Blow Count (bpf)	Field Moisture (%)	γ Unit Weight (pcf)
2.0-4.0	CLY	A-7-5(31)	3TW	UC	6,504	---	3,252	---	37.6	114
4.0-6.0	CLY	A-7-5(48)	SS	SPT	---	---	2,750	22	29.5	---
6.0-8.0	CLY	A-7-5(44)	3TW	UC	8,103	---	2,791	---	40.3	110
8.0-10.0	CLY	A-7-5(49)	SS	SPT	---	---	500	4	40.2	---
10.0-12.0	CLY	A-7-5(33)	3TW	UC	1,555	---	777	---	45.9	104.6
12.0-14.0	CLY	A-7-5(34)	SS	SPT	---	---	500	4	39.6	---
15.0-17.0	CLY	A-7-5(24)	3TW	UC	921	---	460	---	45.7	105.6
17.0-19.0	CLY	A-7-5(19)	SS	SPT	---	---	250	2	42.2	---
20.0-22.0	CLY	A-7-5(17)	3TW	UC	922	---	461	---	51.1	107.8
22.0-24.0	CLY	A-7-5(25)	SS	SPT	---	---	250	2	50.4	---
25.0-27.0	CLY	A-7-5(15)	3TW	UC	804	---	402	---	52.9	105.7
27.0-29.0	CLY	A-7-6(14)	SS	SPT	---	---	250	2	22.9	---
30.0-32.0	CLY	A-7-5(14)	3TW	UC	1,109	---	555	---	45.4	109.2
32.0-34.0	CLY	A-7-5(22)	SS	SPT	---	---	375	3	20.9	---
35.0-37.0	CLY	A-7-5(13)	3TW	UC	1,245	---	622	---	44.6	105.1
37.0-39.0	CLY	A-7-6(17)	SS	SPT	---	---	500	4	42.8	---
40.0-42.0	CLY	A-7-6(9)	3TW	UC	1,197	---	598	---	44.1	109.9
42.0-44.0	CLY	A-7-5(42)	SS	SPT	---	---	1,000	8	49.6	---
45.0-47.0	CLY	A-7-5(47)	3TW	UU	---	---	1,490	---	51.6	107
47.0-49.0	CLY	A-7-5(52)	SS	SPT	---	---	1,125	9	49.6	---
50.0-52.0	CLY	A-7-5(41)	3TW	M	---	---	---	---	53.2	---
52.0-54.0	CLY	A-7-6(24)	SS	SPT	---	---	1,125	9	39.0	---
55.0-57.0	CLY	A-7-5(40)	3TW	UU	---	---	1,704	---	36.5	109.2
57.0-59.0	CLY	A-7-5(58)	SS	SPT	---	---	750	6	32.3	---
60.0-62.0	CLY	A-7-5(69)	3TW	UU	---	---	796	---	57.0	105.1
62.0-64.0	CLY	A-7-5(58)	SS	SPT	---	---	500	4	28.4	---
70.0-72.0	CLY	A-7-5(69)	3TW	UU	---	---	1,011	---	59.9	103.9
72.0-74.0	CLY	A-7-6(55)	SS	SPT	---	---	500	4	28.0	---
80.0-82.0	CLY	A-7-6(57)	3TW	UU	---	---	1,198	---	44.8	112
82.0-84.0	CLY	A-7-6(48)	SS	SPT	---	---	500	4	35.4	---
90.0-92.0	CLY	A-7-5(51)	3TW	UU	---	---	1,006	---	47.9	111.4
92.0-94.0	CLY	A-7-6(54)	SS	SPT	---	---	750	6	23.3	---
100.0-102.0	CLY	A-7-6(59)	3TW	UU	---	---	1,127	---	46.1	111.1
102.0-104.0	CLY	A-7-6(55)	SS	SPT	---	---	750	6	26.9	---
110.0-112.0	CLY	A-7-6(72)	3TW	UU	---	---	1,289	---	49.2	107.6
112.0-114.0	CLY	A-7-6(51)	SS	SPT	---	---	750	6	21.0	---
120.0-122.0	CLY	A-7-6(50)	3TW	UU	---	---	1,216	---	43.2	112.7
122.0-124.0	CLY	A-7-6(41)	SS	SPT	---	---	750	6	34.9	---
130.0-132.0	CLY	A-7-6(33)	3TW	UU	---	---	1,236	---	55.0	109
132.0-134.0	CLY	A-7-6(54)	SS	SPT	---	---	750	6	40.1	---
137.0-138.0	SNDY LM	A-4(0)	3TW	M	---	---	---	---	23.6	---
138.0-140.0	CLY LM	A-6(7)	SS	SPT	---	---	4,750	38	3.8	---
150.0-152.0	CLY LM	A-6(8)	SS	SPT	---	---	4,375	35	4.8	---
160.0-162.0	CLY LM	A-6(8)	SS	SPT	---	---	3,000	24	10.3	---
170.0-172.0	CLY LM	A-6(8)	SS	SPT	---	---	3,125	25	16.6	---
180.0-182.0	SNDY LM	A-4(1)	SS	SPT	---	---	5,125	41	14.0	---
190.0-192.0	CLY	A-6(9)	SS	SPT	---	---	12,500	100	12.3	---
200.0-201.0	CLY LM	A-4(2)	SS	SPT	---	---	12,500	100	5.3	---

SS - Split Spoon
3TW - 3" Thin Wall (Shelby Tube)
M - Moisture Test
D - Density Test
UC - Unconfined Compression Test
UU - Unconsolidated Undrained Triaxial Test
SPT - Standard Penetration Test

Friction and Cohesive values for split spoon samples are estimated from the blow counts. These values are used in absence of triaxial strength testing information.

