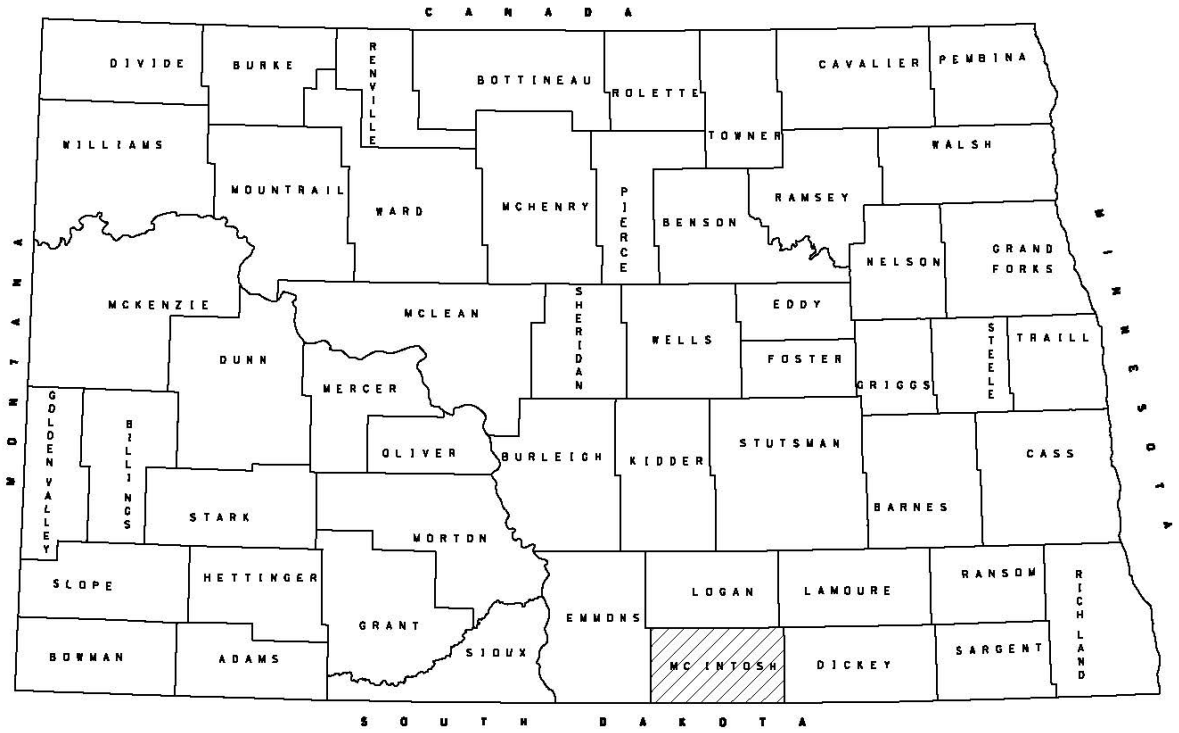
LINEAR SOILS SURVEY AND RECOMMENDATIONS

PROJECT NO. NDS-SS-2-011(041)035

PCN 22937

COUNTY McIntosh

ND 11, RP 35.157 to 35.668



PREPARED BY: Riley McAdoo-Roesler

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

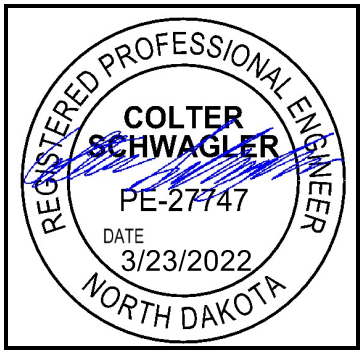
March 2022

NDS-SS-2-011(041)035

ND 11, 5TH AVE SW TO 3RD AVE NE

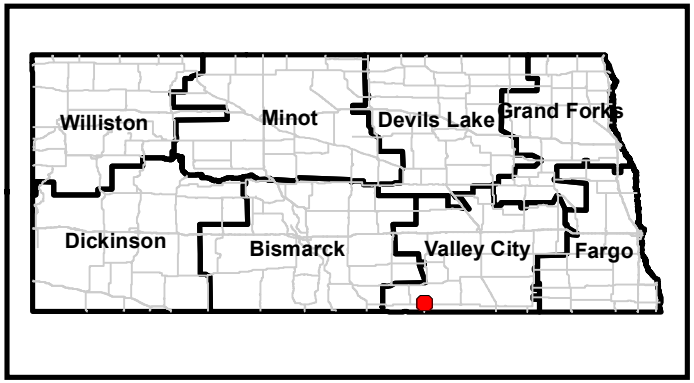
CERTIFICATION

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 Colter J. Schwagler Registration number PE-27747 on 03/23/2022 and the original document is stored at the North Dakota Department of Transportation.



Project Location

Project: NDS-SS-2-011(041)035
PCN: 22937
Scope: Major Rehabilitation
Location: EB, RP 35.157 to RP 35.668



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Introduction

Location: ND 11, 5TH AVE SW to 3RD AVE NE
Reference Points: 35.157 to 35.668
Project Length: 0.5110 Miles
Proposed Project Scope: Major Rehabilitation
Investigation Scope: 250’ Intervals and Identified Maintenance Areas

Maintenance Review

Date of Maintenance Review: 04/13/2021
Materials and Research Person Conducting the Review: Jamie Naumann
Maintenance Person Conducting Review: Todd Docktor

Table 1 – Identified Maintenance Areas

Location RP + Feet	Distress Identified	Maintenance Comments	Drilling Required
35+1340	Alligator Cracking	Possible water line trench. Includes raveling and weathering with longitudinal cracks. Patch yearly.	Yes
35+2255	Longitude Cracks	Includes raveling and weathering.	No

Summary of Soil Investigation

The soil investigation was completed on 8/17/2021. The investigation consisted of 11 borings.

Table 2 – Boring Locations Summary

Boring Location	Pavement Distress	Justification for Boring	Boring Depth	Boring Locations/Comments
35+0829 to 35+3527	-	Major Rehabilitation	5 feet	1 boring every 250' along the roadway within the project limits. A total number of 8 borings.
35+1340	Alligator cracking	Identified Maintenance Area	10 feet	Conduct 1 boring in distressed area and one boring on either side approximately 100 feet away. A total number of 3 borings.

Map of the boring locations are shown in Appendix C. The lab results are included in Appendix E.

Summary of Soil Analysis

Project Limits – 35+0829 to 35+3527: The majority of the soils within this area are lean clays with an AASHTO classification of A-7-6. These soils have an average maximum dry density of approximately 120 lb/ft^3 and an optimum water content of approximately 13%. The in-place moistures of the soils are on average 8% over optimum.

Identified Maintenance Area – 35+1340: The majority of the soils within this area are lean clays with an AASHTO classification of A-7-6. These soils have an average maximum dry density of approximately 119 lb/ft^3 and an optimum water of approximately 13%. The in-place moistures of the soils are on average 10% over optimum.

