

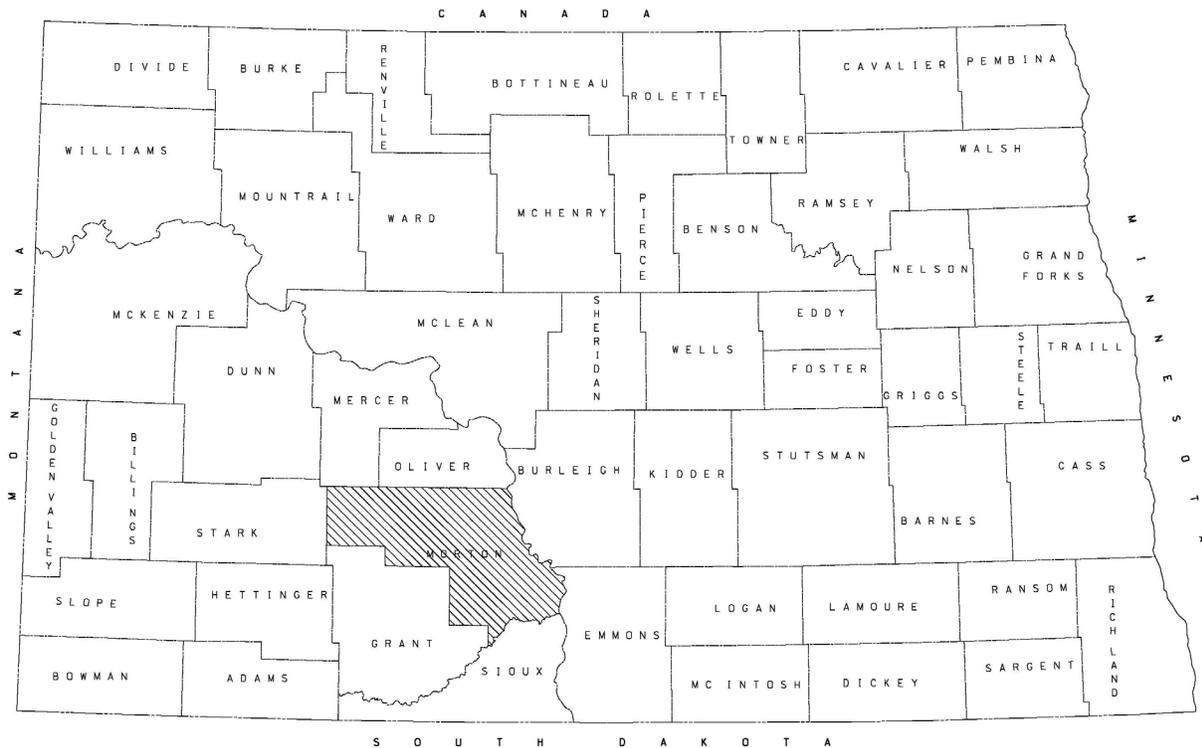
LINEAR SOILS SURVEY AND RECOMMENDATIONS

PROJECT NO. SU-1-806(052)071

PCN 22181

COUNTY Morton

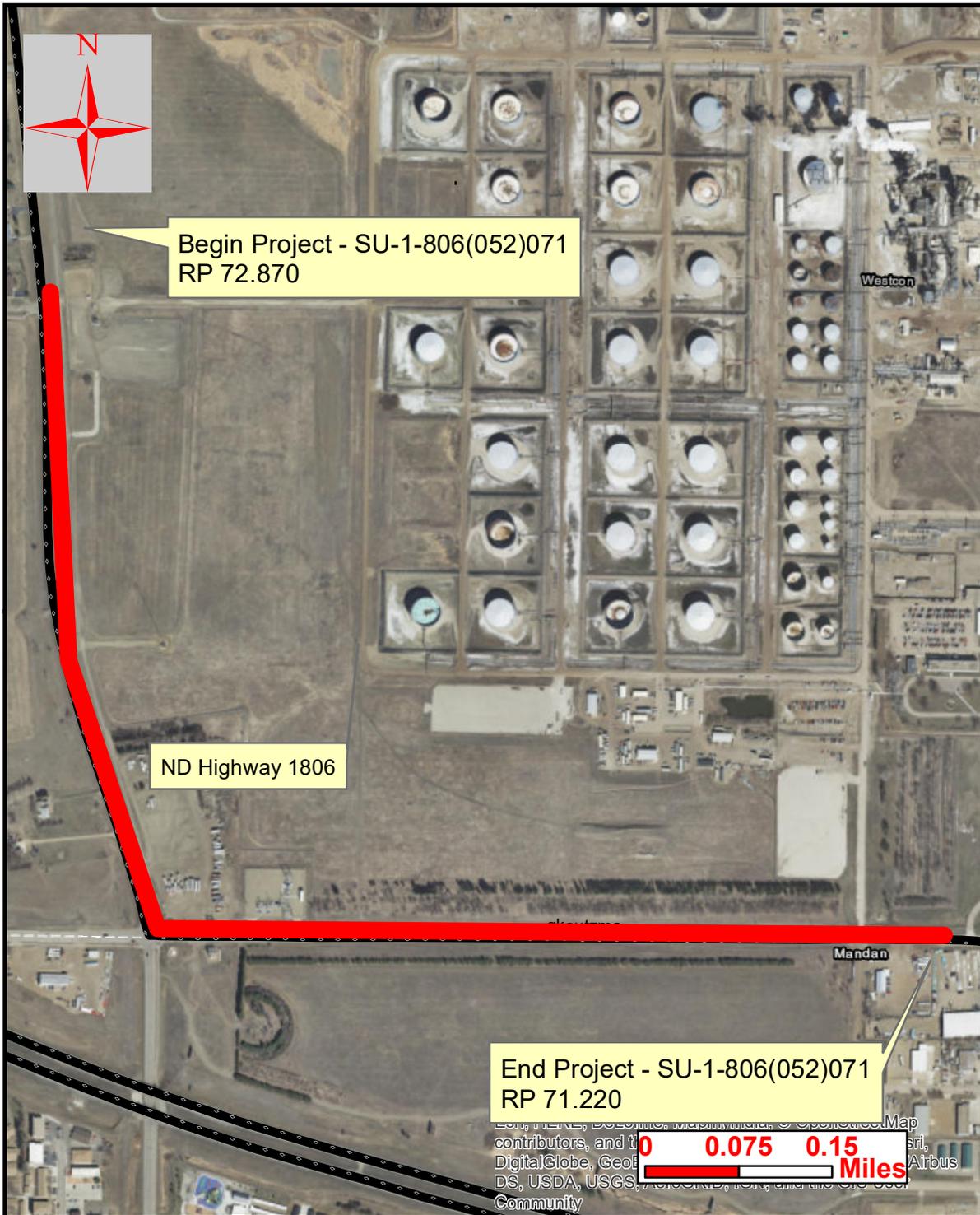
ND Highway 1806 From RP 71.220 to RP 72.870