Notes:
THE BORING DATA SHOWN IS FOR NORTH DAKOTA DEPARTMENT OF TRANSPORTATION'S (NDDOT) DESIGN AND ESTIMATING PURPOSES ONLY. THE BORING LOGS ARE ONLY REPRESENTATIVE OF THE EXACT LOCATION FROM WHICH THE SAMPLES WERE TAKEN AND INTERPRETATION BETWEEN THE SAMPLE LOCATIONS IS DISCOURAGED. THE NDDOT ASSUMES NO RESPONSIBILITY IF THE SOIL CONDITIONS ENCOUNTERED DURING CONSTRUCTION DIFFER FROM THOSE SHOWN. FURTHER SOIL INFORMATION MAY BE AVAILABLE AT:

NDDOT
MATERIALS & RESEARCH DIVISION
300 AIRPORT ROAD
BISMARCK, NORTH DAKOTA 58504-6005
PHONE (701)328-6900

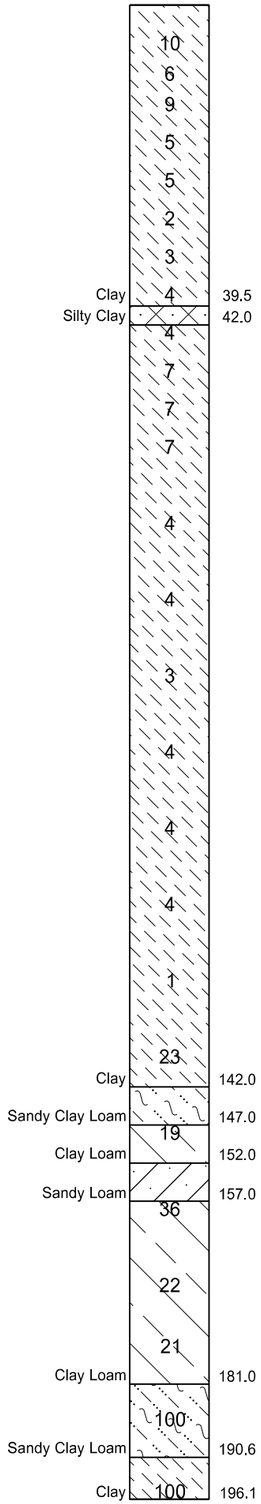
SS - Split Spoon
3TW - 3" Thin Wall Shelby Tube
M - Moisture Test
D - Density Test
UC - Unconfined Compression Test
UU - Unconsolidated Undrained Triaxial Test
SPT - Standard Penetration Test

This document was originally issued and sealed by Jeff Jirava Registration Number PE- 5950, on 4/16/2015 and the original document is stored at the North Dakota Department of Transportation

Boring Log

Bridge #0029-214.223 R - Boring 1

STATE	PROJECT NO.	SECTION NO.	SHEET NO.
ND	BRI-6-029(124)214	175	2



Project Number: BRI-6-029(124)214
PCN: 20691
Bridge Number: 0029-214.223 R
Location: 1 S of ND 59 - NB
Boring Number: 2
Dates Drilled: 7/24/14 - 7/31/14

RP + Feet: 213 + 4420.76'
Station: 175+33.39
Offset: 38.84 Left
Orientation: Southwest Quadrant
Elevation of Boring: 795.88

