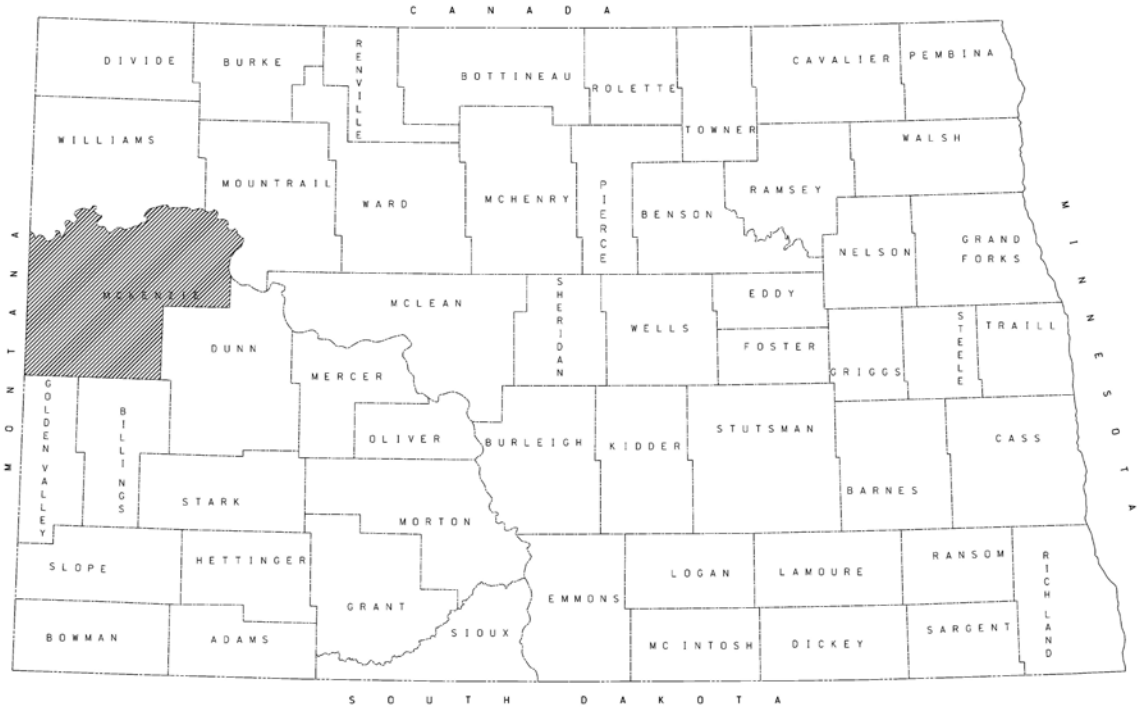
LINEAR SOILS SURVEY AND RECOMMENDATIONS

PROJECT NO. AC-SS-7-068(011)000

PCN 21180

COUNTY McKenzie

Highway 68 RP 0.000 to RP 28.114



PREPARED BY: Jeff Jirava, P.E.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

November 2015

AC-SS-7-068(011)000

State Line East to Junction US 85

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 11/16/15 and the original document is stored at the North Dakota Department of Transportation.

REGISTERED PROFESSIONAL ENGINEER
JEFF
JIRAVA
PE-5950
DATE 11/16/15
NORTH DAKOTA

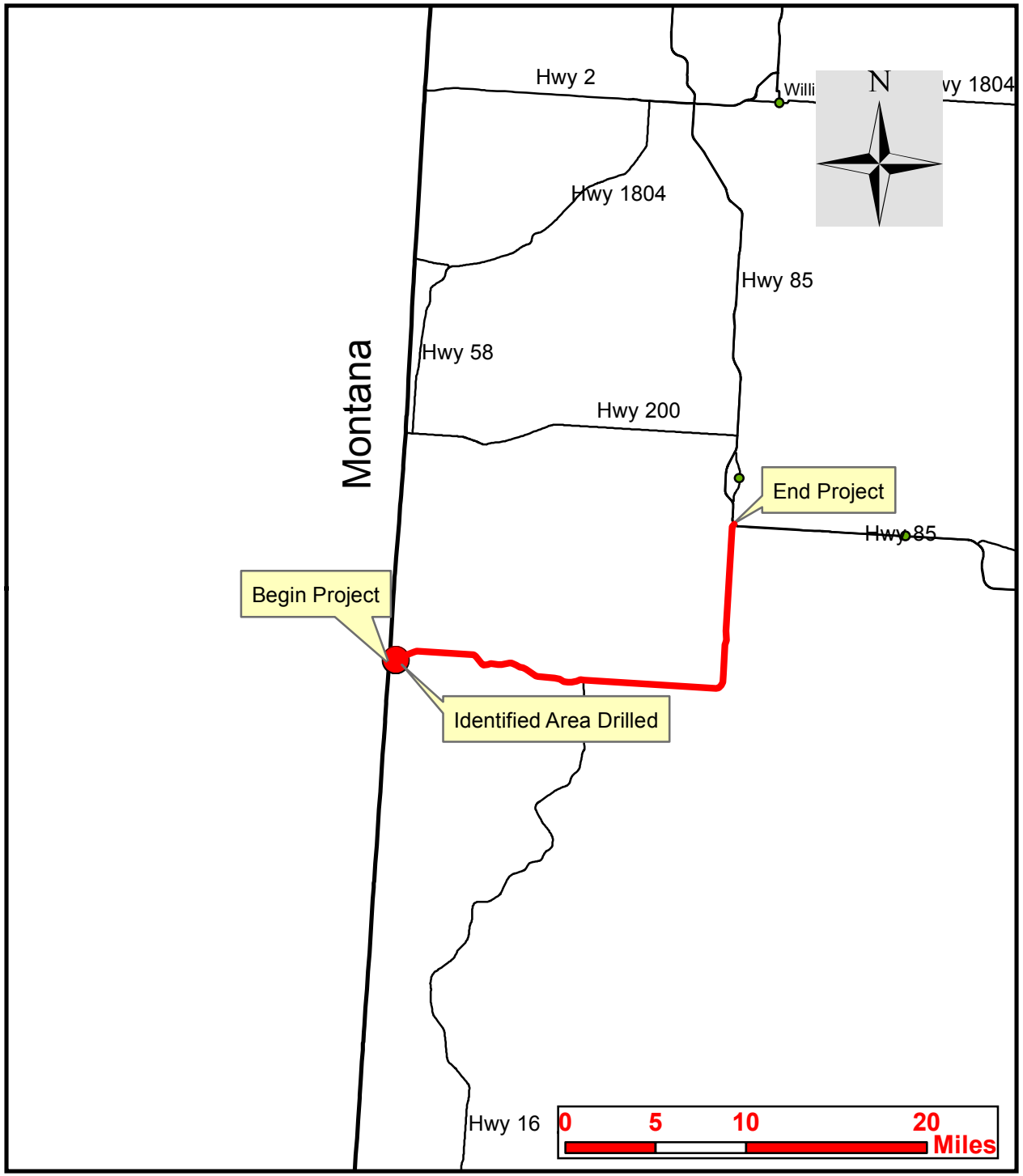
Jeff Jirava, P.E.