PREPARED BY: Kyle Evert, P.E.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

February 2019

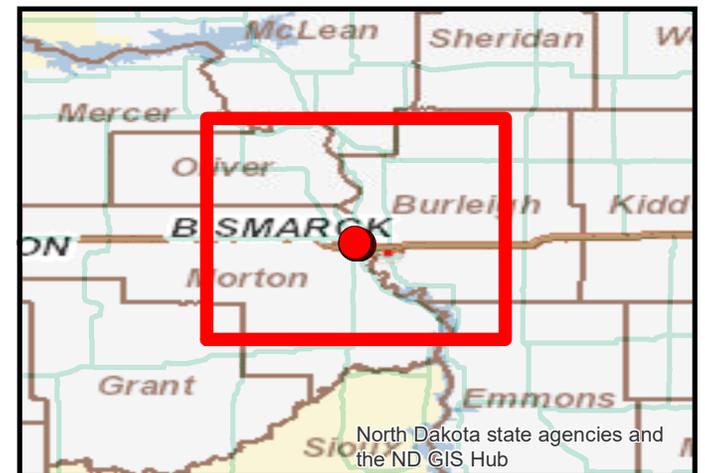


Linear Soils Report and Recommendation

Project: SU-1-806(052)071

Scope: Major Rehabilitation

Location: Old Red Trail to 27th St. NW

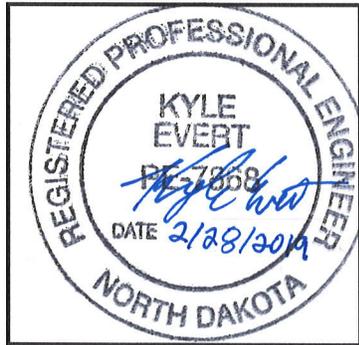


SU-1-806(052)071

Old Red Trail to 27th St. NW

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 Kyle Evert, Registration number PE-7868 on 2/28/2019 and the original document is stored at the North Dakota Department of Transportation.





Kyle Evert, P.E.

2/28/2019

Date

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Introduction

Location: Old Red Trail to 27th St. NW
Reference Points: 71.22 to 72.870
Project Length: 1.65 Miles
Proposed Project: Major Rehabilitation
Investigation Scope: Identified Areas

Maintenance Review

There was no maintenance review on this project.

Summary of Soil Investigation

The investigation included six borings to a depth of 10' near the areas identified by the Geotechnical section. The borings were drilled on October 23, 2018. Maps of the boring locations are shown in Appendix B. The lab results are included in Appendix D.

Summary of Soil Analysis

Most of the soils in this area are very uniform and are classified as a lean clay and fat clays with an AASHTO classification of A-6 and A-7-6. On average these soils have a liquid limit of approximately 50 and a plasticity index of approximately 30. On average the maximum dry density is approximately 118 lb /ft³ and the optimum water content of 13%. The in-place moistures are on average 10% - 16% over optimum.