Depth (ft.)	Textural Class	Soil Class	Sample Type	Test Type	Comp. Strength (psf)	Friction Angle (degr.)	Cohesion (Shear Strength) (psf)	Blow Count (bpf)	Field Moisture (%)	γ Unit Weight (pcf)
2.0-4.0	CLY	A-7-5(45)	3TW	UC	6170	---	3086	---	22.3	112.5
4.0-6.0	CLY	A-7-5(42)	SS	STP	---	---	1250	10	45.2	---
6.0-8.0	CLY	A-7-5(43)	3TW	M	---	---	---	---	49.0	---
8.0-10.0	CLY	A-4(0)	SS	STP	---	---	750	6	38.8	---
10.0-12.0	CLY	A-7-5(33)	3TW	M	---	---	---	---	48.5	---
12.0-14.0	CLY	A-7-5(51)	SS	STP	---	---	1,125	9	44.3	---
15.0-17.0	CLY	A-7-5(52)	3TW	M	---	---	---	---	44.6	---
17.0-19.0	CLY	A-7-5(50)	SS	STP	---	---	625	5	47.0	---
20.0-22.0	CLY	A-7-5(49)	3TW	M	---	---	---	---	47.5	---
22.0-24.0	CLY	A-7-5(51)	SS	STP	---	---	625	5	48.7	---
25.0-27.0	CLY	A-7-5(48)	3TW	UU	---	---	778	---	53.1	104.8
27.0-29.0	CLY	A-7-6(29)	SS	STP	---	---	250	2	50.6	---
30.0-32.0	CLY	A-7-5(38)	3TW	UU	---	---	792	---	50.8	106.6
32.0-34.0	CLY	A-7-6(23)	SS	STP	---	---	375	3	49.8	---
35.0-37.0	CLY	A-7-6(30)	3TW	UU	---	---	678	---	41.5	111.6
37.0-39.0	CLY	A-7-6(28)	SS	STP	---	---	500	4	41.9	---
40.0-42.0	SLTY CLY	A-7-5(31)	3TW	UU	---	---	1,111	---	46.3	110
42.0-44.0	CLY	A-7-6(26)	SS	STP	---	---	500	4	41.3	---
45.0-47.0	CLY	A-7-6(31)	3TW	UU	---	---	850	---	48.4	112.4
47.0-49.0	CLY	A-7-6(31)	SS	STP	---	---	875	7	41.1	---
50.0-52.0	CLY	A-7-6(45)	3TW	UU	---	---	812	---	41.4	111
52.0-54.0	CLY	A-7-6(30)	SS	STP	---	---	875	7	26.3	---
55.0-57.0	CLY	A-7-6(32)	3TW	UU	---	---	1,147	---	45.7	111.9
57.0-59.0	CLY	A-7-6(57)	SS	STP	---	---	875	7	60.0	---
65.0-67.0	CLY	A-7-5(73)	3TW	UU	---	---	924	---	63.5	103.4
67.0-69.0	CLY	A-7-5(82)	SS	STP	---	---	500	4	64.5	---
75.0-77.0	CLY	A-7-6(62)	3TW	UU	---	---	1,166	---	49.0	109.5
77.0-79.0	CLY	A-7-6(53)	SS	STP	---	---	500	4	41.2	---
85.0-87.0	CLY	A-7-6(58)	3TW	UU	---	---	1,221	---	49.7	109.4
87.0-89.0	CLY	A-7-6(56)	SS	STP	---	---	375	3	43.2	---
95.0-97.0	CLY	A-7-6(54)	3TW	UU	---	---	1,120	---	46.4	111.7
97.0-99.0	CLY	A-7-6(52)	SS	STP	---	---	500	4	39.4	---
105.0-107.0	CLY	A-7-6(58)	3TW	UU	---	---	1,163	---	49.8	109.2
107.0-109.0	CLY	A-7-6(59)	SS	STP	---	---	500	4	56.3	---
115.0-117.0	CLY	A-7-6(55)	3TW	UU	---	---	1,209	---	48.9	110.6
117.0-119.0	CLY	A-7-6(53)	SS	STP	---	---	500	4	45.4	---
125.0-127.0	CLY	A-7-5(54)	3TW	UU	---	---	954	---	56.3	106.7
127.0-129.0	CLY	A-7-6(66)	SS	STP	---	---	125	1	56.1	---
135.0-137.0	CLY	A-7-6(32)	3TW	UU	---	---	1,200	---	46.3	115
137.0-139.0	CLY	A-7-6(11)	SS	STP	---	---	2,875	23	47.6	---
145.0-147.0	SNDY CLY LM	A-6(3)	3TW	UU	---	---	2,046	---	17.8	135.2
147.0-149.0	CLY LM	A-6(9)	SS	STP	---	---	2,375	19	15.2	---
155.0-157.0	SNDY LM	A-6(4)	3TW	UU	---	---	3,643	---	21.4	135.7
157.0-159.0	CLY LM	A-6(7)	SS	STP	---	---	4,500	36	11.8	---
165.0-167.0	CLY LM	A-6(7)	3TW	UC	6853	---	3,426	---	16.6	134
167.0-169.0	CLY LM	A-6(8)	SS	STP	---	---	2,750	22	14.4	---
175.0-177.0	CLY LM	A-6(8)	SS	STP	---	---	2,625	21	15.1	---
185.0-186.2	SNDY CLY LM	A-4(1)	SS	STP	---	---	12,500	100	11.5	---
195.0-196.1	CLY	A-6(8)	SS	STP	---	---	12,500	100	13.3	---

SS - Split Spoon
3TW - 3" Thin Wall (Shelby Tube)
M - Moisture Test
D - Density Test
UC - Unconfined Compression Test
UU - Unconsolidated Undrained Triaxial Test
SPT - Standard Penetration Test

Friction and Cohesive values for split spoon samples are estimated from the blow counts. These values are used in absence of triaxial strength testing information.