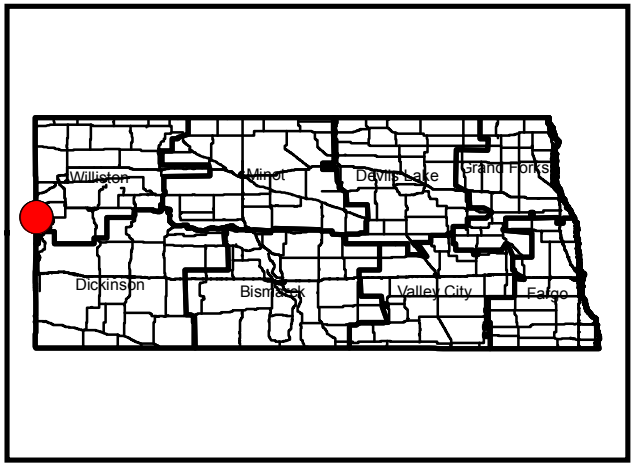
16 NOV 2015
Date

Linear Soils Survey and Recommendations

Project: AC-SS-7-068(011)000
PCN: 21169
Scope: Hot Bituminous Surfacing
Length: 28.1423 Miles
Location: State Line East to Junction US 85

Drilled Identified Area





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Introduction

Location: State Line East to Junction US 85
Reference Points: 0.000 to 28.114
Project Length: 28.114
Proposed Project Scope: Hot Bituminous Surfacing
Investigation Scope: Identified Areas

Existing Roadway Section

Construction History

Table 1 - Construction History RP 0.000 to RP 11.441

Construction History				
Year	**Construction**	**Depth (in)**	**Width (ft)**	**Oil**
1970	Grade		38.0	
1970	Traffic Service Gravel	2.0	36.0	
1972	Bituminous Base	5.0	34.0	SM-K
1978	Hot Bit Pavement	2.5	24.0	120-150
1990	Hot Bit Pavement	2.0	27.0	120-150
1990	Milling	-0.8	24.0	
1990	Salvaged Aggregate Base	1.3	3.0/---/3.0	
1996	Int Cont Patch	1.5		
1997	Contract Chip Seal		27.0	

Table 2 - Construction History RP 11.441 to RP 28.114

Construction History				
Year	**Construction**	**Depth (in)**	**Width (ft)**	**Oil**
1970	Grade		38.0	
1970	Traffic Service Gravel	2.0	36.0	
1971	Bituminous Base	5.0	34.0	SM-K
1978	Hot Bit Pavement	2.5	24.0	120-150
1990	Hot Bit Pavement	2.0	27.0	120-150
1990	Milling	-0.8	24.0	
1990	Salvaged Aggregate Base	1.3	3.0/---/3.0	
1996	Int Cont Patch	1.5		
1997	Contract Chip Seal		27.0	
2006	Microsurfacing		25.0	
2011	Federal Aid Chip Seal		24.0	CRS2P

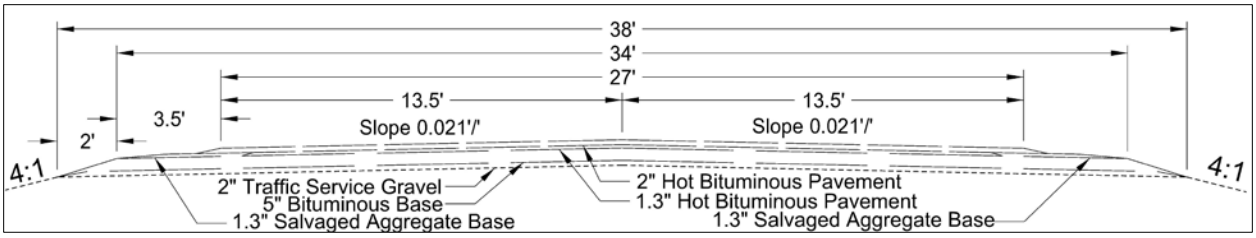

Figure 1 - Existing Typical Section

Existing Roadway Condition

Distress Data

Table 3 - Distress Data (2014)

Reference Point	Alligator Cracking (0-18)	Longitudinal Cracking (0-9)	Transverse Cracking (0-9)	Block Cracking (0-9)	Bituminous Patching (0-18)	Rutting (0-12)
0	3	0	7	0	2	0
1	3	0	7	0	0	0
2	3	4	7	0	4	0
3	3	1	4	0	4	0
4	3	1	4	0	2	0
5	3	1	7	0	0	0
6	3	7	7	0	2	0
7	0	7	4	0	0	0
8	3	4	7	0	0	0
9	3	1	4	0	0	0
10	3	7	4	0	0	0
11	3	4	7	0	0	0
12	3	4	7	0	0	0
13	3	1	7	0	0	0
14	3	4	7	0	0	0
15	3	0	7	0	0	0
16	3	1	4	0	0	0
17	3	7	7	0	0	0
18	3	4	7	0	0	0
19	3	4	4	0	2	0
20	3	0	7	0	0	0
21	3	7	7	0	6	0
22	3	4	4	0	4	0
23	3	1	7	0	6	0
24	3	4	7	0	6	0
25	12	1	4	0	6	0
26	3	4	4	0	6	0
27	0	0	0	0	6	0
28	0	0	0	0	0	0
Average	**3**	**3**	**5**	**0**	**2**	**0**

Ride Data

Table 4 - Ride Data (2014)

Reference Point	Distress Score		Rut (inches)		International Roughness Index (inches/mile)	
	Excellent	≥ 98	Excellent	< 0.25	Excellent	< 61
	Good	88 - 97	Good	0.25 - 0.375	Good	61 - 99
	Fair	77 - 87	Fair	0.376 - 0.50	Fair	100 - 145
	Poor	≤ 76	Poor	> 0.50	Poor	>145
0	87		0.28		115	
1	89		0.35		113	
2	81		0.40		172	
3	87		0.48		133	
4	89		0.54		180	
5	88		0.47		232	
6	80		0.35		243	
7	88		0.31		120	
8	85		0.33		148	
9	91		0.34		142	
10	85		0.30		168	
11	79		0.30		175	
12	85		0.42		145	
13	88		0.35		126	
14	85		0.39		147	
15	89		0.40		103	
16	91		0.41		144	
17	82		0.35		160	
18	85		0.28		150	
19	86		0.41		128	
20	89		0.39		144	
21	76		0.37		139	
22	84		0.42		107	
23	82		0.42		122	
24	79		0.42		149	
25	76		0.40		129	
26	82		0.42		171	
27	93		0.40		142	
28	99		0.05		160	
Average	**86**		**0.37**		**149**	

Maintenance Review

Date of Maintenance Review: 8/19/2015
Materials and Research Person Conducting the Review: Jamie Naumann
District Maintenance Person Conducting Review: Kelly Kulseth

The summary of the identified maintenance areas that were drilled are shown in the following table. The detailed evaluation log delineating all maintenance areas can be found in Appendix B.

Table 5 - Identified Maintenance Areas

Location RP + Feet	Distress Identified	Maintenance Comment
0+2480 to 0+2600	Dip	Been getting worse for the last 5 years

Summary of Soil Analysis

A summary of the locations that were drilled is shown in following table.

Table 6 - Boring Locations Summary

Location RP + Feet	Boring Interval, Depth and Method	Reason for Boring
0+2427 to 0+2638	Identified Areas, 10 feet deep using a solid flight auger.	Obtain subgrade information throughout the area