Soil Sample Distribution

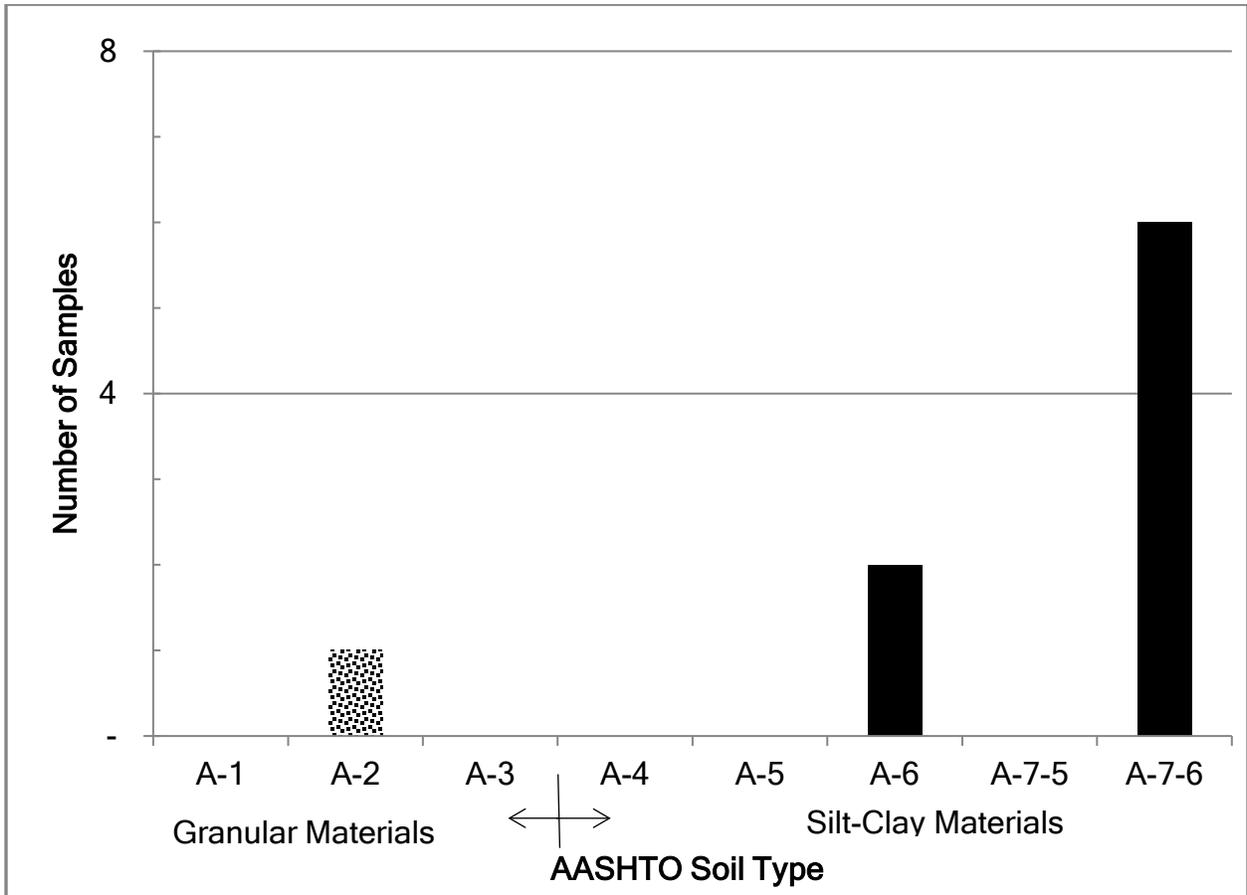


Figure 1 - Soil Sample Distribution

Design Recommendations

The following table describes the distresses identified in the and subsurface investigation scope. The table also contains the recommendations and justifications.

Table 1 – Design Recommendations

Location RP + Feet	Distress Identified	Recommendation	Justification
71+1161 to 72+4594	Rutting	Do Nothing	This location has lean and fat clays with the top 4' of soil being sandy clays. The roadway does not appear to have many distresses. The recommended pavement design should be adequate.

Design Information

Pipe Replacement: Any pipes replaced on this may require a nonstandard pipe backfill detail. Contact the materials and Research Geotechnical Section prior to the PS&E if any pipes are being replaced with this project. Please include any pertinent information such as location, size, depth to inlet, etc.

Compaction Method: T 180

Subgrade Prep: None

Subcut: None

Remarks: 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

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)			
	A-1		A-3	A-2				A-4	A-5	A-6	A-7
Group Classification	A-1-a	A-1-b		A-2-4	A-2-5	A-2-6	A-2-7				A-7-5
(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	$C_u \geq 4$ and $1 \leq C_c \leq 3^c$	GW
		Less than 5% fines ^a	$C_u < 4$ 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	$C_u \geq 6$ and $1 \leq C_c \leq 3^c$	SW
		Less than 5% fines ^b	$C_u < 6$ and/or $1 > C_c > 3^c$	SP
Sands with Fines		$PI < 4$ or plots below "A" line (Figure 5.3)	SM	
More than 12% fines ^{b,d}		$PI > 7$ 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
			PI plots on or above "A" line (Figure 5.3)	CH
	Silts and clays Liquid limit 50 or more	Inorganic	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

^aGravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.

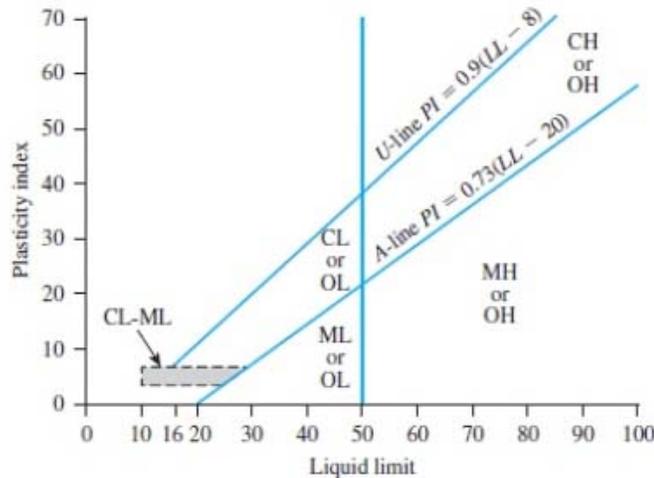
^bSands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.