Notes:
THE BORING DATA SHOWN IS FOR NORTH DAKOTA DEPARTMENT OF TRANSPORTATION'S (NDDOT) DESIGN AND ESTIMATING PURPOSES ONLY. THE BORING LOGS ARE ONLY REPRESENTATIVE OF THE EXACT LOCATION FROM WHICH THE SAMPLES WERE TAKEN AND INTERPRETATION BETWEEN THE SAMPLE LOCATIONS IS DISCOURAGED. THE NDDOT ASSUMES NO RESPONSIBILITY IF THE SOIL CONDITIONS ENCOUNTERED DURING CONSTRUCTION DIFFER FROM THOSE SHOWN. FURTHER SOIL INFORMATION MAY BE AVAILABLE AT:

NDDOT
MATERIALS & RESEARCH DIVISION
300 AIRPORT ROAD
BISMARCK, NORTH DAKOTA 58504-6005
PHONE (701)328-6900

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Boring Log

Bridge #0029-214.223 R - Boring 2

APPENDIX B

Lab Results

Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	375	376	377	378
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	2.0 - 4.0	4.0 - 6.0	6.0 - 8.0	8.0 - 10.0
Field Sample No.	375	376	377	378
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	98	100	100	100
% Pass. No. 10 Sieve	96	99	99	100
% Coarse Sand (-No. 10 + No.40)	3	0	0	1
% Fine Sand (-No. 40 + No. 200)	6	1	2	1
% Silt (0.074 - 0.005 mm)	32	32	33	36
% Clay (-0.005 mm)	54	65	64	62
Liquid Limit (-No. 40)	62	77	76	79
Plasticity Index (-No. 40)	31	39	35	39
Plastic Limit	31	38	40	40
Soil Color	BrnBlk	BrnBlk	BrnBlk	BrnBlk
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(31)	A-7-5(48)	A-7-5(44)	A-7-5(49)
Frost Class	F3	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	37.6	29.5	40.3	40.2

Scott W. Wutzke
Testing Lab. Supervisor

Date Printed: 3/10/2015

Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	379	380	381	382
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	10.0 - 12.0	12.0 - 14.0	15.0 - 17.0	17.0 - 19.0
Field Sample No.	379	380	381	382
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	99
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	2	4	15	17
% Silt (0.074 - 0.005 mm)	48	49	35	43
% Clay (-0.005 mm)	50	47	50	38
Liquid Limit (-No. 40)	63	63	57	52
Plasticity Index (-No. 40)	27	29	25	21
Plastic Limit	36	34	32	32
Soil Color	BrnBlk	Brn	Brn	Brn
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(33)	A-7-5(34)	A-7-5(24)	A-7-5(19)
Frost Class	F4	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	45.9	39.6	45.7	42.2

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Testing Lab. Supervisor

Date Printed: 3/10/2015

Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	383	384	385	386
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	20.0 - 22.0	22.0 - 24.0	25.0 - 27.0	27.0 - 29.0
Field Sample No.	383	384	385	386
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	99	99	100	99
% Coarse Sand (-No. 10 + No.40)	0	0	0	1
% Fine Sand (-No. 40 + No. 200)	18	13	21	28
% Silt (0.074 - 0.005 mm)	44	41	42	35
% Clay (-0.005 mm)	37	45	37	35
Liquid Limit (-No. 40)	50	55	48	48
Plasticity Index (-No. 40)	19	25	17	20
Plastic Limit	31	30	31	28
Soil Color	Brn	Brn	Brn	Brn
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(17)	A-7-5(25)	A-7-5(15)	A-7-6(14)
Frost Class	F4	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	51.1	50.4	52.9	22.9

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Testing Lab. Supervisor

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Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	387	388	389	390
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	30.0 - 32.0	32.0 - 34.0	35.0 - 37.0	37.0 - 39.0
Field Sample No.	387	388	389	390
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	99	100	100	100
% Coarse Sand (-No. 10 + No.40)	1	0	1	1
% Fine Sand (-No. 40 + No. 200)	23	11	26	21
% Silt (0.074 - 0.005 mm)	38	49	36	40
% Clay (-0.005 mm)	38	40	37	37
Liquid Limit (-No. 40)	48	52	49	49
Plasticity Index (-No. 40)	18	20	17	20
Plastic Limit	31	32	33	30
Soil Color	BrnGry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(14)	A-7-5(22)	A-7-5(13)	A-7-6(17)
Frost Class	F4	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	45.4	20.9	44.6	42.8

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Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
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Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	391	392	393	394
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	40.0 - 42.0	42.0 - 44.0	45.0 - 47.0	47.0 - 49.0
Field Sample No.	391	392	393	394
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	99
% Coarse Sand (-No. 10 + No.40)	4	1	0	0
% Fine Sand (-No. 40 + No. 200)	31	2	1	1
% Silt (0.074 - 0.005 mm)	28	34	33	29
% Clay (-0.005 mm)	37	64	66	69
Liquid Limit (-No. 40)	44	70	75	79
Plasticity Index (-No. 40)	16	34	38	43
Plastic Limit	28	36	37	37
Soil Color	Gry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(9)	A-7-5(42)	A-7-5(47)	A-7-5(52)
Frost Class	F4	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	44.1	49.6	51.6	49.6

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Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	395	396	397	398
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	50.0 - 52.0	52.0 - 54.0	55.0 - 57.0	57.0 - 59.0
Field Sample No.	395	396	397	398
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	99	100	99	99
% Coarse Sand (-No. 10 + No.40)	0	0	1	0
% Fine Sand (-No. 40 + No. 200)	1	8	4	1
% Silt (0.074 - 0.005 mm)	41	52	35	8
% Clay (-0.005 mm)	58	40	59	90
Liquid Limit (-No. 40)	71	51	67	81
Plasticity Index (-No. 40)	32	23	35	50
Plastic Limit	38	29	31	31
Soil Color	Gry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(41)	A-7-6(24)	A-7-5(40)	A-7-5(58)
Frost Class	F4	F4	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	53.2	39.0	36.5	32.3