Soil Sample Distribution

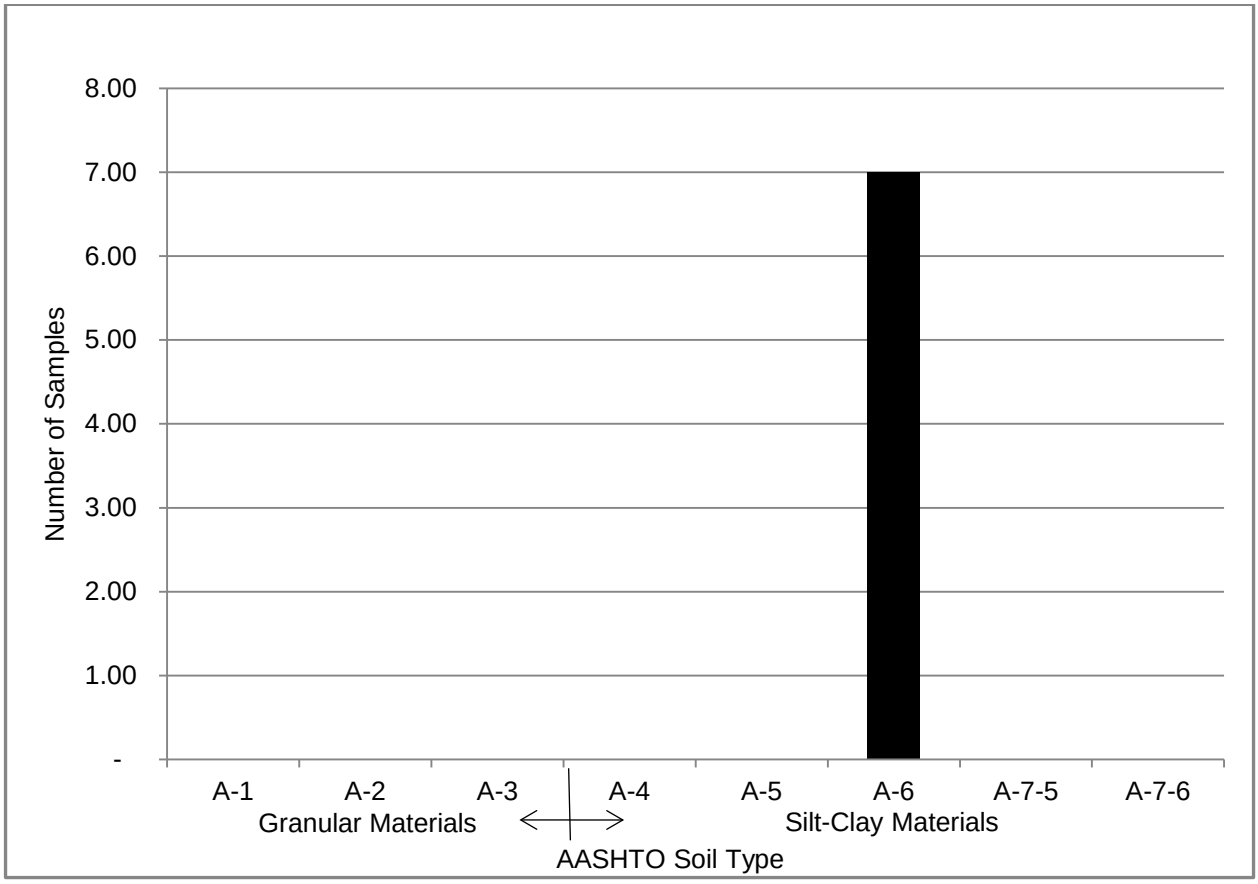

Figure 2 - Soil Sample Distribution

Moisture

The moisture contents provided in this report and summarized below have been obtained from samples taken on 9/16/15.

Table 7 - Summary of In-Place and Optimum Moisture Contents

Quantity	AASHTO Classification	In-Place Moisture Range (%)	In-Place Moisture Average (%)	Optimum Moisture Average (%)	Difference Between Average In-Place and Optimum Moistures (%)
7	A-6	17-20.3	18.3	10.9	7.4

Table 8 - Summary of In-Place versus Optimum Moisture Content

Quantity	AASHTO Classification	Below Optimum	Optimum to Moderate (0 to 6% over optimum)	Moderate to High (6 to 10% over optimum)	High (10 to 16% over optimum)	Very High (> 16% over optimum)
7	A-6	0%	0%	100%	0%	0%

Atterberg Limits

Table 9 - Summary of Atterberg Limits

AASHTO Classification	Liquid Limit Range (%)	Liquid Limit Average (%)	Plastic Limit Range (%)	Plastic Limit Average (%)	Plasticity Index Range (%)	Plasticity Index Average (%)
A-6	29-36	32	16-18	17	12-19	15

Swell Potential

The swell potential, which is based on the Plasticity Index (PI), is shown in the following table.

Table 10 - Swell Potential

Low (Plasticity Index < 25)	Marginal (25 ≤ Plasticity Index ≤ 35)	High (Plasticity Index > 35)
100%	0%	0%

Frost Susceptibility

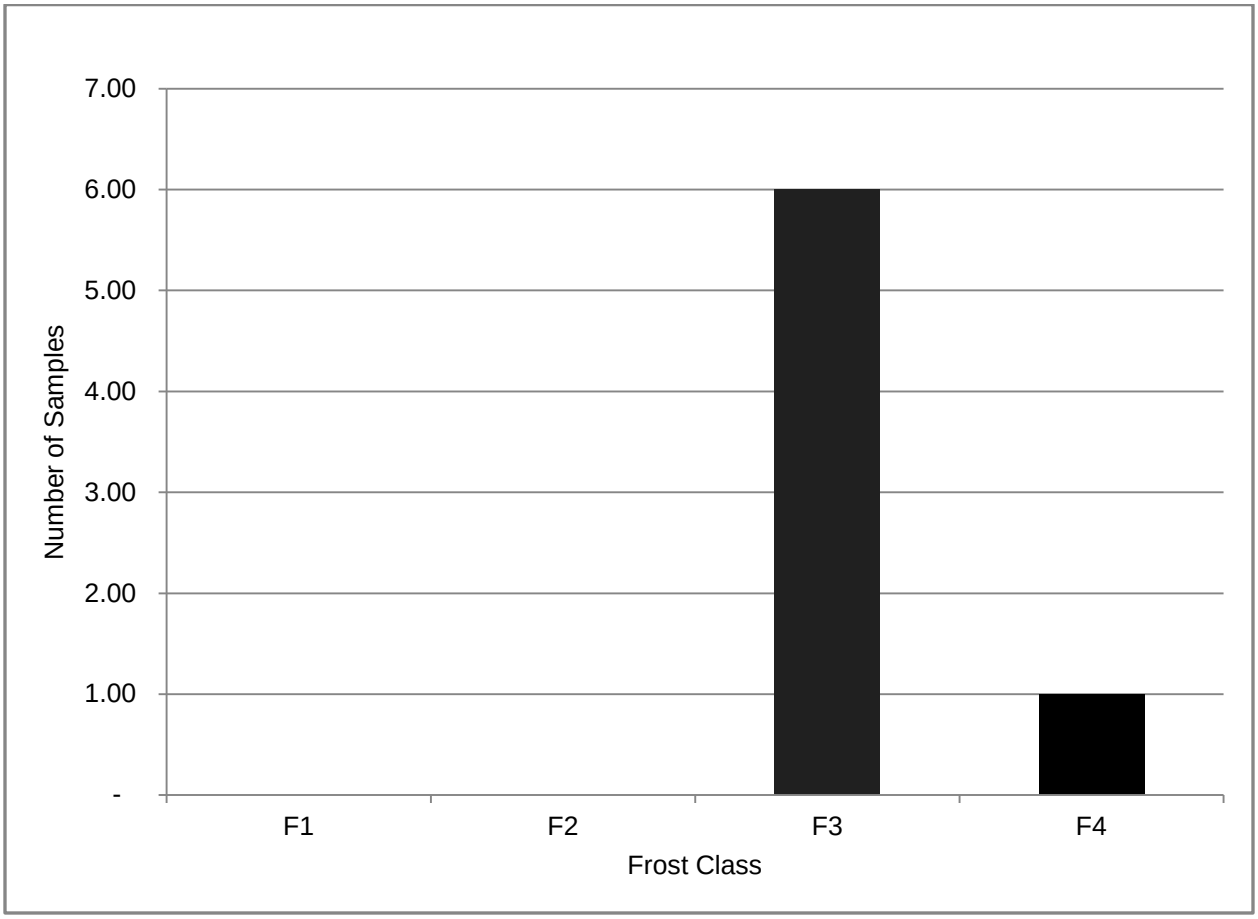

Figure 3 - Frost Susceptibility Distribution

Group Index

The Group Index is a parameter used to evaluate the quality of a soil as a subgrade material. The group index is always zero for A-1, A-2 and A-3 soils (Granular Soils). A group index of 20 or greater indicates a “very poor” subgrade material. The group indices are summarized in the following table.

Table 11 - Group Indices

AASHTO Classification	Group Index Range	Group Index Average
A-6	9-16	12

Design Recommendations

The dip area that was evaluated for a possible subgrade issue did not show any problematic subgrade soils. It is the recommendation of this report to leave the subgrade undisturbed and reconstruct the segment to correct the roadway profile.

Design Information

Dense Graded Base Compaction Method: T-180 – As per section 714.04 A.7

Reconstruction Limits:

Table 12 – Reconstruction Area

Location	Reconstruction Section
0+2480 to 0+2600	*As per the Pavement Design Recommendation dated 11/9/2015.
*The subgrade should be left undisturbed and the geogrid should be placed directly on the subgrade. The profile should be corrected by thickening up the dense graded base on top of the geogrid.	

The recommendations in this report are based on the scope specified in the Introduction. If the scope of work, vertical profile or horizontal alignment is changed, in either the conceptual phase or the design phase, the Geotechnical Engineer must be notified as soon as possible to ensure that there is adequate geotechnical information addressing these areas.