Soil Sample Distribution

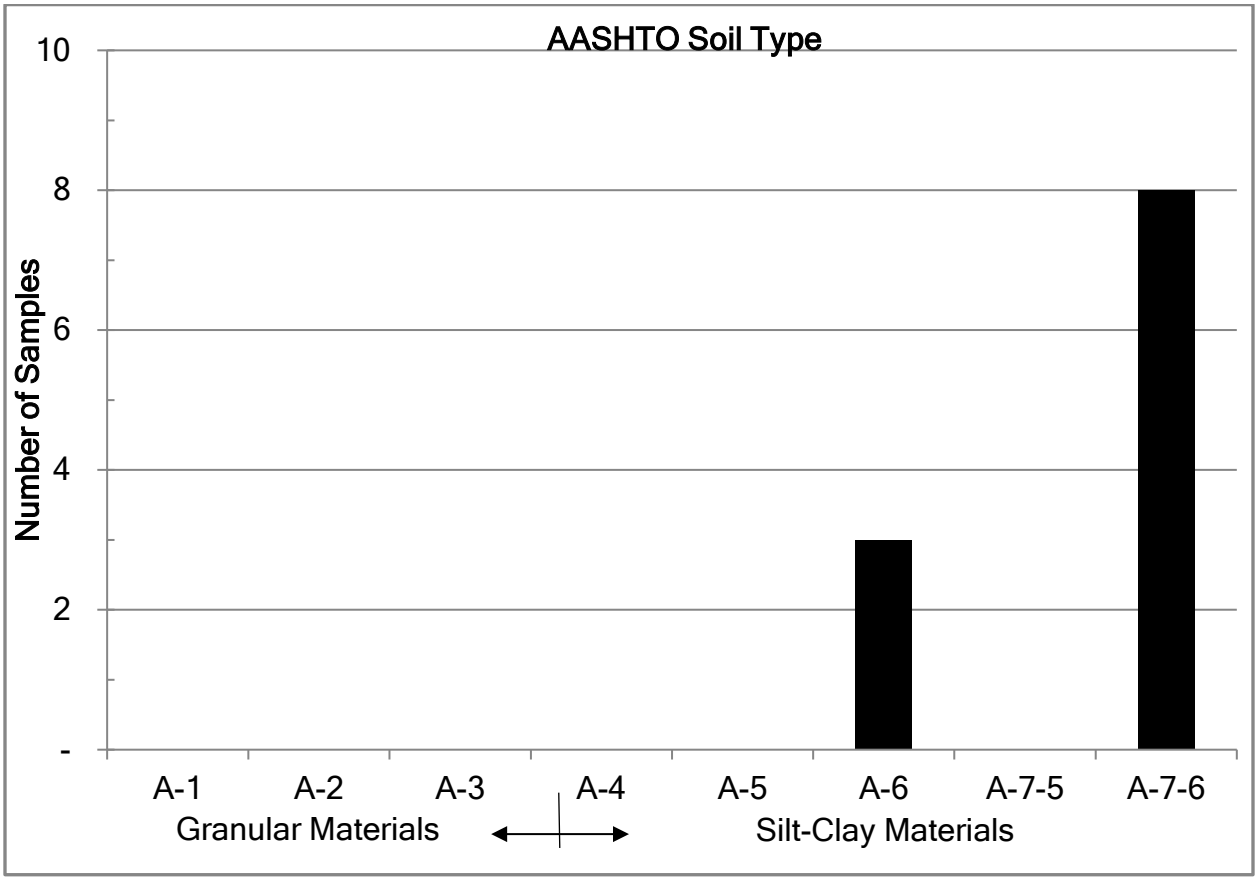


Figure 1 - Soil Sample Distribution

Design Recommendations

Project Limits – 35+0829 to 35+3527: In order to provide a sufficient working platform, complete subgrade prep along the project limits on all cut and fill areas less than 18".

Identified Maintenance Area – 35+1340: The existing soils in this area are lean clays. The soils throughout the maintenance area have a lower in-place moisture then the soils sampled in the borings directly adjacent to the identified maintenance area. Additionally, there is not a change in soil type that would indicate that the subgrade is causing the roadway distress at this location. Therefore, the proposed improvement and subgrade prep should remediate the roadway distress.

Design Information

Pipe Replacement: None

Compaction Method: T-180

Subgrade Prep:

Location RP+ Feet	Recommendation	Justification
35+0829 to 35+3527	12" Subgrade Prep on all cut and fill areas of less than 18"	The subgrade needs to provide a sufficient working platform to allow for the compaction of base material.

Subcut Recommendations: None

Drainage: None

Plan Notes

None

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 & FROST HEAVE

AASHTO 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%)

Unified Soil Classification System, USCS

Table 5.2 Unified Soil Classification System (Based on Material Passing 76.2-mm Sieve)

Criteria for assigning group symbols				Group symbol
Coarse-grained soils More than 50% of retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[a]	$C_u \geq 4$ and $1 \leq C_c \leq 3$[c]	GW
			$C_u < 4$ and/or $1 > C_c > 3$[c]	GP
		Gravels with Fines More than 12% fines[a,d]	$PI < 4$ or plots below "A" line (Figure 5.3)	GM
			$PI > 7$ and plots on or above "A" line (Figure 5.3)	GC
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[b]	$C_u \geq 6$ and $1 \leq C_c \leq 3$[c]	SW
			$C_u < 6$ and/or $1 > C_c > 3$[c]	SP
		Sands with Fines More than 12% fines[b,d]	$PI < 4$ or plots below "A" line (Figure 5.3)	SM
			$PI > 7$ and plots on or above "A" line (Figure 5.3)	SC
Fine-grained soils 50% or more passes No. 200 sieve	Silts and clays Liquid limit less than 50	Inorganic	$PI > 7$ and plots on or above "A" line (Figure 5.3)[e]	CL
			$PI < 4$ or plots below "A" line (Figure 5.3)[e]	ML
		Organic	$\frac{\text{Liquid limit — oven dried}}{\text{Liquid limit — not dried}} < 0.75$; see Figure 5.3; OL zone	OL
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line (Figure 5.3)	CH
			PI plots below "A" line (Figure 5.3)	MH
		Organic	$\frac{\text{Liquid limit — oven dried}}{\text{Liquid limit — not dried}} < 0.75$; see Figure 5.3; OH zone	OH
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			Pt

[a] Gravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.

[b] Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.

[c] $C_u = \frac{D_{60}}{D_{10}}$; $C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$

[d] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 5.3, use dual symbol GC-GM or SC-SM.

[e] If $4 \leq PI \leq 7$ and plots in the hatched area in Figure 5.3, use dual symbol CL-ML.

Plasticity Chart :

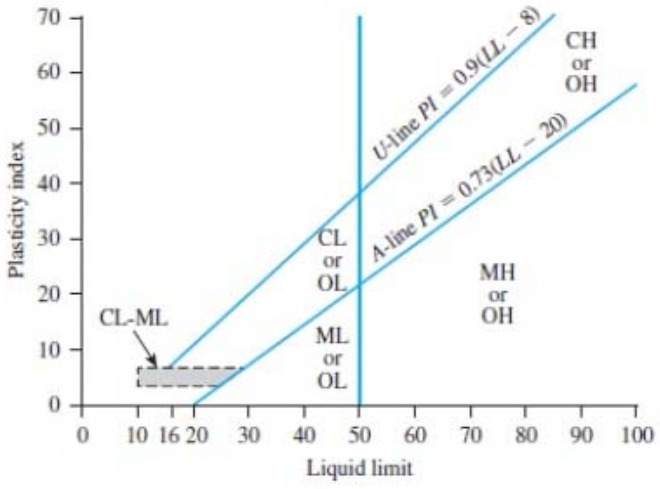


Table 7-12. Frost susceptibility classification of soils (NCHRP 1-37A).