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Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	399	400	401	402
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	60.0 - 62.0	62.0 - 64.0	70.0 - 72.0	72.0 - 74.0
Field Sample No.	399	400	401	402
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	99	82	98	99
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	0	0	1	1
% Silt (0.074 - 0.005 mm)	3	1	0	13
% Clay (-0.005 mm)	96	81	97	86
Liquid Limit (-No. 40)	94	98	94	76
Plasticity Index (-No. 40)	58	62	58	47
Plastic Limit	36	36	37	29
Soil Color	Gry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(69)	A-7-5(58)	A-7-5(69)	A-7-6(55)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	57.0	28.4	59.9	28.0

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Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	403	404	405	406
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	80.0 - 82.0	82.0 - 84.0	90.0 - 92.0	92.0 - 94.0
Field Sample No.	403	404	405	406
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	99	99	99	97
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	0	0	0	0
% Silt (0.074 - 0.005 mm)	13	18	14	20
% Clay (-0.005 mm)	85	81	85	77
Liquid Limit (-No. 40)	77	69	74	74
Plasticity Index (-No. 40)	49	41	43	48
Plastic Limit	28	28	30	26
Soil Color	Gry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(57)	A-7-6(48)	A-7-5(51)	A-7-6(54)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	44.8	35.4	47.9	23.3

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Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	407	408	409	410
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	100.0 - 102.0	102.0 - 104.0	110.0 - 112.0	112.0 - 114.0
Field Sample No.	407	408	409	410
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	0	0	0	0
% Silt (0.074 - 0.005 mm)	12	12	5	16
% Clay (-0.005 mm)	88	88	95	84
Liquid Limit (-No. 40)	76	73	89	68
Plasticity Index (-No. 40)	50	47	61	44
Plastic Limit	26	26	28	24
Soil Color	Gry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(59)	A-7-6(55)	A-7-6(72)	A-7-6(51)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	46.1	26.9	49.2	21.0

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300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	411	412	413	414
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	120.0 - 122.0	122.0 - 124.0	130.0 - 132.0	132.0 - 134.0
Field Sample No.	411	412	413	414
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	99
% Pass. No. 10 Sieve	99	100	99	97
% Coarse Sand (-No. 10 + No.40)	0	0	2	4
% Fine Sand (-No. 40 + No. 200)	0	0	4	6
% Silt (0.074 - 0.005 mm)	18	27	3	7
% Clay (-0.005 mm)	81	73	89	79
Liquid Limit (-No. 40)	68	59	59	80
Plasticity Index (-No. 40)	44	35	31	56
Plastic Limit	24	24	27	24
Soil Color	Gry	Gry	Gry	Gry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(50)	A-7-6(41)	A-7-6(33)	A-7-6(54)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	43.2	34.9	55.0	40.1

Scott W. Wutzke
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Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-25-2014	**Date Reported**	9/30/2014	**Boring Number**	1
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	415	416	417	418
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	137.0 - 138.0	138.0 - 140.0	150.0 - 152.0	160.0 - 162.0
Field Sample No.	415	416	417	418
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	98	98	97	96
% Pass. No. 10 Sieve	97	94	93	90
% Coarse Sand (-No. 10 + No.40)	2	8	9	10
% Fine Sand (-No. 40 + No. 200)	56	17	19	19
% Silt (0.074 - 0.005 mm)	28	40	39	33
% Clay (-0.005 mm)	12	28	26	29
Liquid Limit (-No. 40)	0	31	33	34
Plasticity Index (-No. 40)	0	13	16	17
Plastic Limit	0	18	17	16
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	SNDY LM	CLY LM	CLY LM	CLY LM
Soil Class (AASHTO M-145)	A-4(0)	A-6(7)	A-6(8)	A-6(8)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	23.6	3.8	4.8	10.3

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Deep Foundations Laboratory Analysis

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	419	420	421	422
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	170.0 - 172.0	180.0 - 182.0	190.0 - 192.0	200.0 - 201.0
Field Sample No.	419	420	421	422
% Pass. 3/8" Sieve	100	98	99	100
% Pass. No. 4 Sieve	96	93	99	98
% Pass. No. 10 Sieve	91	87	97	93
% Coarse Sand (-No. 10 + No.40)	10	7	4	7
% Fine Sand (-No. 40 + No. 200)	20	35	32	24
% Silt (0.074 - 0.005 mm)	33	26	26	35
% Clay (-0.005 mm)	27	18	37	27
Liquid Limit (-No. 40)	34	23	33	20
Plasticity Index (-No. 40)	18	8	20	9
Plastic Limit	16	15	13	11
Soil Color	DrkGry	DrkGry	DrkGry	Tan
Textural Class	CLY LM	SNDY LM	CLY	CLY LM
Soil Class (AASHTO M-145)	A-6(8)	A-4(1)	A-6(9)	A-4(2)
Frost Class	F3	F3	F3	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	16.6	14.0	12.3	5.3