APPENDIX A

SOIL CLASSIFICATION AND FROST SUSCEPTIBILITY

AASHTO Soil Classification System

Table 5.1. AASHTO Classification System

General Classification	*Granular materials (35% or less passing No. 200 Sieve (0.075 mm)*							*Silt-clay Materials More than 35% passing No. 200 Sieve (0.075 mm)*			
Group Classification	*A—1*		*A—3*	*A—2*				*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*
(*a*) Sieve Analysis: Percent Passing											
(*i*) 2.00 mm (No. 10)	50 max										
(*ii*) 0.425 mm (No. 40)	30 max	50 max	51 min								
(*iii*) 0.075 mm (No. 200)	15 max	25 max	10 max	35 max	35 max	35 max	35 max	36 min	36 min	36 min	36 min
(*b*) Characteristics of fraction passing 0.425 mm (No. 40)											
(*i*) Liquid limit				40 max	41 min	40 max	41 min	40 max	41 min	40 max	41 min
(*ii*) Plasticity index	6 max		N.P.	10 max	10 max	11 min	11 min	10 max	10 max	11 min	11 min*
(*c*) Usual types of significant Constituent materials	Stone Fragments Gravel and sand		Fine Sand	Silty or Clayey Gravel Sand				Silty Soils		Clayey Soils	
(*d*) General rating as subgrade.	Excellent to Good							Fair to Poor			

* If plasticity index is equal to or less than (liquid Limit—30), the soil is A—7—5 (*i.e.* PL > 30%)
If plasticity index is greater than (Liquid Limit—30), the soil is A—7—6 (*i.e.* PL < 30%)

Frost Susceptibility Index (Bases on US Army Corps of Engineers)

Frost Class	Frost Susceptibility	Soil Type	Percent Finer than 0.02 mm by weight %
F1	Negligible to Low	• Gravely Soils	3 – 10
F2	Low to Medium	• Gravely Soils • Sands	10 – 20 3 – 15
F3	High	• Gravelly Soils • Sands, except very fine silty sands • Clays, PI > 12	Greater than 20 Greater than 15 ---
F4	Very High	• All Silts • Very Fine Silty Sands • Clays, PI > 12 • Varved Clays and other fine-grained banded sediments	--- Greater than 15 --- ---

APPENDIX B

PAVEMENT EVALUATION AND PHOTOS

PAVEMENT EVALUATION LOG FOR LINEAR SOIL SURVEY

North Dakota Department of Transportation, Materials & Research
SFN 60472 (9-2013)

Project Number	PCN	Date of Survey
SS-7-068(011)000	21180	8/19/2015
Section Maintenance Contact: Kelly Kulseth		Completed By: Jamie Naumann
Highway Reference Points: 0+0000 to 19+0000	Surface Type: Asphalt	

Location	Pavement Distress	Description	Maintenance Comment	Picture Number	Drilling Required
0+0000 to 1+4000	Transv. Cracks	Depressed			No
0+2480 to 0+2600	Other	Dip	Been there getting worse for last 5 years.	1-7	Yes
1+4000 to 5+0000	Rutting	LC-WP, MHP, TC-D			No
4+0600 to 4+1100	Longitude Cracks	WP	MHP	8-10	No
4+2400 to 4+2500	Longitude Cracks	Dip, LC-WP	MHP	11-13	No
5+0000 to 11+0300	Transv. Cracks	Depressed, SV		14-16	No
11+0300 to 11+1000	Transv. Cracks	Down hill	MHP	17-18	No
11+1000 to 17+1000	Transv. Cracks	Depressed, RT	Miles 16-17 SV, RT	19-20	No
17+1000 to 19+0000	Transv. Cracks	Depressed			No

Comments

PAVEMENT EVALUATION LOG FOR LINEAR SOIL SURVEY

North Dakota Department of Transportation, Materials & Research
SFN 60472 (9-2013)

Project Number	PCN	Date of Survey
SS-7-068(011)000	21180	8/19/2015
Section Maintenance Contact: Kelly Kulseth		Completed By: Jamie Naumann
Highway Reference Points: 19+0000 to 28+0600	Surface Type: Asphalt	

Location	Pavement Distress	Description	Maintenance Comment	Picture Number	Drilling Required
19+0000 to 23+0000	Longitude Cracks	WP,RT, SV, TC-D	MBP	21-22	No
23+0000 to 28+0600	Transv. Cracks	Depressed	MBP	23-31	No
27+3879 to 27+3925	Rutting	SV	MBP	32-38	No
	Select One				Select One
	Select One				Select One
	Select One				Select One
	Select One				Select One
	Select One				Select One
	Select One				Select One

Comments

Met with Kelly Kulseth on 8/19/2015 and he indicated these areas of greatest distress. The last date of crack seal was unknown. All of the milling and chip seals were done that day. The MBP and MHP have been done very year for last 5 years as worse spots arose. Some areas had 1.3' of asphalt according to the coring crew out that day. The rutting was as deep as 0.4' in both tires of a duel vehicle in right track mostly. East and North bound lanes much worse.

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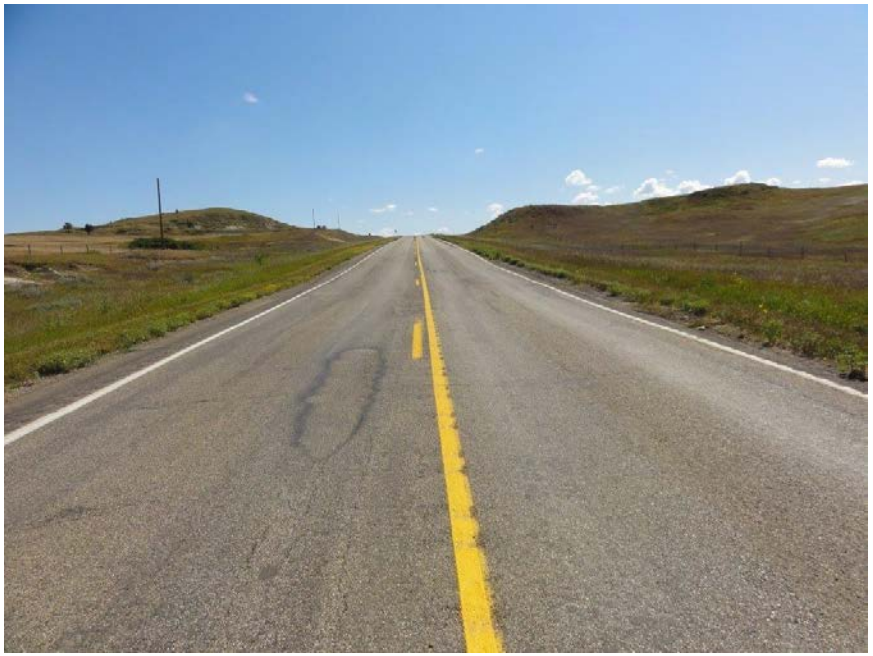