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

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

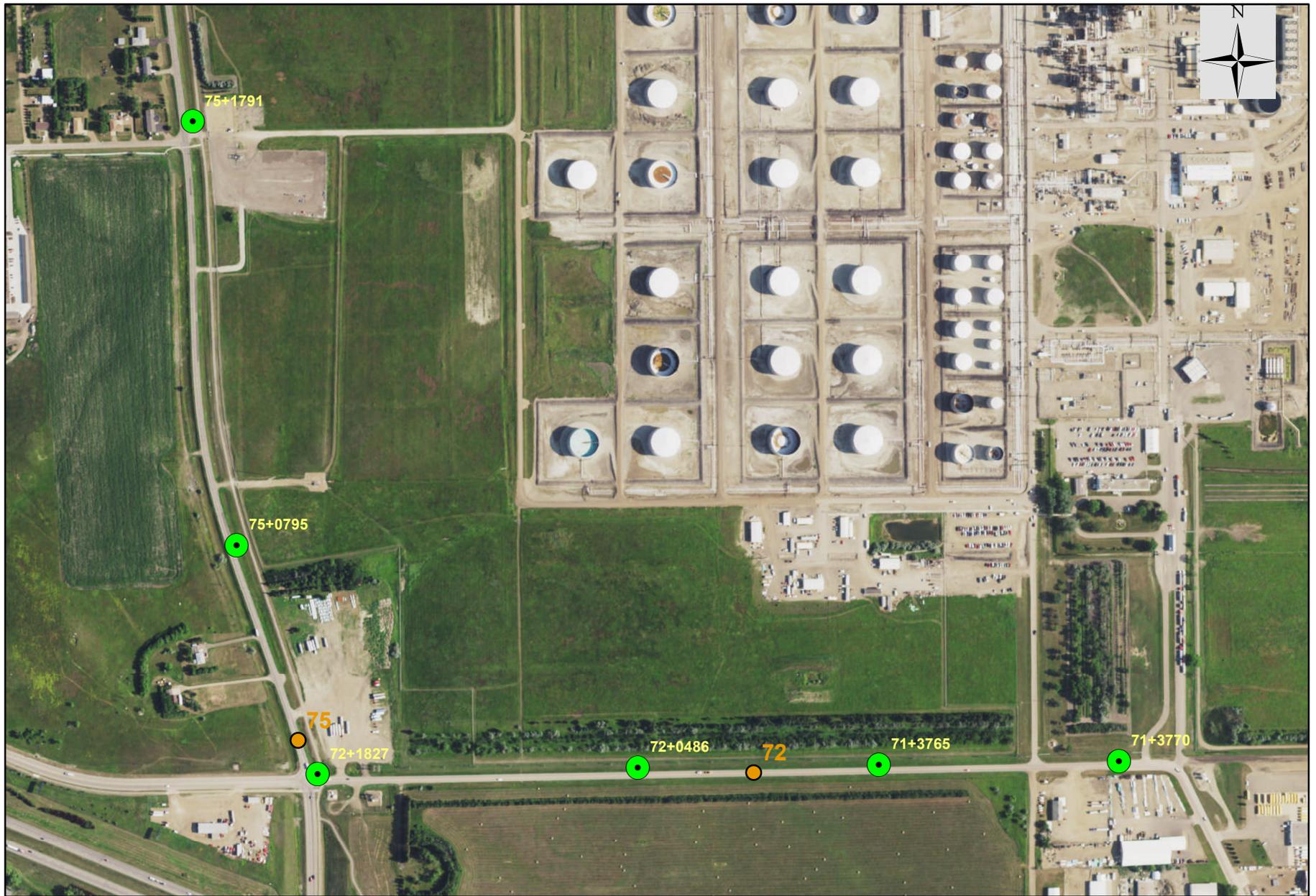
^eIf $4 \leq PI \leq 7$ and plots in the hatched area in Figure 5.3, use dual symbol CL-ML.

Plasticity Chart :