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Report Number	SS-26-2014	**Date Reported**	9/30/2014	**Boring Number**	2
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	423	424	425	426
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	2.0 - 4.0	4.0 - 6.0	6.0 - 8.0	8.0 - 10.0
Field Sample No.	423	424	425	426
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10 + No.40)	0	1	1	0
% Fine Sand (-No. 40 + No. 200)	2	2	2	2
% Silt (0.074 - 0.005 mm)	27	28	28	32
% Clay (-0.005 mm)	71	70	70	66
Liquid Limit (-No. 40)	73	73	76	0
Plasticity Index (-No. 40)	37	33	34	0
Plastic Limit	36	39	43	0
Soil Color	Blk	Blk	BrnBlk	BrnBlk
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(45)	A-7-5(42)	A-7-5(43)	A-4(0)
Frost Class	F4	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	22.3	45.2	49.8	38.8

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Report Number	SS-26-2014	**Date Reported**	9/30/2014	**Boring Number**	2
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	427	428	429	430
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	10.0 - 12.0	12.0 - 14.0	15.0 - 17.0	17.0 - 19.0
Field Sample No.	427	428	429	430
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	3	1	1	1
% Silt (0.074 - 0.005 mm)	43	30	24	32
% Clay (-0.005 mm)	53	68	75	68
Liquid Limit (-No. 40)	61	78	81	76
Plasticity Index (-No. 40)	27	41	42	40
Plastic Limit	34	37	39	35
Soil Color	Brn	Brn	Brn	Brn
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(33)	A-7-5(51)	A-7-5(52)	A-7-5(50)
Frost Class	F4	F4	F4	F4
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	48.5	44.3	44.6	47.0

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	431	432	433	434
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	20.0 - 22.0	22.0 - 24.0	25.0 - 27.0	27.0 - 29.0
Field Sample No.	431	432	433	434
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	1	1	1	5
% Silt (0.074 - 0.005 mm)	28	22	37	53
% Clay (-0.005 mm)	71	77	63	42
Liquid Limit (-No. 40)	76	78	74	53
Plasticity Index (-No. 40)	39	42	39	26
Plastic Limit	38	36	35	28
Soil Color	Brn	Brn	BlkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(49)	A-7-5(51)	A-7-5(48)	A-7-6(29)
Frost Class	F4	F4	F4	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	47.5	48.7	53.1	50.6

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	435	436	437	438
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	30.0 - 32.0	32.0 - 34.0	35.0 - 37.0	37.0 - 39.0
Field Sample No.	435	436	437	438
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	2	9	5	3
% Silt (0.074 - 0.005 mm)	39	48	50	54
% Clay (-0.005 mm)	59	42	46	43
Liquid Limit (-No. 40)	63	50	55	53
Plasticity Index (-No. 40)	32	23	27	25
Plastic Limit	31	28	28	29
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(38)	A-7-6(23)	A-7-6(30)	A-7-6(28)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	50.8	49.8	41.5	41.9

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	439	440	441	442
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	40.0 - 42.0	42.0 - 44.0	45.0 - 47.0	47.0 - 49.0
Field Sample No.	439	440	441	442
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	100	100	100
% Coarse Sand (-No. 10 + No.40)	1	0	0	0
% Fine Sand (-No. 40 + No. 200)	3	7	5	7
% Silt (0.074 - 0.005 mm)	60	51	48	43
% Clay (-0.005 mm)	37	42	47	51
Liquid Limit (-No. 40)	56	52	55	57
Plasticity Index (-No. 40)	26	24	28	29
Plastic Limit	30	28	27	28
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	SLTY CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(31)	A-7-6(26)	A-7-6(31)	A-7-6(31)
Frost Class	F4	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	46.3	41.3	48.4	41.1

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Report Number	SS-26-2014	**Date Reported**	9/30/2014	**Boring Number**	2
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	443	444	445	446
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	50.0 - 52.0	52.0 - 54.0	55.0 - 57.0	57.0 - 59.0
Field Sample No.	443	444	445	446
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	99	100	100	100
% Pass. No. 10 Sieve	96	100	100	100
% Coarse Sand (-No. 10 + No.40)	2	1	0	0
% Fine Sand (-No. 40 + No. 200)	3	7	5	3
% Silt (0.074 - 0.005 mm)	23	45	48	15
% Clay (-0.005 mm)	68	48	47	82
Liquid Limit (-No. 40)	69	56	57	78
Plasticity Index (-No. 40)	43	28	29	50
Plastic Limit	26	28	28	28
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(45)	A-7-6(30)	A-7-6(32)	A-7-6(57)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	41.4	26.3	45.7	60.0

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	447	448	449	450
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	65.0 - 67.0	67.0 - 69.0	75.0 - 77.0	77.0 - 79.0
Field Sample No.	447	448	449	450
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	95	100	100	100
% Pass. No. 10 Sieve	94	100	100	100
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	0	0	0	0
% Silt (0.074 - 0.005 mm)	1	1	11	13
% Clay (-0.005 mm)	93	98	88	87
Liquid Limit (-No. 40)	99	100	79	71
Plasticity Index (-No. 40)	66	69	53	46
Plastic Limit	33	31	27	25
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(73)	A-7-5(82)	A-7-6(62)	A-7-6(53)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	63.5	64.5	49.0	41.2