Frost Group	Degree of Frost Susceptibility	Type of Soil	Percentage Finer than 0.075 mm (# 200) by wt.	Typical Soil Classification
F1	Negligible to low	Gravelly soils	3-10	GC, GP, GC-GM, GP-GM
F2	Low to medium	Gravelly soils	10-20	GM, GC-GM, GP-GM
		Sands	3-15	SW, SP, SM, SW-SM, SP-SM
F3	High	Gravelly Soils	Greater than 20	GM-GC
		Sands, except very fine silty sands	Greater than 15	SM, SC
		Clays PI>12	—	CL, CH
F4	Very high	All Silts	—	ML-MH
		Very Fine Silty Sands	Greater than 15	SM
		Clays PI<12	—	CL, CL-ML
		Varied clays and other fine grained, banded sediments	—	CL, ML, SM, CH

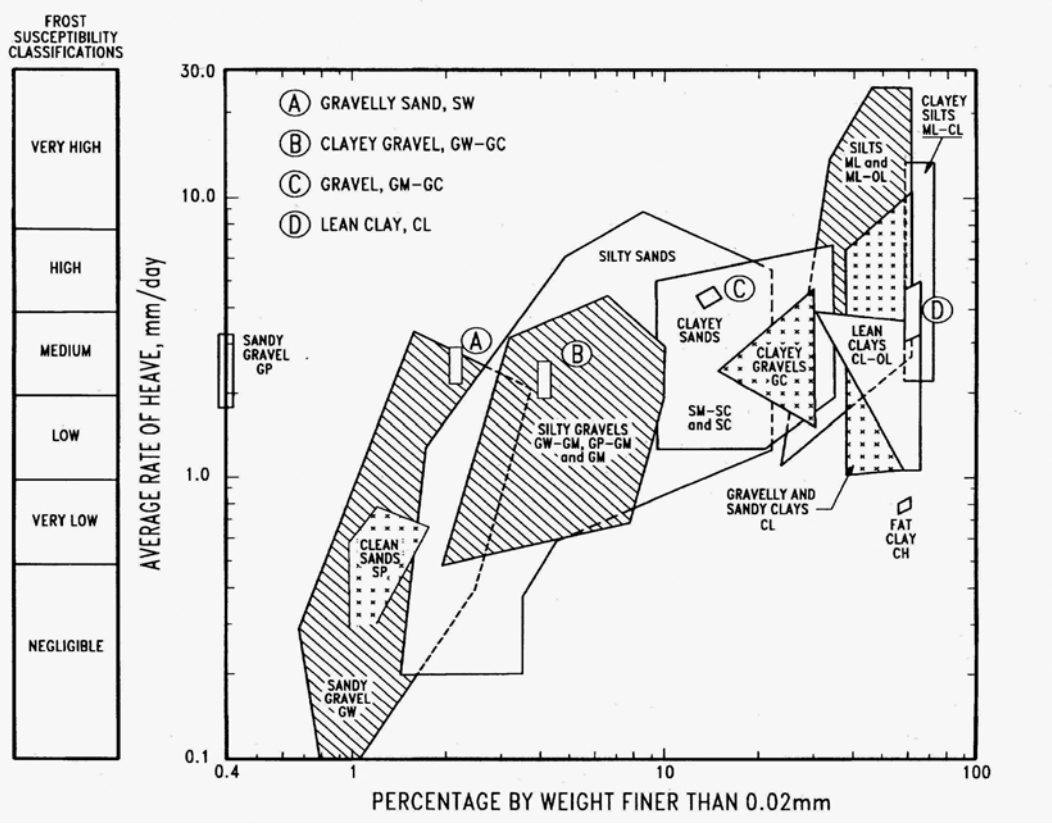


Figure 7-20. Average rate of heave versus % fines for natural soil gradations (Kaplar, 1974).

Frost Depth Map

APPENDIX B

MAINTENANCE REVIEW AND SUBSURFACE INVESTIGATION SCOPE

PAVEMENT EVALUATION LOG FOR LINEAR SOIL SURVEY

North Dakota Department of Transportation, Materials & Research

SFN 60472 (6-2017)

Sheet 1 of 1

Project Number	PCN	Date of Survey
SS-2-011(041)035	22937	04/13/2021

Section Maintenance Contact	Completed By
Todd Docktor	Jamie Naumann

Highway Reference Points	Surface Types
35+0829 to 35+3527	Asphalt

Location	Pavement Distress	Description	Maintenance Comment	Picture Number	Drilling Required
35+1340	Alligator Cracking	Possible water line trench. Includes raveling and weathering with longitudinal cracks.	Patch yearly.	1-2	Yes
35+2255	Longitude Cracks	Includes raveling and weathering.	Patch yearly.	3	No

Comments

Most recent crack seal done last spring. Potholes throughout project are patched yearly.