APPENDIX B

Boring Locations



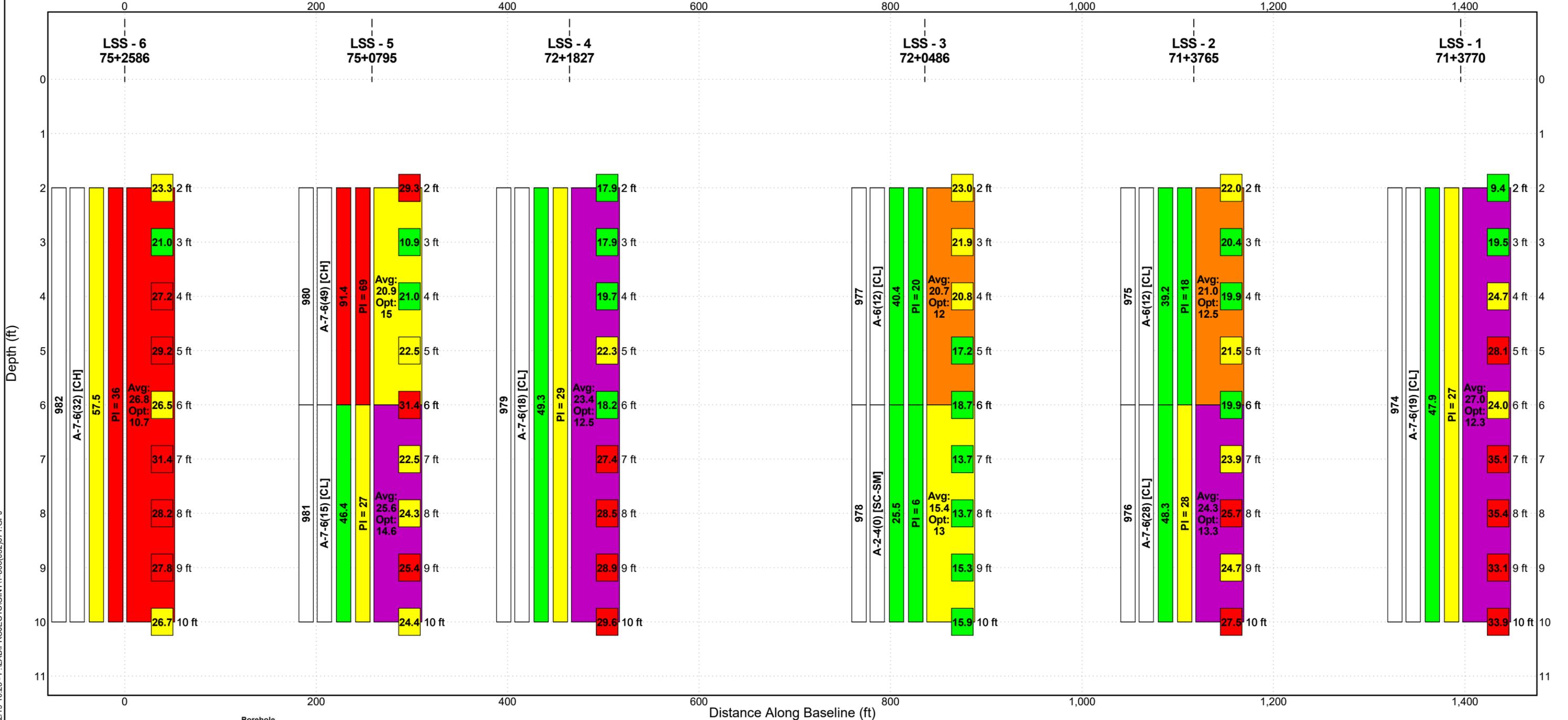
Legend

- Reference Point
- Borings

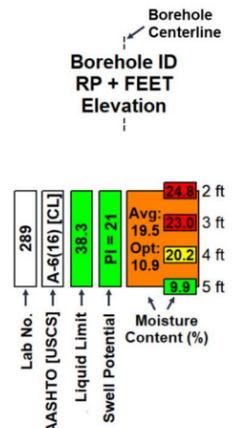


APPENDIX C

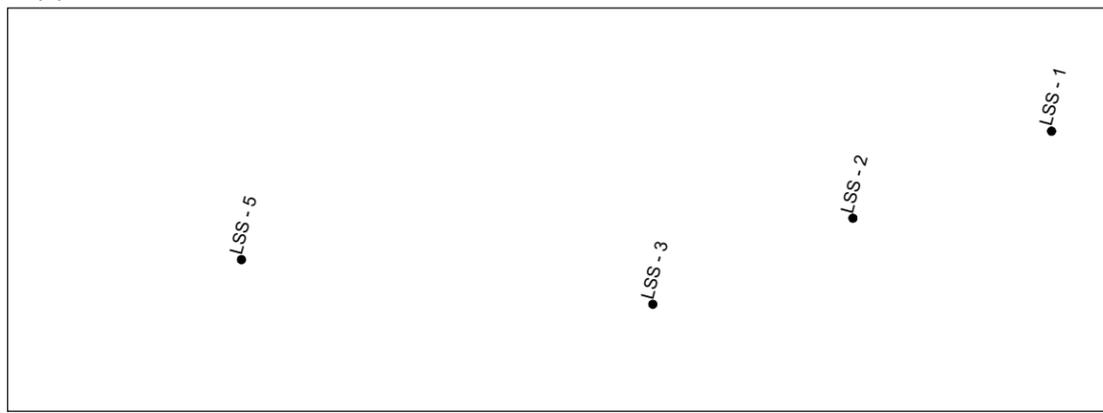
SUMMARY OF SOILS ANALYSIS



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



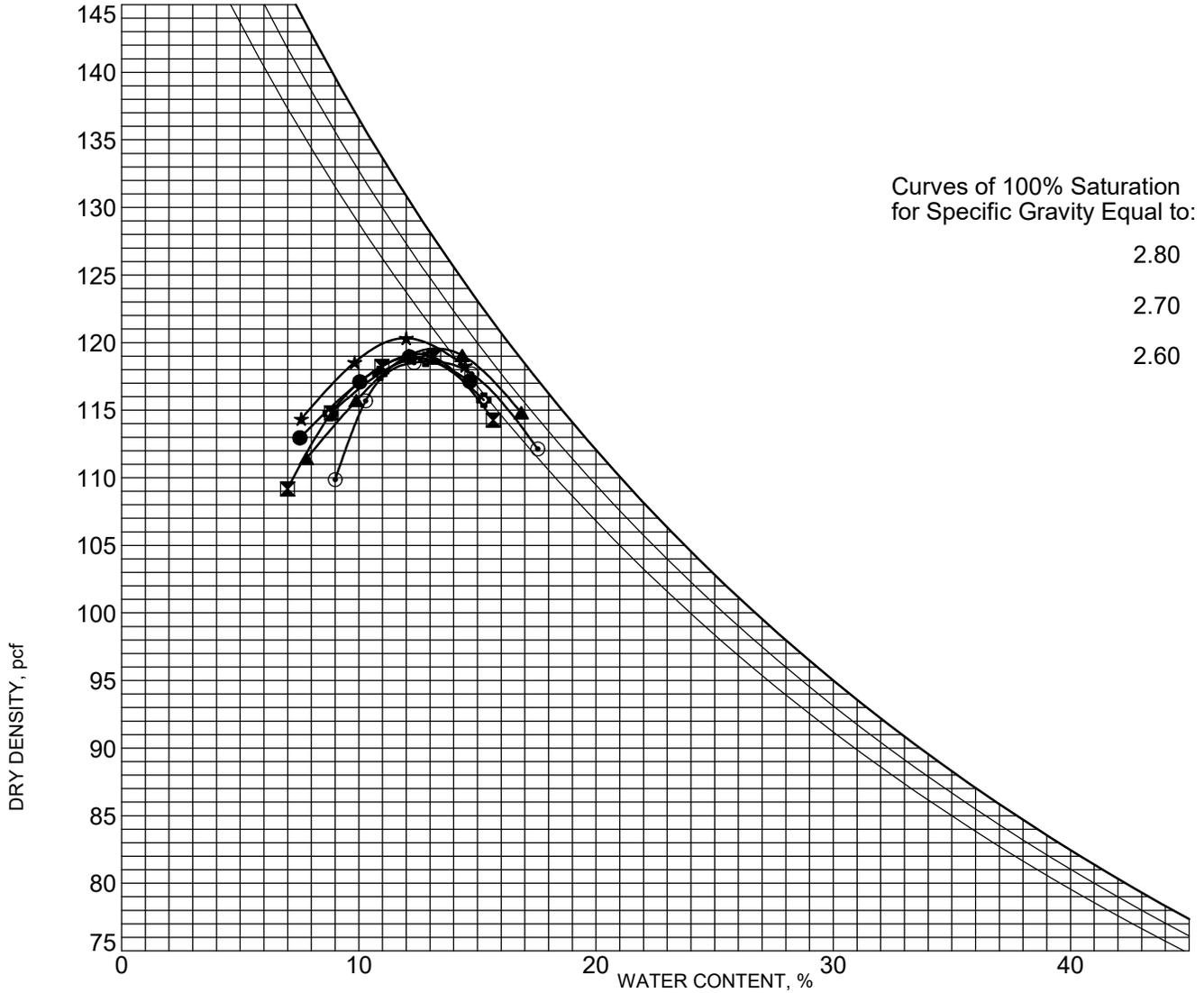
APPENDIX D

LAB RESULTS

PROJECT NUMBER SU-1-806(052)071

LOCATION Morton County

PCN 22181



BOREHOLE	DEPTH	AASHTO Classification	USCS Description
● LSS - 1	2.0	A-7-6 (19)	LEAN CLAY with SAND(CL)
☒ LSS - 2	2.0	A-6 (12)	LEAN CLAY with SAND(CL)
▲ LSS - 2	6.0	A-7-6 (28)	LEAN CLAY(CL)
★ LSS - 3	2.0	A-6 (12)	SANDY LEAN CLAY(CL)
⊙ LSS - 3	6.0	A-2-4 (0)	SILTY, CLAYEY SAND(SC-SM)
⊕ LSS - 4	2.0	A-7-6 (18)	LEAN CLAY with SAND(CL)

BOREHOLE	DEPTH	Test Method	LL	PL	PI	Max DD	Optimum WC
● LSS - 1	2.0	AASHTO T-180 Method A	48	21	27	118.9 PCF	12.3 %
☒ LSS - 2	2.0	AASHTO T-180 Method A	39	21	18	119.2 PCF	12.5 %
▲ LSS - 2	6.0	AASHTO T-180 Method A	48	20	28	119.6 PCF	13.3 %
★ LSS - 3	2.0	AASHTO T-180 Method A	40	20	20	120.3 PCF	12.0 %
⊙ LSS - 3	6.0	AASHTO T-180 Method A	26	20	6	118.6 PCF	13.0 %
⊕ LSS - 4	2.0	AASHTO T-180 Method A	49	21	28	118.8 PCF	12.5 %