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Report Number	SS-26-2014	**Date Reported**	9/30/2014	**Boring Number**	2
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	451	452	453	454
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	85.0 - 87.0	87.0 - 89.0	95.0 - 97.0	97.0 - 99.0
Field Sample No.	451	452	453	454
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	99
% Pass. No. 10 Sieve	100	99	100	98
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	0	0	0	0
% Silt (0.074 - 0.005 mm)	9	14	14	14
% Clay (-0.005 mm)	90	85	86	85
Liquid Limit (-No. 40)	75	74	71	71
Plasticity Index (-No. 40)	50	49	47	46
Plastic Limit	25	25	24	25
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(58)	A-7-6(56)	A-7-6(54)	A-7-6(52)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	49.7	43.2	46.4	39.4

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	455	456	457	458
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	105.0 - 107.0	107.0 - 109.0	115.0 - 117.0	117.0 - 119.0
Field Sample No.	455	456	457	458
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	100	100	100	100
% Pass. No. 10 Sieve	100	99	100	100
% Coarse Sand (-No. 10 + No.40)	0	0	0	0
% Fine Sand (-No. 40 + No. 200)	0	0	0	0
% Silt (0.074 - 0.005 mm)	11	9	14	16
% Clay (-0.005 mm)	88	90	86	84
Liquid Limit (-No. 40)	76	77	73	70
Plasticity Index (-No. 40)	49	51	47	45
Plastic Limit	26	26	26	25
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-6(58)	A-7-6(59)	A-7-6(55)	A-7-6(53)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	49.8	56.3	48.9	45.4

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	459	460	461	462
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	125.0 - 127.0	127.0 - 129.0	135.0 - 137.0	137.0 - 139.0
Field Sample No.	459	460	461	462
% Pass. 3/8" Sieve	95	100	82	95
% Pass. No. 4 Sieve	95	100	80	86
% Pass. No. 10 Sieve	95	99	77	79
% Coarse Sand (-No. 10 + No.40)	0	1	3	10
% Fine Sand (-No. 40 + No. 200)	1	2	6	15
% Silt (0.074 - 0.005 mm)	10	4	12	17
% Clay (-0.005 mm)	84	91	56	37
Liquid Limit (-No. 40)	83	88	73	46
Plasticity Index (-No. 40)	47	59	49	28
Plastic Limit	36	29	24	18
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-7-5(54)	A-7-6(66)	A-7-6(32)	A-7-6(11)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	56.3	56.1	46.3	47.6

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County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	463	464	465	466
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	145.0 - 147.0	147.0 - 149.0	155.0 - 157.0	157.0 - 159.0
Field Sample No.	463	464	465	466
% Pass. 3/8" Sieve	68	100	72	100
% Pass. No. 4 Sieve	66	98	71	95
% Pass. No. 10 Sieve	64	94	68	91
% Coarse Sand (-No. 10 + No.40)	6	10	7	10
% Fine Sand (-No. 40 + No. 200)	13	20	14	19
% Silt (0.074 - 0.005 mm)	23	35	28	37
% Clay (-0.005 mm)	21	28	20	26
Liquid Limit (-No. 40)	33	34	33	32
Plasticity Index (-No. 40)	17	18	16	16
Plastic Limit	17	16	17	17
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	SNDY CLY LM	CLY LM	SNDY LM	CLY LM
Soil Class (AASHTO M-145)	A-6(3)	A-6(9)	A-6(4)	A-6(7)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	17.8	15.2	21.4	11.8

Scott W. Wutzke
Testing Lab. Supervisor

Date Printed: 3/10/2015

Deep Foundations Laboratory Analysis

Department of Transportation, Materials and Research Division
300 Airport Road, Bismarck ND 58504 (701) 328-6900

Report Number	SS-26-2014	**Date Reported**	9/30/2014	**Boring Number**	2
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	467	468	469	470
Distance From CenterLine (Ft.)	0 ft	0 ft	0 ft	0 ft
Depth, Ft.	165.0 - 167.0	167.0 - 169.0	175.0 - 177.0	185.0 - 186.2
Field Sample No.	467	468	469	470
% Pass. 3/8" Sieve	97	100	100	99
% Pass. No. 4 Sieve	96	98	97	93
% Pass. No. 10 Sieve	92	93	91	86
% Coarse Sand (-No. 10 + No.40)	8	9	10	18
% Fine Sand (-No. 40 + No. 200)	18	21	21	22
% Silt (0.074 - 0.005 mm)	38	33	31	25
% Clay (-0.005 mm)	28	30	30	21
Liquid Limit (-No. 40)	31	34	33	23
Plasticity Index (-No. 40)	14	17	17	10
Plastic Limit	18	16	16	13
Soil Color	DrkGry	DrkGry	DrkGry	DrkGry
Textural Class	CLY LM	CLY LM	CLY LM	SNDY CLY LM
Soil Class (AASHTO M-145)	A-6(7)	A-6(8)	A-6(8)	A-4(1)
Frost Class	F3	F3	F3	F3
Optimum Moisture (%)				
Maximum Dry Density (pcf)				
Ph of Soil				
% Organic Content				
Pocket Pentrometer				
Depth (Ft.) | Moisture (%)				
Avg. Moisture (%)	16.6	14.4	15.1	11.5