1
35+1340

2
35+1340

3
35+2255

APPENDIX C

BORING LOCATIONS

Legend

- Reference Point
- Boring Locations

0 500 1,000 Feet

Project Number: NDS-SS-2-011(041)035

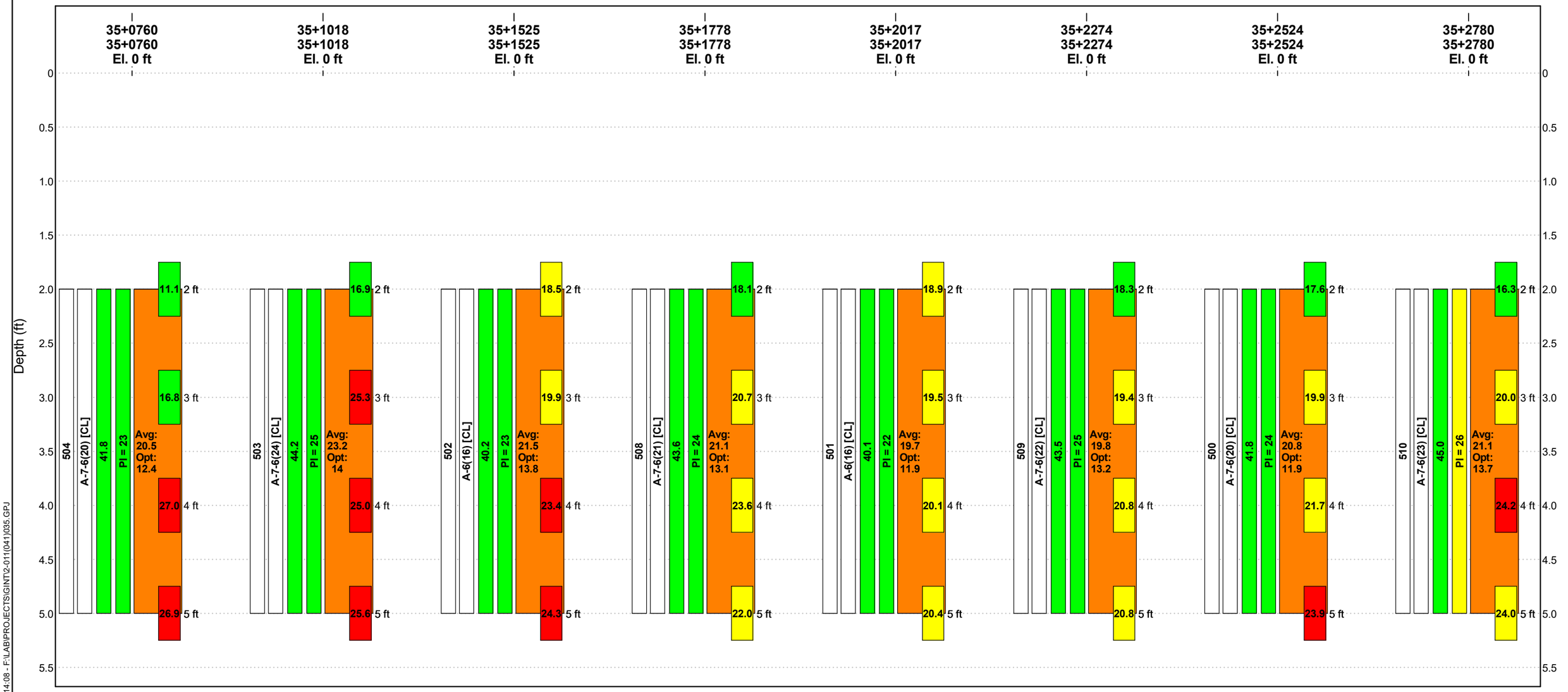
APPENDIX D

SUMMARY OF SOILS ANALYSIS

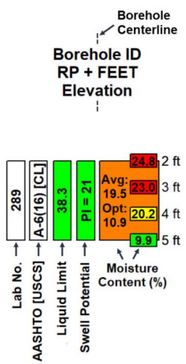
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **PCN** 22937

LOCATION Mcintosh County

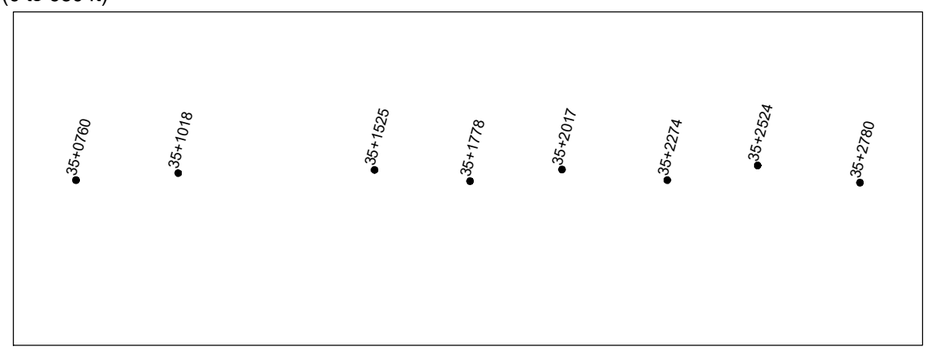


LEGEND



Liquid Limit	LL<50	50<=LL<60	LL>=60	
Swell Potential	Low	Marginal	High	
Moisture Content	Below PL	0-5% Over PL	>5% Over PL	Non-Plastic
Avg. 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

Boreholes Equally Spaced (0 to 650 ft)



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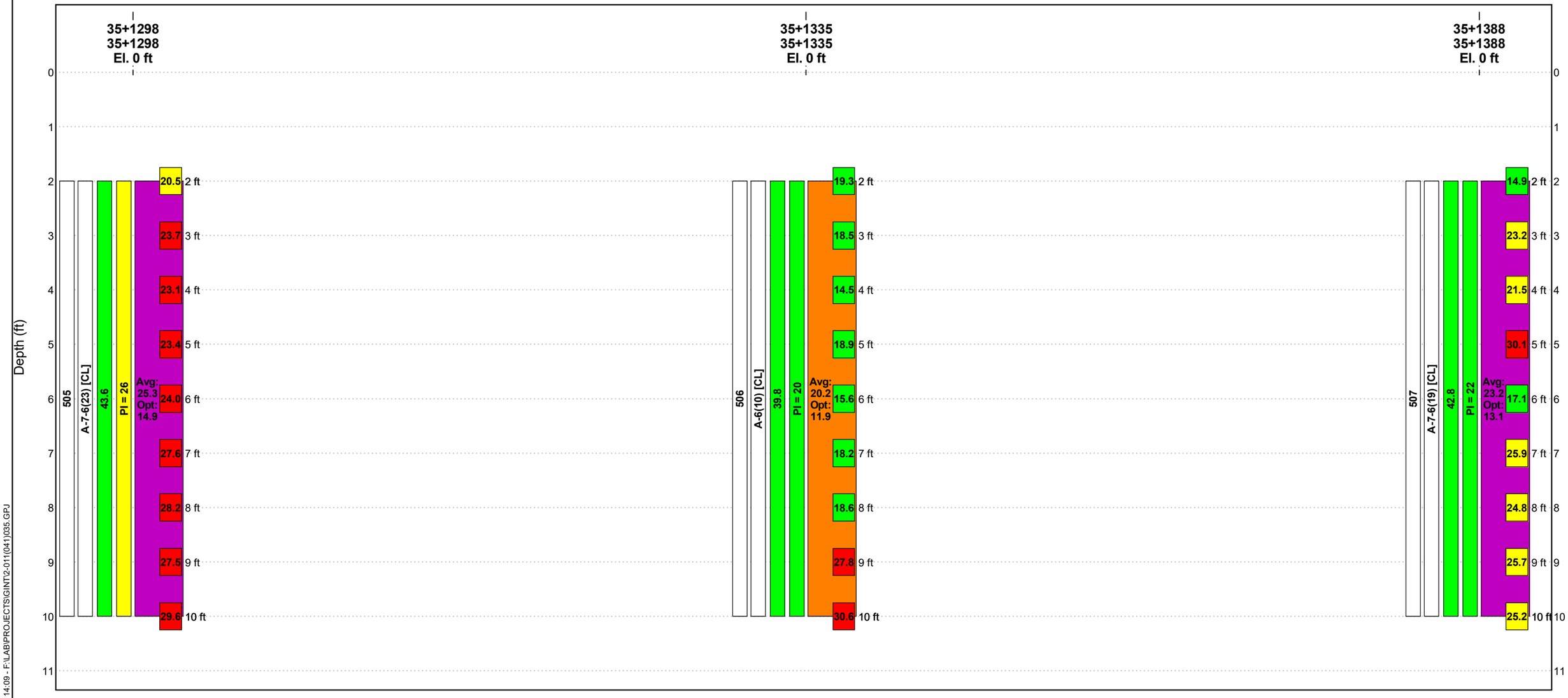
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
300 AIRPORT ROAD
BISMARCK, ND 58504

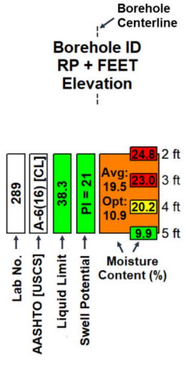
PROJECT NUMBER SS-2-011(041)035 **PCN** 22937

LOCATION Mcintosh County

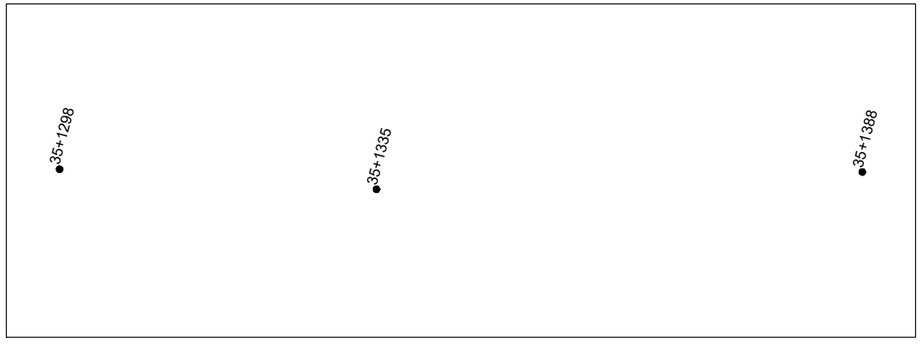


Boreholes Equally Spaced (0 to 28 ft)