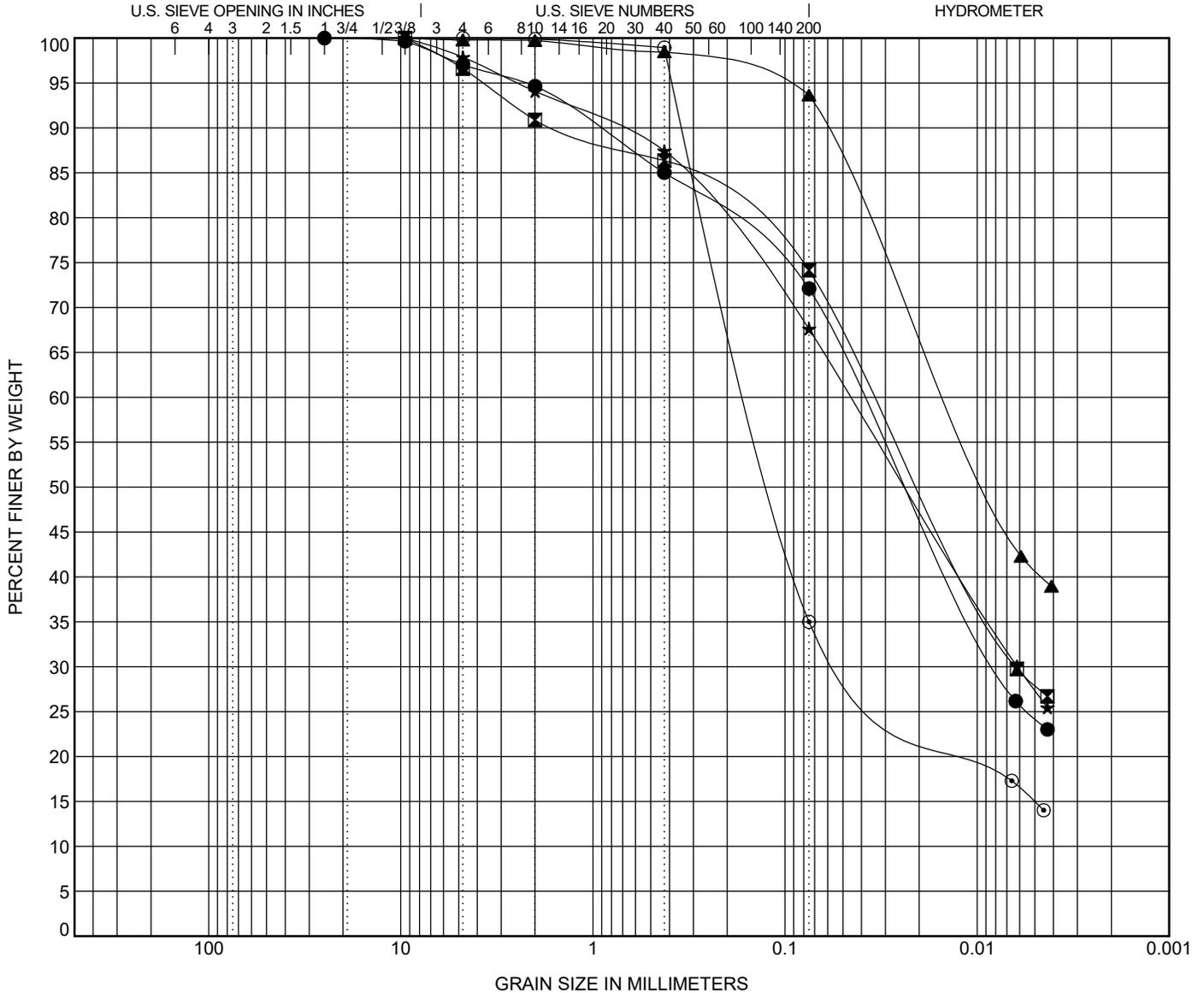


GRAIN SIZE DISTRIBUTION

PROJECT NUMBER SU-1-806(052)071

LOCATION Morton County

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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● LSS - 1	2.0	A-7-6 (19)	CL	48	21	27		
☒ LSS - 2	2.0	A-6 (12)	CL	39	21	18		
▲ LSS - 2	6.0	A-7-6 (28)	CL	48	20	28		
★ LSS - 3	2.0	A-6 (12)	CL	40	20	20		
◎ LSS - 3	6.0	A-2-4 (0)	SC-SM	26	20	6		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LSS - 1	2.0	25	0.039	0.008		3.0	24.9	47.8	24.3
☒ LSS - 2	2.0	9.5	0.034	0.006		3.4	22.5	46.2	28.0
▲ LSS - 2	6.0	9.5	0.014			0.2	6.1	52.9	40.8
★ LSS - 3	2.0	9.5	0.045	0.006		2.1	30.3	40.3	27.3
◎ LSS - 3	6.0	4.75	0.148	0.038		0.0	65.0	20.1	14.9

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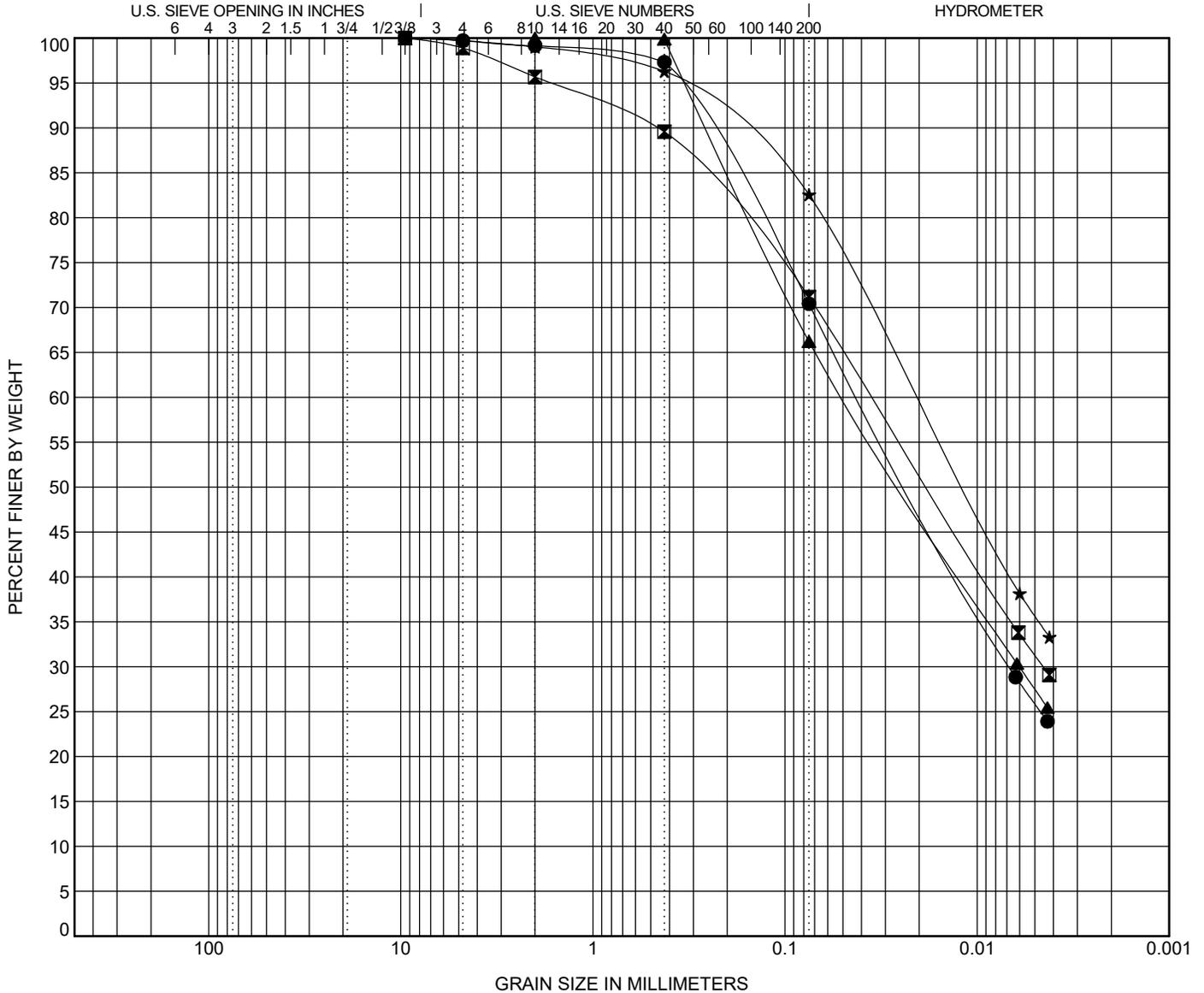
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
300 AIRPORT ROAD
BISMARCK, ND 58504