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Report Number	SS-26-2014	**Date Reported**	9/30/2014	**Boring Number**	2
County	PEMBINA	**Submitted By**	Naumann	**Project Number**	BRI-6-029(124)214
District		**Structure Location**		**PCN**	20691

Comments

Lab Number	471
Distance From CenterLine (Ft.)	0 ft
Depth, Ft.	195.0 - 196.1
Field Sample No.	471
% Pass. 3/8" Sieve	100
% Pass. No. 4 Sieve	97
% Pass. No. 10 Sieve	92
% Coarse Sand (-No. 10 + No.40)	7
% Fine Sand (-No. 40 + No. 200)	26
% Silt (0.074 - 0.005 mm)	21
% Clay (-0.005 mm)	39
Liquid Limit (-No. 40)	32
Plasticity Index (-No. 40)	19
Plastic Limit	12
Soil Color	DrkGry
Textural Class	CLY
Soil Class (AASHTO M-145)	A-6(8)
Frost Class	F3
Optimum Moisture (%)	
Maximum Dry Density (pcf)	
Ph of Soil	
% Organic Content	
Pocket Pentrometer	
Depth (Ft.) | Moisture (%)	
Avg. Moisture (%)	13.3

Scott W. Wutzke
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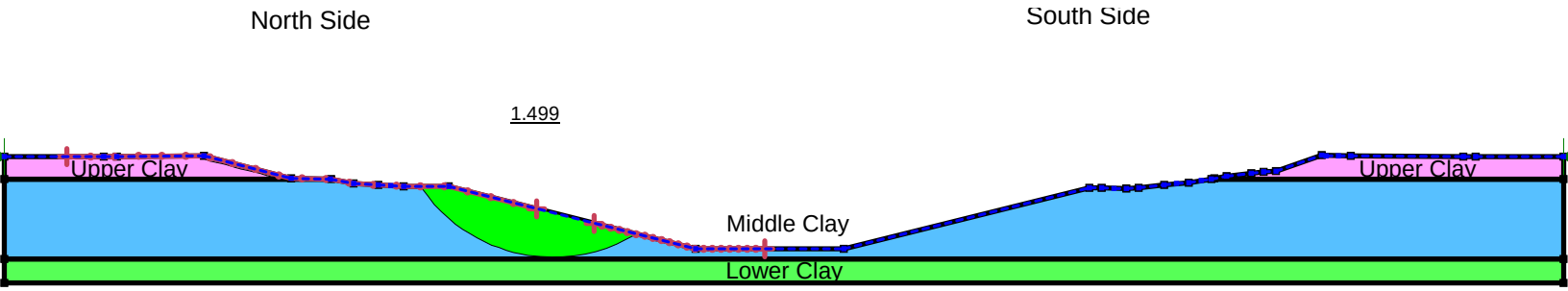
APPENDIX C

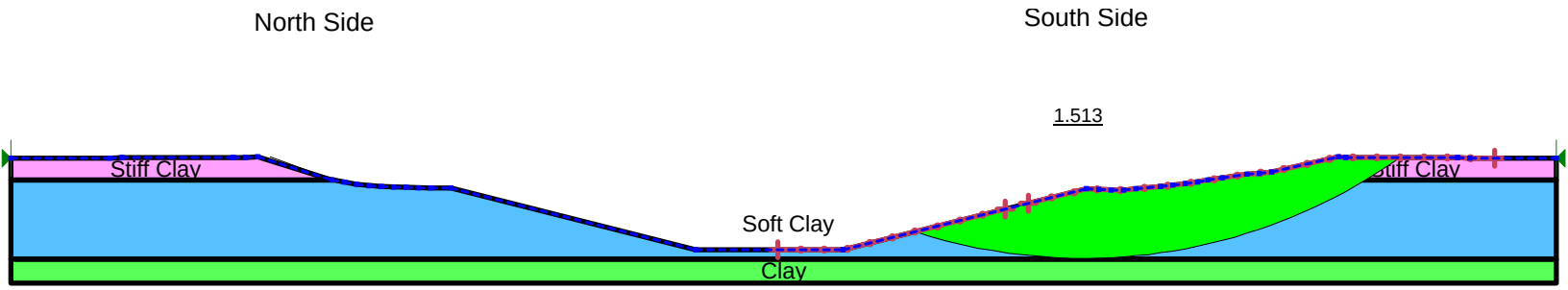
Stability Analysis



Name: Upper Clay
Unit Weight: 105 pcf
Cohesion': 750 psf
Phi': 0 °

Name: Lower Clay
Unit Weight: 107.5 pcf
Cohesion': 1,100 psf
Phi': 0 °

Name: Middle Clay
Unit Weight: 107.5 pcf
Cohesion': 375 psf
Phi': 0 °



Name: Clay
Unit Weight: 107.5 pcf
Cohesion': 1,100 psf
Phi': 0 °

Name: Soft Clay
Unit Weight: 107.5 pcf
Cohesion': 375 psf
Phi': 0 °

Name: Stiff Clay
Unit Weight: 105 pcf
Cohesion': 750 psf
Phi': 0 °