LEGEND



Liquid Limit	LL<50	50<=LL<60	LL>=60	
Swell Potential	Low	Marginal	High	
Moisture Content	Below PL	0-5% Over PL	>5% Over PL	Non-Plastic
Avg. 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



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APPENDIX E

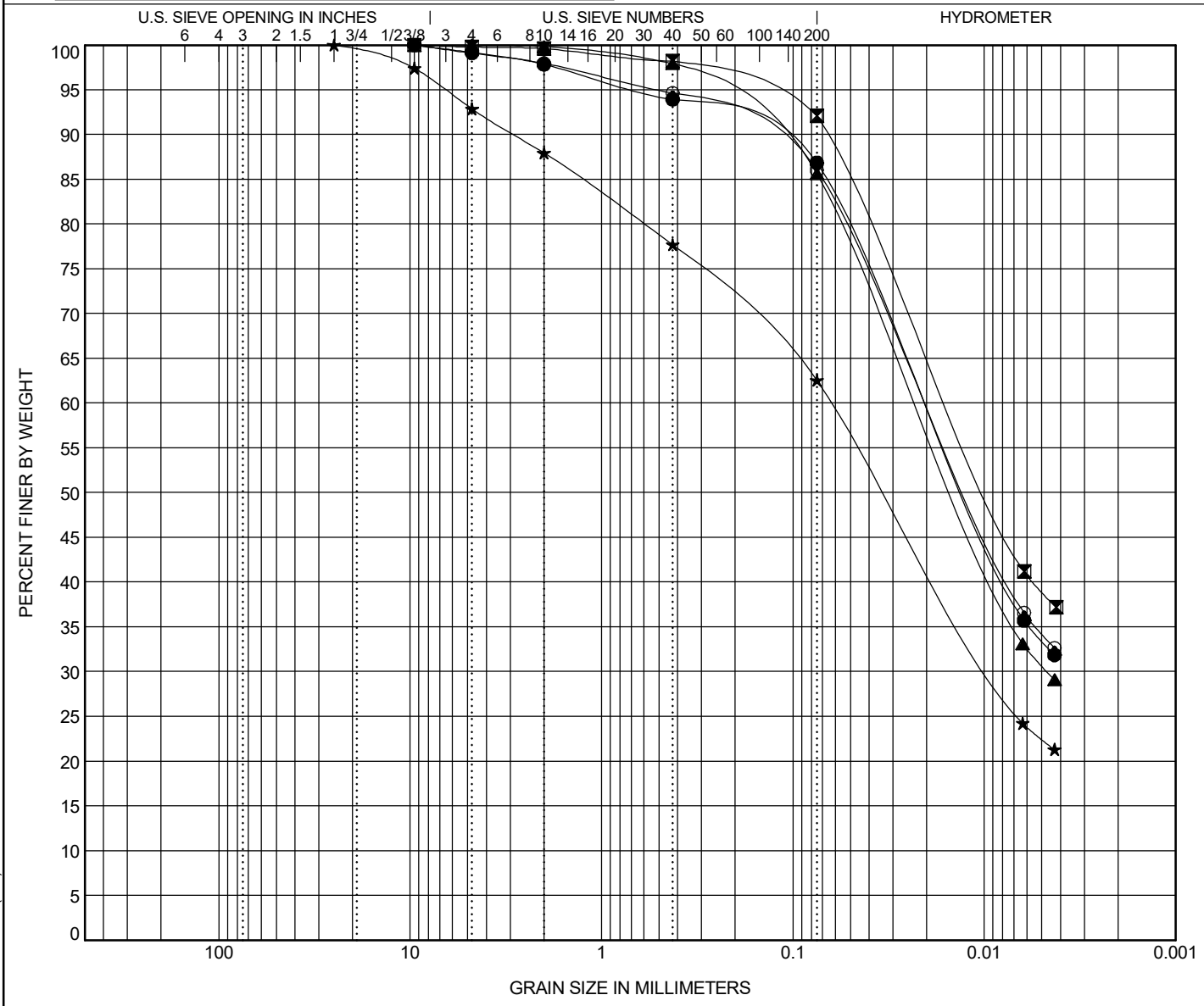
LAB RESULTS

GRAIN SIZE DISTRIBUTION

NDDOT North Dakota Department of Transportation
NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
●	35+0760	2.0	A-7-6 (20)	CL	42	19	23		
⊠	35+1018	2.0	A-7-6 (24)	CL	44	19	25		
▲	35+1298	2.0	A-7-6 (23)	CL	44	18	26		
★	35+1335	2.0	A-6 (10)	CL	40	20	20		
⊙	35+1388	2.0	A-7-6 (19)	CL	43	21	22		

	BOREHOLE	DEPTH	D100	D50	D30	D15	%Gravel	%Sand	%Silt	%Clay
●	35+0760	2.0	9.5	0.012			0.8	12.3	86.8	
⊠	35+1018	2.0	9.5	0.01			0.2	7.7	92.1	
▲	35+1298	2.0	4.75	0.014	0.005		0.0	14.4	85.6	
★	35+1335	2.0	25	0.033	0.009		7.1	30.3	62.5	
⊙	35+1388	2.0	9.5	0.012			0.9	13.1	86.0	