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER SU-1-806(052)071

LOCATION Morton County

PCN 22181



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● LSS - 4	2.0	A-7-6 (18)	CL	49	21	28		
■ LSS - 5	2.0	A-7-6 (49)	CH	91	22	69		
▲ LSS - 5	6.0	A-7-6 (15)	CL	46	20	26		
★ LSS - 6	2.0	A-7-6 (32)	CH	58	22	36		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LSS - 4	2.0	9.5	0.04	0.007		0.3	29.3	44.6	25.9
■ LSS - 5	2.0	9.5	0.035	0.005		1.1	27.7	39.9	31.3
▲ LSS - 5	6.0	2	0.049	0.006		0.0	33.8	38.7	27.5
★ LSS - 6	2.0	9.5	0.021			0.3	17.1	46.9	35.7

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SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER SU-1-806(052)071

LOCATION Morton County

PCN 22181

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Classification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
LSS - 1	2.0	48	21	27	25	72	A-7-6 (19)	CL	9.4	27.0			
LSS - 1	3.0								19.5	27.0			
LSS - 1	4.0								24.7	27.0			
LSS - 1	5.0								28.1	27.0			
LSS - 1	6.0								24.0	27.0			
LSS - 1	7.0								35.1	27.0			
LSS - 1	8.0								35.4	27.0			
LSS - 1	9.0								33.1	27.0			
LSS - 1	10.0								33.9	27.0			
LSS - 2	2.0	39	21	18	9.5	74	A-6 (12)	CL	22.0	21.0			
LSS - 2	3.0								20.4	21.0			
LSS - 2	4.0								19.9	21.0			
LSS - 2	5.0								21.5	21.0			
LSS - 2	6.0	48	20	28	9.5	94	A-7-6 (28)	CL	19.9	24.3			
LSS - 2	7.0								23.9	24.3			
LSS - 2	8.0								25.7	24.3			
LSS - 2	9.0								24.7	24.3			
LSS - 2	10.0								27.5	24.3			
LSS - 3	2.0	40	20	20	9.5	68	A-6 (12)	CL	23.0	20.7			
LSS - 3	3.0								21.9	20.7			
LSS - 3	4.0								20.8	20.7			
LSS - 3	5.0								17.2	20.7			
LSS - 3	6.0	26	20	6	4.75	35	A-2-4 (0)	SC-SM	18.7	15.4			
LSS - 3	7.0								13.7	15.4			
LSS - 3	8.0								13.7	15.4			
LSS - 3	9.0								15.3	15.4			
LSS - 3	10.0								15.9	15.4			
LSS - 4	2.0	49	21	28	9.5	70	A-7-6 (18)	CL	17.9	23.4			
LSS - 4	3.0								17.9	23.4			
LSS - 4	4.0								19.7	23.4			
LSS - 4	5.0								22.3	23.4			
LSS - 4	6.0								18.2	23.4			
LSS - 4	7.0								27.4	23.4			
LSS - 4	8.0								28.5	23.4			
LSS - 4	9.0								28.9	23.4			
LSS - 4	10.0								29.6	23.4			
LSS - 5	2.0	91	22	69	9.5	71	A-7-6 (49)	CH	29.3	20.9			
LSS - 5	3.0								10.9	20.9			
LSS - 5	4.0								21.0	20.9			
LSS - 5	5.0								22.5	20.9			
LSS - 5	6.0	46	20	26	2	66	A-7-6 (15)	CL	31.4	25.6			
LSS - 5	7.0								22.5	25.6			
LSS - 5	8.0								24.3	25.6			

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SUMMARY OF LABORATORY RESULTS

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LOCATION Morton County

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Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	AASHTO Classification	USCS Classification	Water Content (%)	Avg. Water Content (%)	Dry Density (pcf)	Saturation (%)	Void Ratio
LSS - 5	9.0								25.4	25.6			
LSS - 5	10.0								24.4	25.6			
LSS - 6	2.0	58	22	36	9.5	83	A-7-6 (32)	CH	23.3	26.8			
LSS - 6	3.0								21.0	26.8			
LSS - 6	4.0								27.2	26.8			
LSS - 6	5.0								29.2	26.8			
LSS - 6	6.0								26.5	26.8			
LSS - 6	7.0								31.4	26.8			
LSS - 6	8.0								28.2	26.8			
LSS - 6	9.0								27.8	26.8			
LSS - 6	10.0								26.7	26.8			