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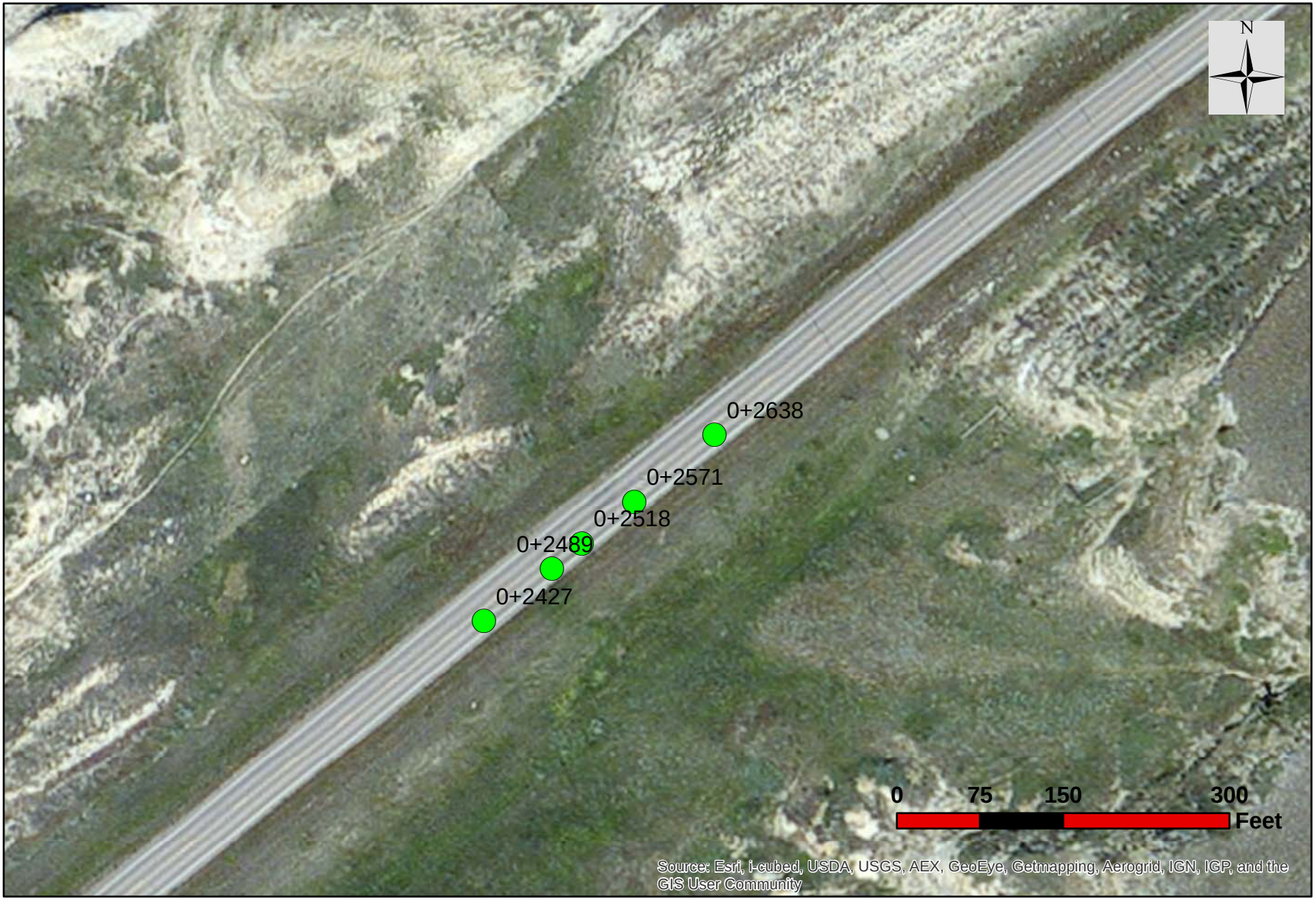
APPENDIX C

BORING LOCATIONS



Legend

Boring Locations

Project Number: AC-SS-7-068(011)000

APPENDIX D

SUMMARY OF SOILS ANALYSIS

Project No.: SS-7-068(011)000

PCN: 21180

Color Key

Swell Potential:	Low	Marginal	High	Moisture Content:	Below PL	0-5% Over PL	>5% Over PL
Group Index:	GI≤20	GI>20		Ave. In-Place: Moisture Content	MC < Opt.	0 ≤ MC < 6% Over opt.	6 ≤ MC < 10% Over opt.	10 ≤ MC < 16% Over opt.	MC >16% Over opt.

Lab No.	STA	Offset	Depth of Sample (ft)	Plastic Limit (PL)	AASHTO Class	Group Index	Optimum Moisture	Swell Potential (PI)	Ave. In-Place Moisture	Moisture Content @ Depth (ft)																									Frost Class
										2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
1273	0+2427	Rt 7 EB	0.5-6	16.1	A-6(10)	10	10.7	14	17.8	19.2	14.5	19.2	20.8	11.3	17.6	18.2	21.0	18.4																	F3
1274	0+2489	Rt 7 EB	0.8-10	17.8	A-6(9)	9	11.0	12	18.6	16.2	18.1	20.9	20.6	16.0	17.7	17.5	21.1	19.5																	F3
1275	0+2518	Rt 7 EB	0.8-6.5	15.9	A-6(16)	16	11.2	19	20.3	16.7	16.5	26.6	19.9	21.9																					F3
1276	0+2518	Rt 7 EB	6.5-10	17.6	A-6(10)	10	11.2	12	18.3						17.5	17.0	19.2	19.4																	F4
1277	0+2571	Rt 7 EB	0.6-5	16.2	A-6(9)	9	10.3	13	17.0	18.4	15.9	18.8	14.9																						F3
1278	0+2571	Rt 7 EB	5-10	17.8	A-6(16)	16	11.1	19	18.7					18.9	18.4	19.0	18.6	18.4																	F3
1279	0+2638	Rt 7 EB	0.4-10	17.7	A-6(11)	11	10.9	14	17.2	13.9	19.5	17.6	19.9	18.2	17.4	16.5	15.4	16.2																	F3

APPENDIX E

LAB RESULTS

Linear Laboratory Analysis

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

Report Number	SS-48-2015	**Date Reported**	10/7/2015	**District**	Bismarck
County	MCKENZIE	**Submitted By**	Naumann	**Project Number**	SS-7-068(011)000
		AASHTO Test Method	T-180	**PCN**	21180

Comments

Lab Number	1273	1274	1275	1276
Reference Pt + Feet	0+2427	0+2489	0+2518	0+2518
Distance From CenterLine (Ft.)	Rt 7 EB	Rt 7 EB	Rt 7 EB	Rt 7 EB
Depth, Ft.	0.5 - 6.0	0.8 - 10.0	0.8 - 6.5	6.5 - 10.0
Field Sample No.	1273	1274	1275	1276
% Pass. 3/8" Sieve	100	100	100	100
% Pass. No. 4 Sieve	99	100	99	100
% Pass. No. 10 Sieve	97	97	99	99
% Coarse Sand (-No. 10 + No. 40)	2	2	2	1
% Fine Sand (-No. 40 + No. 200)	11	8	8	8
% Silt (0.074 - 0.005 mm)	49	59	46	56
% Clay (-0.005 mm)	35	29	43	34
Liquid Limit (-No. 40)	30	30	35	30
Plasticity Index (-No. 40)	14	12	19	12
Plastic Limit	16	18	16	18
Soil Color	BRN/GRY/BLK	BRN/GRY	BRN	BRN
Textural Class	CLY	SLTY CLY LM	CLY	SLTY CLY
Soil Class (AASHTO M-145)	A-6(10)	A-6(9)	A-6(16)	A-6(10)
Frost Class	F3	F3	F3	F4
Optimum Moisture (%)	10.7	11.0	11.2	11.2
Maximum Dry Density (pcf)	126.7	126.2	125.7	125.0
% Organic Content				

Depth (Ft.)	**Moisture (%)**	**Depth (Ft.)**	**Moisture (%)**	**Depth (Ft.)**	**Moisture (%)**	**Depth (Ft.)**	**Moisture (%)**
2	19.2	2	16.2	2	16.7	7	17.5
3	14.5	3	18.1	3	16.5	8	17.0
4	19.2	4	20.9	4	26.6	9	19.2
5	20.8	5	20.6	5	19.9	10	19.4
6	11.3	6	16.0	6	21.9		18.3
7	17.6	7	17.7		20.3		
8	18.2	8	17.5				
9	21.0	9	21.1				
10	18.4	10	19.5				
Avg. Moisture of Sample Depth	17.1		18.6				

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 11/13/2015

Linear Laboratory Analysis

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

Report Number	SS-48-2015	**Date Reported**	10/7/2015	**District**	Bismarck
County	MCKENZIE	**Submitted By**	Naumann	**Project Number**	SS-7-068(011)000
		AASHTO Test Method	T-180	**PCN**	21180

Comments

Lab Number	1277	1278	1279
Reference Pt + Feet	0+2571	0+2571	0+2638
Distance From CenterLine (Ft.)	Rt 7 EB	Rt 7 EB	Rt 7 EB
Depth, Ft.	0.6 - 5.0	5.0 - 10.0	0.4 - 10.0
Field Sample No.	1277	1278	1279
% Pass. 3/8" Sieve	100	100	100
% Pass. No. 4 Sieve	99	99	100
% Pass. No. 10 Sieve	98	99	99
% Coarse Sand (-No. 10 + No. 40)	2	1	1
% Fine Sand (-No. 40 + No. 200)	12	8	12
% Silt (0.074 - 0.005 mm)	50	45	53
% Clay (-0.005 mm)	34	45	33
Liquid Limit (-No. 40)	29	36	32
Plasticity Index (-No. 40)	13	19	14
Plastic Limit	16	18	18
Soil Color	BRN/GRY	BRN/GRY	BRN
Textural Class	CLY	CLY	CLY
Soil Class (AASHTO M-145)	A-6(9)	A-6(16)	A-6(11)
Frost Class	F3	F3	F3
Optimum Moisture (%)	10.3	11.1	10.9
Maximum Dry Density (pcf)	127.9	126.3	125.8
% Organic Content			