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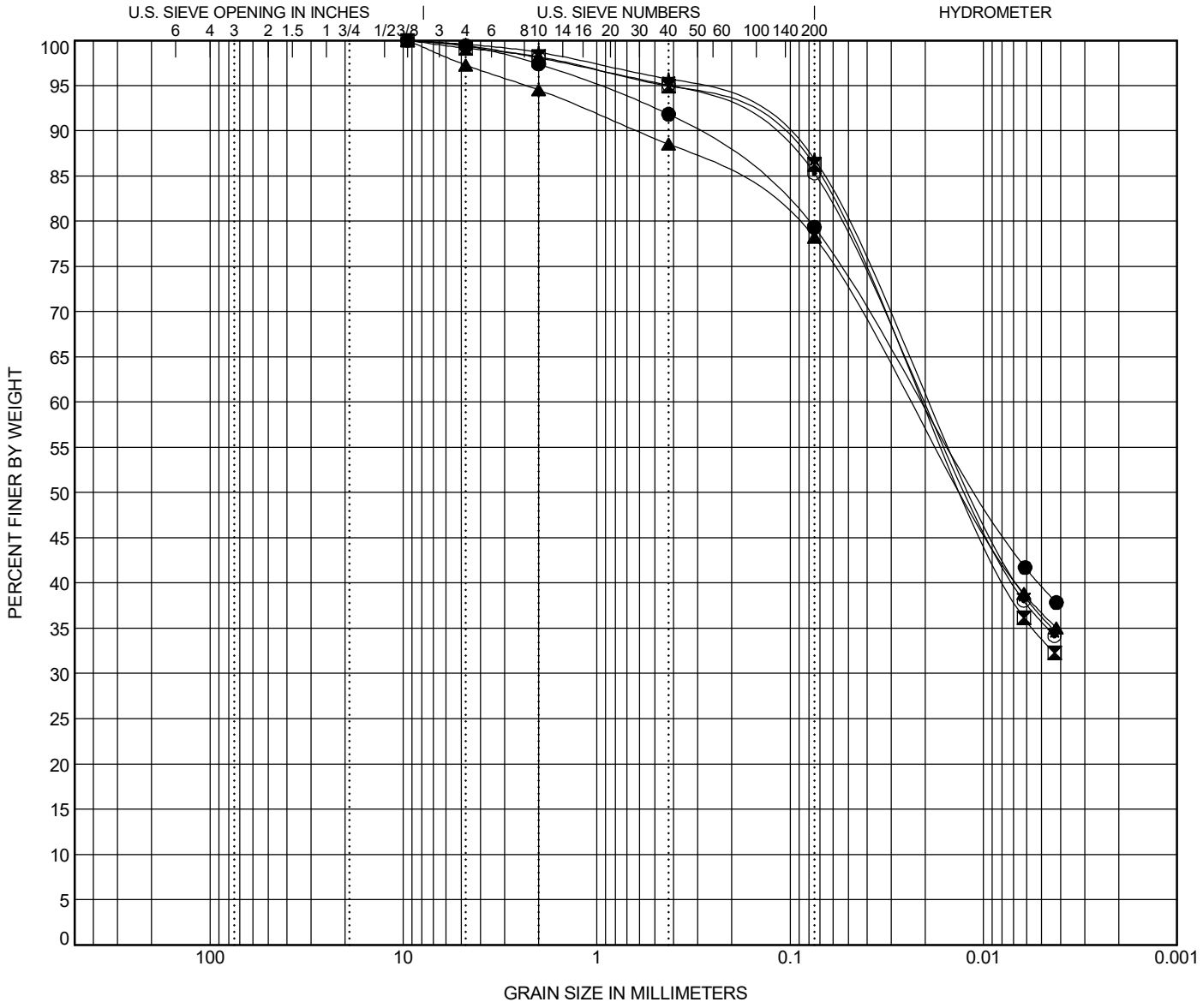
GRAIN SIZE DISTRIBUTION

NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● 35+1525	2.0	A-6 (16)	CL	40	18	22		
⊠ 35+1778	2.0	A-7-6 (21)	CL	44	20	24		
▲ 35+2017	2.0	A-6 (16)	CL	40	18	22		
★ 35+2274	2.0	A-7-6 (22)	CL	44	19	25		
⊙ 35+2524	2.0	A-7-6 (20)	CL	42	18	24		

BOREHOLE	DEPTH	D100	D50	D30	D15	%Gravel	%Sand	%Silt	%Clay
● 35+1525	2.0	9.5	0.011			0.6	20.1	79.3	
⊠ 35+1778	2.0	9.5	0.012			0.9	12.9	86.3	
▲ 35+2017	2.0	9.5	0.013			2.7	19.0	78.2	
★ 35+2274	2.0	9.5	0.011			0.4	12.7	86.9	
⊙ 35+2524	2.0	9.5	0.012			0.6	14.1	85.3	

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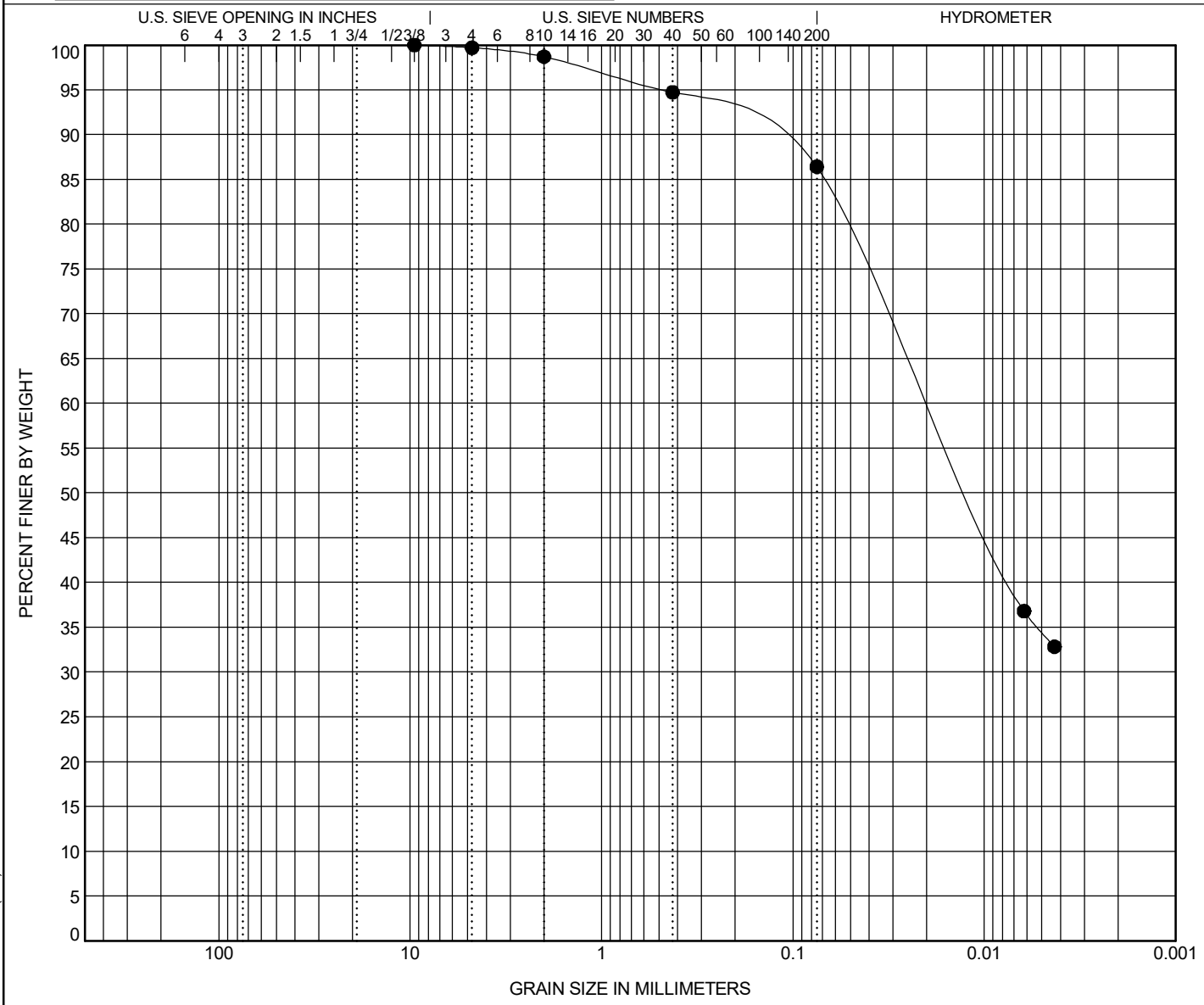
GRAIN SIZE DISTRIBUTION

NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
●	**35+2780**	**2.0**	**A-7-6 (23)**	**CL**	**45**	**19**	**26**		

	BOREHOLE	DEPTH	D100	D50	D30	D15	%Gravel	%Sand	%Silt	%Clay
●	**35+2780**	**2.0**	**9.5**	**0.012**			**0.3**	**13.3**	**86.4**	