Depth (Ft.)	**Moisture (%)**		**Depth (Ft.)**	**Moisture (%)**		**Depth (Ft.)**	**Moisture (%)**
2	18.4		6	18.9		2	13.9
3	15.9		7	18.4		3	19.5
4	18.8		8	19.0		4	17.6
5	14.9		9	18.6		5	19.9
Avg. Moisture of Sample Depth	17.0		10	18.4		6	18.2
				18.7		7	17.4
						8	16.5
						9	15.4
						10	16.2
							17.1

Scott W. Wutzke, Testing Lab Supervisor
Date Printed: 11/13/2015

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation	Date		
T-180	**11/4/2015**		**1273**

Density

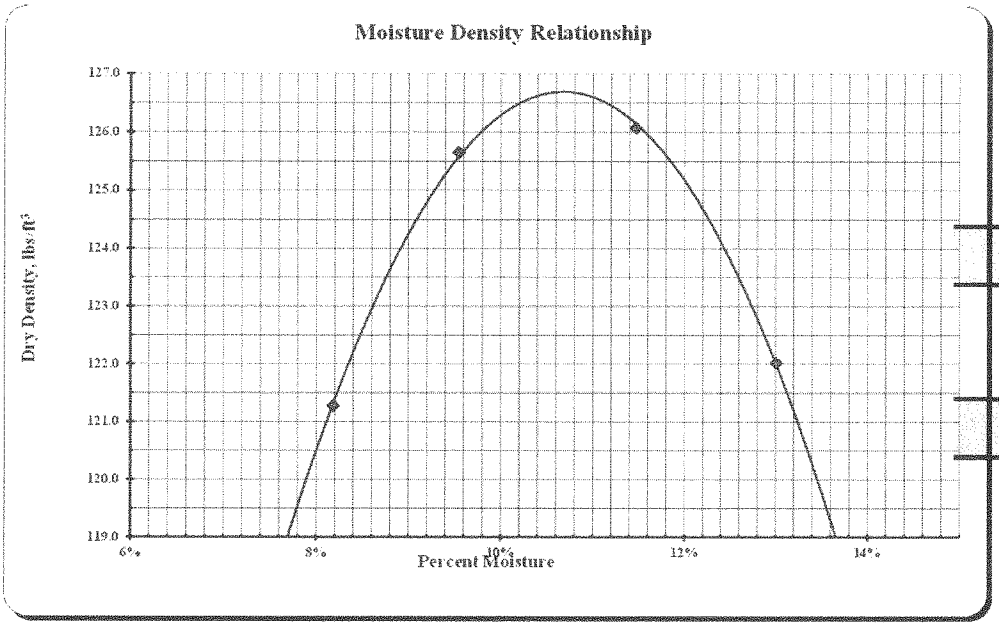
			Test Count	4				
	Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
		lbs.	8.75	8.97	9.06	8.97		
C	Weight of Mold	lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D	Weight of Compacted Soil = B - C	lbs.	4.36	4.57	4.67	4.58		
E	Wet Density = D / A	lbs./cu.ft.	131.2	137.7	140.5	137.9		
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	**121.3**	**125.7**	**126.1**	**122.0**	**#VALUE!**	**#VALUE!**

Moisture Content

AASHTO T99 or T180 Tested by:

	Container No.		61	62	63	64		
G	Wet Weight / Container	grams	169.5	179.9	164.6	176.3		
H	Dry Weight / Container	grams	159.5	167.5	151.5	160.3		
I	Moisture Loss = G - H	grams	10.0	12.4	13.1	16.0		
J	Tare Weight of Container	grams	37.3	37.6	37.3	37.3		
K	Dry Soil = H - J	grams	122.2	129.9	114.2	123.0		
L	%Moisture = (I / K) x 100	%	**8.2%**	**9.5%**	**11.5%**	**13.0%**		

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

126.7 lbs./cu.ft.

Optimum Moisture

10.7%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

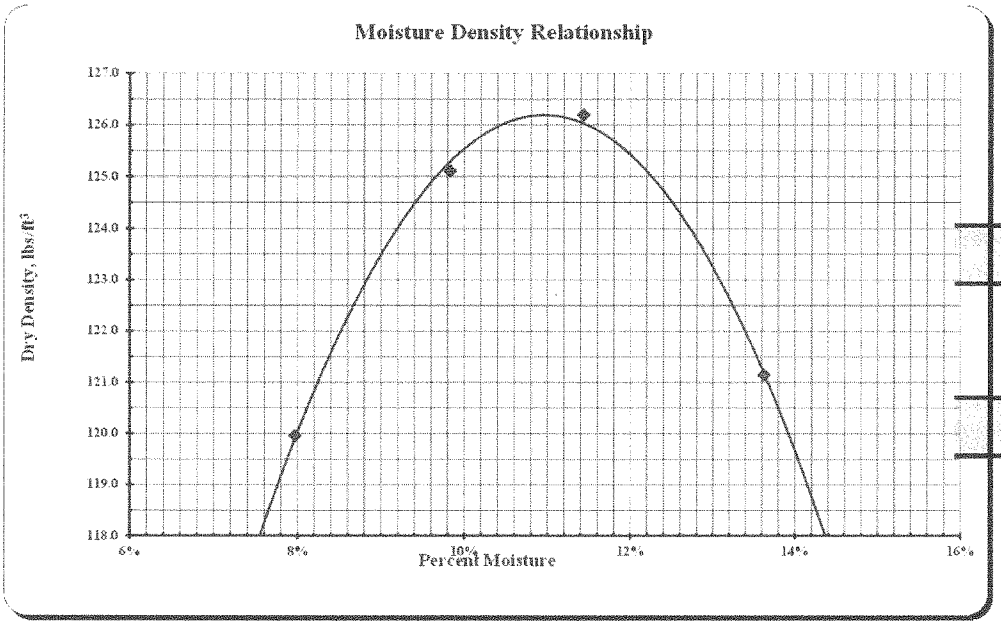
Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation	Date		
T-180	**11/4/2015**		**1274**

Density		Test Count	4				
Determination No.		1	2	3	4	5	6
A Volume of Mold	cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
	lbs.	8.70	8.96	9.07	8.97		
C Weight of Mold	lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D Weight of Compacted Soil = B - C	lbs.	4.30	4.56	4.67	4.57		
E Wet Density = D / A	lbs./cu.ft.	129.5	137.4	140.6	137.7		
F Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	**120.0**	**125.1**	**126.2**	**121.1**	**#VALUE!**	**#VALUE!**

Moisture Content AASHTO T99 or T180 Tested by:

Container No.		65	66	67	68		
G Wet Weight / Container	grams	166.5	178.5	144.4	173.8		
H Dry Weight / Container	grams	157.0	165.9	133.4	157.4		
I Moisture Loss = G - H	grams	9.5	12.6	11.0	16.4		
J Tare Weight of Container	grams	37.8	37.7	37.2	37.0		
K Dry Soil = H - J	grams	119.2	128.2	96.2	120.4		
L %Moisture = (I / K) x 100	%	**8.0%**	**9.8%**	**11.4%**	**13.6%**		

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

126.2 lbs./cu.ft.

Optimum Moisture

11.0%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation **T-180**	Date **11/4/2015**		**1275**

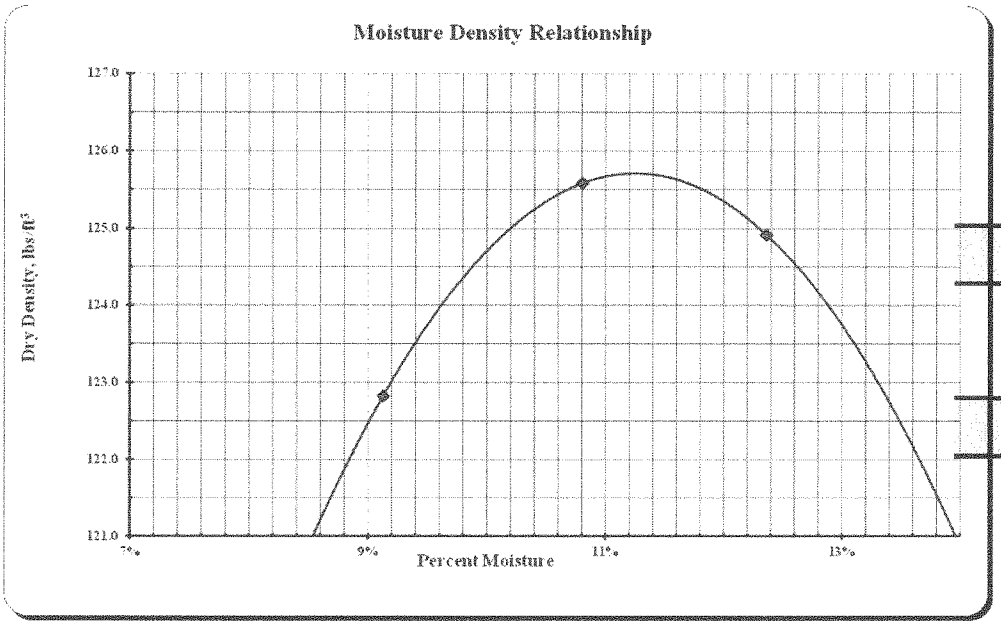
Density — Test Count: 3

	Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
		lbs.	8.85	9.02	9.06			
C	Weight of Mold	lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D	Weight of Compacted Soil = B - C	lbs.	4.45	4.62	4.66			
E	Wet Density = D / A	lbs./cu.ft.	134.0	139.2	140.4			
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	**122.8**	**125.6**	**124.9**	**#VALUE!**	**#VALUE!**	**#VALUE!**

Moisture Content — AASHTO T99 or T180 Tested by:

	Container No.		69	70	71			
G	Wet Weight / Container	grams	171.6	179.1	159.0			
H	Dry Weight / Container	grams	160.4	165.3	145.6			
I	Moisture Loss = G - H	grams	11.2	13.8	13.4			
J	Tare Weight of Container	grams	37.7	37.6	37.2			
K	Dry Soil = H - J	grams	122.7	127.7	108.4			
L	%Moisture = (I / K) x 100	%	**9.1%**	**10.8%**	**12.4%**			

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

125.7 lbs./cu.ft.

Optimum Moisture

11.2%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation **T-180**	Date **11/4/2015**		**1276**

Density

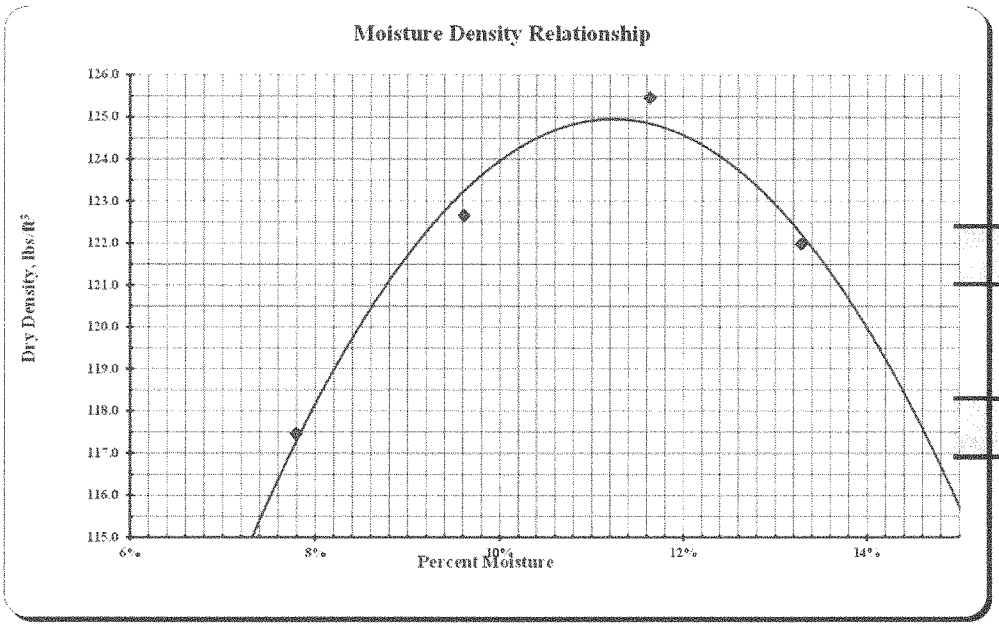
			Test Count	4				
	Determination No.		1	2	3	4	5	6
A	Volume of Mold	cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
		lbs.	8.60	8.86	9.05	8.98		
C	Weight of Mold	lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D	Weight of Compacted Soil = B - C	lbs.	4.20	4.46	4.65	4.59		
E	Wet Density = D / A	lbs./cu.ft.	126.6	134.5	140.1	138.2		
F	Dry Density = (E x 100) / (100 + L)	lbs./cu.ft.	**117.5**	**122.7**	**125.5**	**122.0**	**#VALUE!**	**#VALUE!**

Moisture Content

AASHTO T99 or T180 Tested by:

	Container No.		72	73	74	75		
G	Wet Weight / Container	grams	159.8	173.1	148.7	171.2		
H	Dry Weight / Container	grams	150.9	161.2	137.1	155.5		
I	Moisture Loss = G - H	grams	8.9	11.9	11.6	15.7		
J	Tare Weight of Container	grams	36.7	37.4	37.4	37.3		
K	Dry Soil = H - J	grams	114.2	123.8	99.7	118.2		
L	%Moisture = (I / K) x 100	%	**7.8%**	**9.6%**	**11.6%**	**13.3%**		

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

125.0 lbs./cu.ft.

Optimum Moisture

11.2%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation **T-180**	Date **11/4/2015**		**1277**

Density

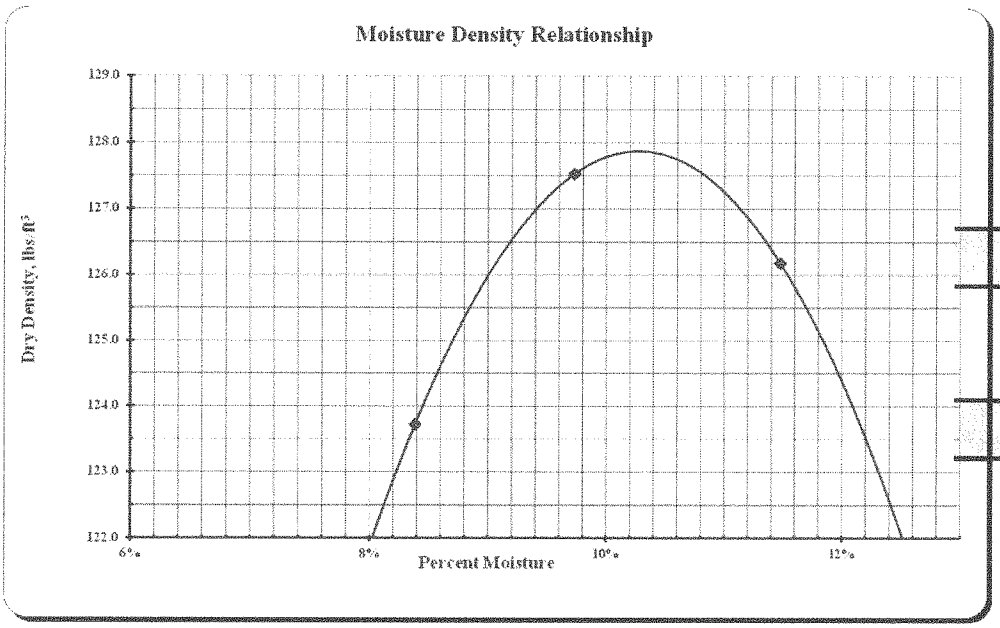
		Test Count	3				
	Determination No.	1	2	3	4	5	6
A	Volume of Mold cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
	lbs.	8.85	9.04	9.07			
C	Weight of Mold lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D	Weight of Compacted Soil = B - C lbs.	4.45	4.65	4.67			
E	Wet Density = D / A lbs./cu.ft.	134.1	139.9	140.7			
F	Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	**123.7**	**127.5**	**126.2**	**#VALUE!**	**#VALUE!**	**#VALUE!**

Moisture Content

AASHTO T99 or T180 Tested by:

	Container No.	76	77	78			
G	Wet Weight / Container grams	162.1	154.1	166.4			
H	Dry Weight / Container grams	152.5	143.7	153.1			
I	Moisture Loss = G - H grams	9.6	10.4	13.3			
J	Tare Weight of Container grams	38.0	36.8	37.2			
K	Dry Soil = H - J grams	114.5	106.9	115.9			
L	%Moisture = (I / K) x 100 %	**8.4%**	**9.7%**	**11.5%**			

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

127.9 lbs./cu.ft.