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SUMMARY OF LABORATORY RESULTS

NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Class-ification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
35+0760	2.0	42	19	23	9.5	87	A-7-6 (20)	CL	11.1	20.5			
35+0760	3.0								16.8	20.5			
35+0760	4.0								27.0	20.5			
35+0760	5.0								26.9	20.5			
35+1018	2.0	44	19	25	9.5	92	A-7-6 (24)	CL	16.9	23.2			
35+1018	3.0								25.3	23.2			
35+1018	4.0								25.0	23.2			
35+1018	5.0								25.6	23.2			
35+1298	2.0	44	18	26	4.75	86	A-7-6 (23)	CL	20.5	25.3			
35+1298	3.0								23.7	25.3			
35+1298	4.0								23.1	25.3			
35+1298	5.0								23.4	25.3			
35+1298	6.0								24.0	25.3			
35+1298	7.0								27.6	25.3			
35+1298	8.0								28.2	25.3			
35+1298	9.0								27.5	25.3			
35+1298	10.0								29.6	25.3			
35+1335	2.0	40	20	20	25	63	A-6 (10)	CL	19.3	20.2			
35+1335	3.0								18.5	20.2			
35+1335	4.0								14.5	20.2			
35+1335	5.0								18.9	20.2			
35+1335	6.0								15.6	20.2			
35+1335	7.0								18.2	20.2			
35+1335	8.0								18.6	20.2			
35+1335	9.0								27.8	20.2			
35+1335	10.0								30.6	20.2			
35+1388	2.0	43	21	22	9.5	86	A-7-6 (19)	CL	14.9	23.2			
35+1388	3.0								23.2	23.2			
35+1388	4.0								21.5	23.2			
35+1388	5.0								30.1	23.2			
35+1388	6.0								17.1	23.2			
35+1388	7.0								25.9	23.2			
35+1388	8.0								24.8	23.2			
35+1388	9.0								25.7	23.2			
35+1388	10.0								25.2	23.2			
35+1525	2.0	40	18	22	9.5	79	A-6 (16)	CL	18.5	21.5			
35+1525	3.0								19.9	21.5			
35+1525	4.0								23.4	21.5			
35+1525	5.0								24.3	21.5			
35+1778	2.0	44	20	24	9.5	86	A-7-6 (21)	CL	18.1	21.1			
35+1778	3.0								20.7	21.1			
35+1778	4.0								23.6	21.1			
35+1778	5.0								22.0	21.1			

SUMMARY OF LABORATORY RESULTS

NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937

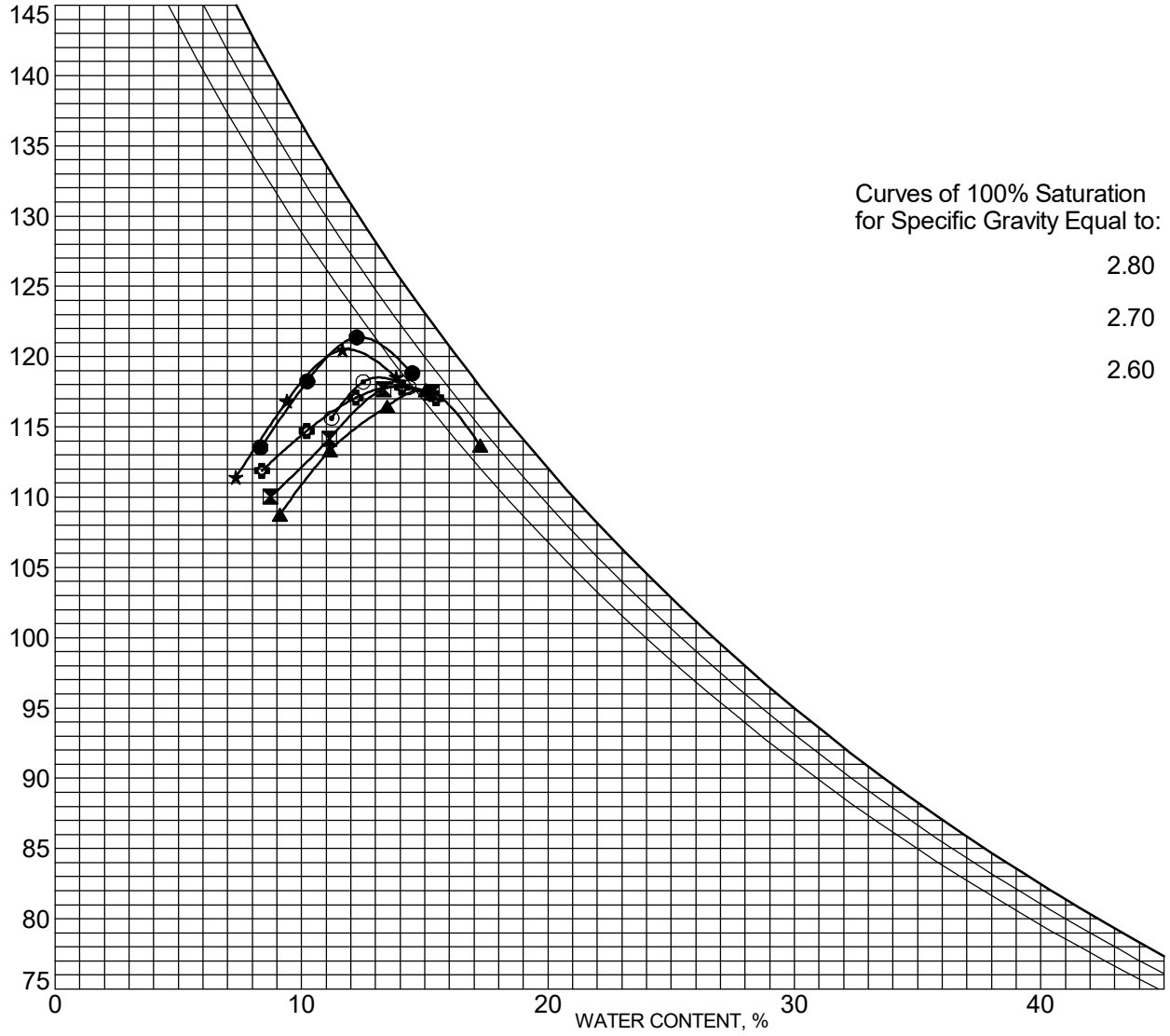
Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Class-ification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
35+2017	2.0	40	18	22	9.5	78	A-6 (16)	CL	18.9	19.7			
35+2017	3.0								19.5	19.7			
35+2017	4.0								20.1	19.7			
35+2017	5.0								20.4	19.7			
35+2274	2.0	44	19	25	9.5	87	A-7-6 (22)	CL	18.3	19.8			
35+2274	3.0								19.4	19.8			
35+2274	4.0								20.8	19.8			
35+2274	5.0								20.8	19.8			
35+2524	2.0	42	18	24	9.5	85	A-7-6 (20)	CL	17.6	20.8			
35+2524	3.0								19.9	20.8			
35+2524	4.0								21.7	20.8			
35+2524	5.0								23.9	20.8			
35+2780	2.0	45	19	26	9.5	86	A-7-6 (23)	CL	16.3	21.1			
35+2780	3.0								20.0	21.1			
35+2780	4.0								24.2	21.1			
35+2780	5.0								24.0	21.1			