Optimum Moisture

10.3%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation	Date		
T-180	**11/4/2015**		**1278**

Density

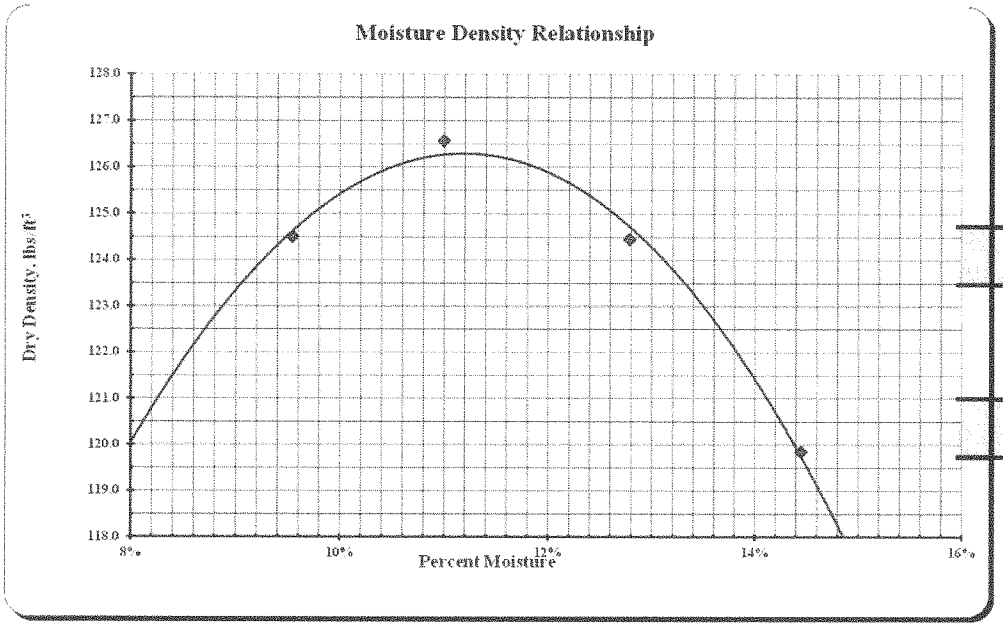
		Test Count	4				
	Determination No.	1	2	3	4	5	6
A	Volume of Mold cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
	lbs.	8.92	9.06	9.06	8.95		
C	Weight of Mold lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D	Weight of Compacted Soil = B - C lbs.	4.53	4.66	4.66	4.55		
E	Wet Density = D / A lbs./cu.ft.	136.4	140.5	140.4	137.2		
F	Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	**124.5**	**126.6**	**124.5**	**119.9**	**#VALUE!**	**#VALUE!**

Moisture Content

AASHTO T99 or T180 Tested by:

	Container No.	79	80	81	82		
G	Wet Weight / Container grams	161.1	175.4	162.2	160.2		
H	Dry Weight / Container grams	150.3	161.7	148.1	144.7		
I	Moisture Loss = G - H grams	10.8	13.7	14.1	15.5		
J	Tare Weight of Container grams	37.1	37.1	37.8	37.4		
K	Dry Soil = H - J grams	113.2	124.6	110.3	107.3		
L	%Moisture = (I / K) x 100 %	**9.5%**	**11.0%**	**12.8%**	**14.4%**		

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

126.3 lbs./cu.ft.

Optimum Moisture

11.1%

MOISTURE-DENSITY RELATIONS OF SOILS

North Dakota Department Of Transportation, Materials & Research Division

SFN 10063 (Rev. 03-2006)

Project No.	PCN	Station	Depth Below Grade
SS-7-068(011)000			
Offset From Centerline		Type of Soil	
AASTHO Designation	Date		
T-180	**11/4/2015**		**1279**

Density

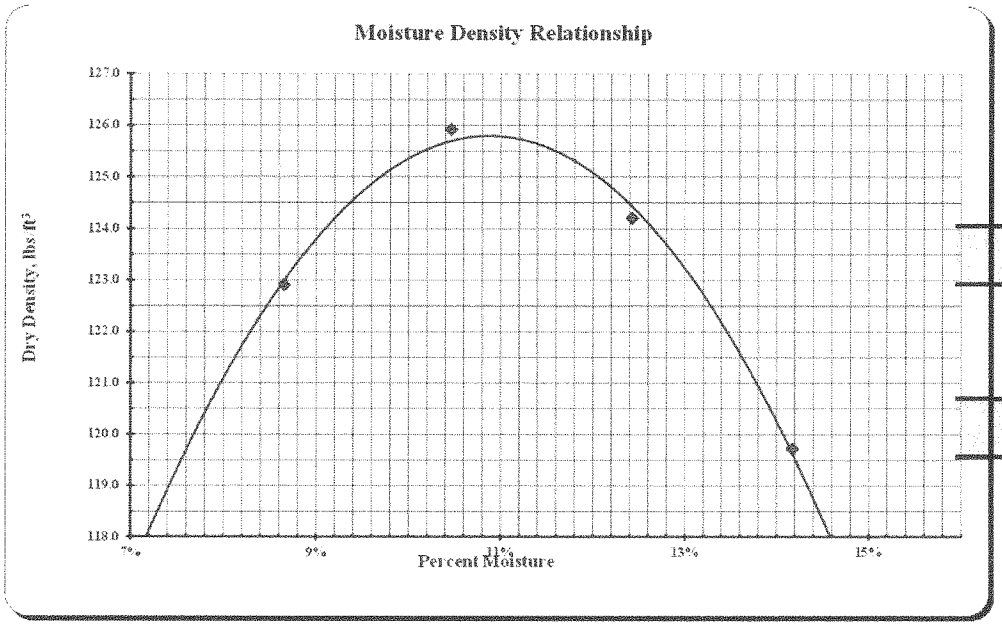
		Test Count	4				
	Determination No.	1	2	3	4	5	6
A	Volume of Mold cu. ft.	0.0332	0.0332	0.0332	0.0332	0.0332	0.0332
	lbs.	8.83	9.01	9.03	8.93		
C	Weight of Mold lbs.	4.40	4.40	4.40	4.40	4.40	4.40
D	Weight of Compacted Soil = B - C lbs.	4.43	4.62	4.64	4.54		
E	Wet Density = D / A lbs./cu.ft.	133.6	139.1	139.6	136.7		
F	Dry Density = (E x 100) / (100 + L) lbs./cu.ft.	**122.9**	**125.9**	**124.2**	**119.7**	**#VALUE!**	**#VALUE!**

Moisture Content

AASHTO T99 or T180 Tested by:

	Container No.	83	84	85	86		
G	Wet Weight / Container grams	155.2	161.5	169.9	165.7		
H	Dry Weight / Container grams	145.8	149.7	155.3	149.8		
I	Moisture Loss = G - H grams	9.4	11.8	14.6	15.9		
J	Tare Weight of Container grams	37.2	36.9	37.8	37.6		
K	Dry Soil = H - J grams	108.6	112.8	117.5	112.2		
L	%Moisture = (I / K) x 100 %	**8.7%**	**10.5%**	**12.4%**	**14.2%**		

ASTM D4643 AASHTO T217 or T265 Tested by: ML



Max Dry Density

125.8 lbs./cu.ft.

Optimum Moisture

10.9%