MOISTURE-DENSITY RELATIONSHIP

NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937



BOREHOLE		DEPTH	AASHTO Classification	USCS Description
●	**35+0760**	**2.0**	**A-7-6 (20)**	**LEAN CLAY(CL)**
⊠	**35+1018**	**2.0**	**A-7-6 (24)**	**LEAN CLAY(CL)**
▲	**35+1298**	**2.0**	**A-7-6 (23)**	**LEAN CLAY(CL)**
★	**35+1335**	**2.0**	**A-6 (10)**	**SANDY LEAN CLAY(CL)**
⊙	**35+1388**	**2.0**	**A-7-6 (19)**	**LEAN CLAY(CL)**
✿	**35+1525**	**2.0**	**A-6 (16)**	**LEAN CLAY with SAND(CL)**

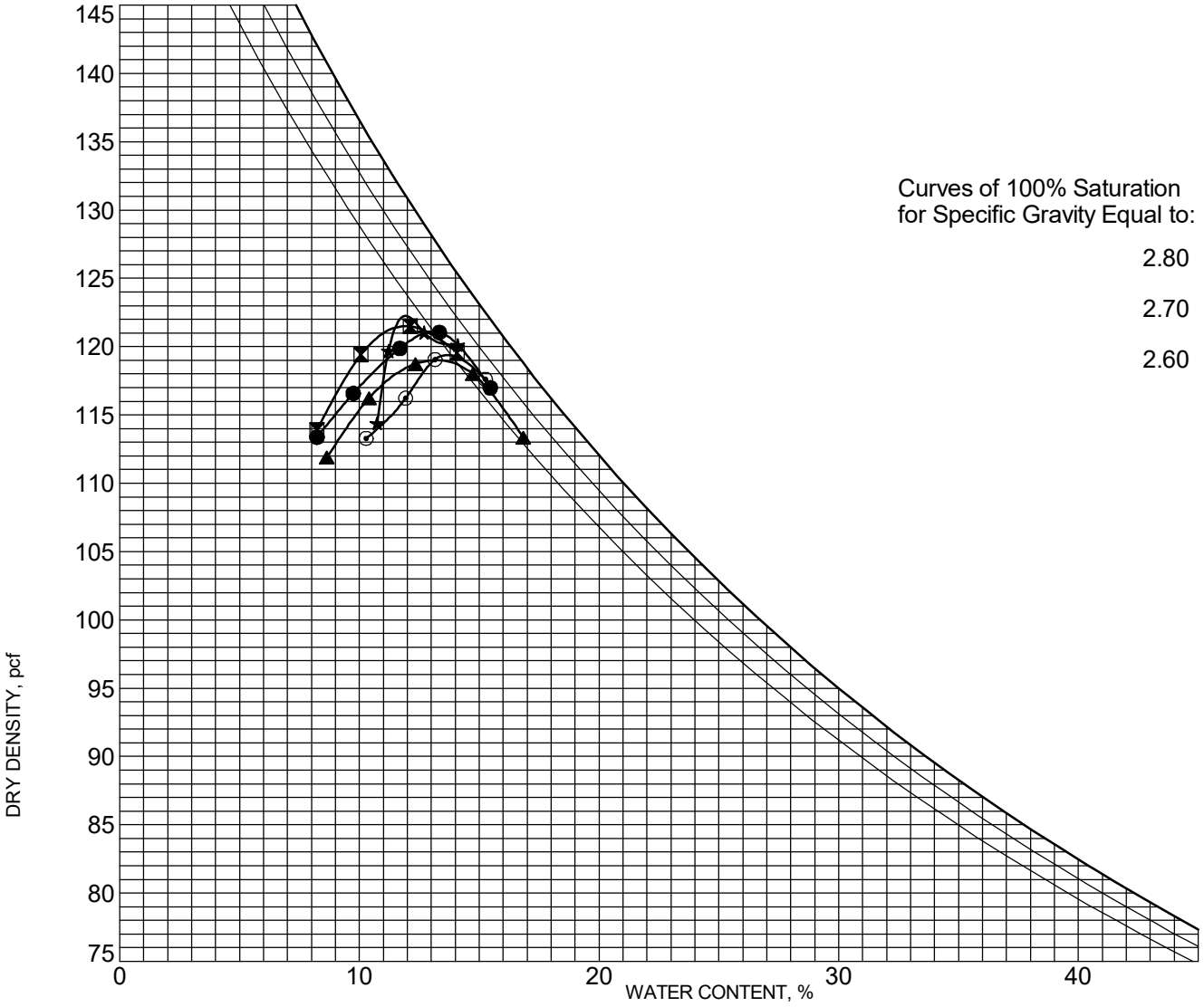
BOREHOLE		DEPTH	Test Method	LL	PL	PI	Max DD	Optimum WC
●	**35+0760**	**2.0**	**AASHTO T-180 Method A**	**42**	**19**	**23**	**121.4 PCF**	**12.4 %**
⊠	**35+1018**	**2.0**	**AASHTO T-180 Method A**	**44**	**19**	**25**	**117.9 PCF**	**14.0 %**
▲	**35+1298**	**2.0**	**AASHTO T-180 Method A**	**44**	**18**	**26**	**117.6 PCF**	**14.9 %**
★	**35+1335**	**2.0**	**AASHTO T-180 Method A**	**40**	**20**	**20**	**120.5 PCF**	**11.9 %**
⊙	**35+1388**	**2.0**	**AASHTO T-180 Method A**	**43**	**21**	**22**	**118.5 PCF**	**13.1 %**
✿	**35+1525**	**2.0**	**AASHTO T-180 Method A**	**40**	**18**	**22**	**117.9 PCF**	**13.8 %**

MOISTURE-DENSITY RELATIONSHIP

NORTH DAKOTA DEPARTMENT OF TRANSPORATION
300 AIRPORT ROAD
BISMARCK, ND 58504

PROJECT NUMBER SS-2-011(041)035 **LOCATION** Mcintosh County

PCN 22937



	BOREHOLE	DEPTH	AASHTO Classification	USCS Description
●	**35+1778**	**2.0**	**A-7-6 (21)**	**LEAN CLAY(CL)**
⊠	**35+2017**	**2.0**	**A-6 (16)**	**LEAN CLAY with SAND(CL)**
▲	**35+2274**	**2.0**	**A-7-6 (22)**	**LEAN CLAY(CL)**
★	**35+2524**	**2.0**	**A-7-6 (20)**	**LEAN CLAY(CL)**
⊙	**35+2780**	**2.0**	**A-7-6 (23)**	**LEAN CLAY(CL)**

	BOREHOLE	DEPTH	Test Method	LL	PL	PI	Max DD	Optimum WC
●	**35+1778**	**2.0**	**AASHTO T-180 Method A**	**44**	**20**	**24**	**121.1 PCF**	**13.1 %**
⊠	**35+2017**	**2.0**	**AASHTO T-180 Method A**	**40**	**18**	**22**	**121.5 PCF**	**11.9 %**
▲	**35+2274**	**2.0**	**AASHTO T-180 Method A**	**44**	**19**	**25**	**119.0 PCF**	**13.2 %**
★	**35+2524**	**2.0**	**AASHTO T-180 Method A**	**42**	**18**	**24**	**122.2 PCF**	**11.9 %**
⊙	**35+2780**	**2.0**	**AASHTO T-180 Method A**	**45**	**19**	**26**	**119.4 PCF**	**13.7 %**