

LINEAR SOILS SURVEY AND RECOMMENDATIONS

PROJECT NO. NHU-2-094(158)928

PCN 22173

COUNTY Barnes

Interstate 94, RP 928.128 to 929.4407



PREPARED BY: Colter Schwagler, PE

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

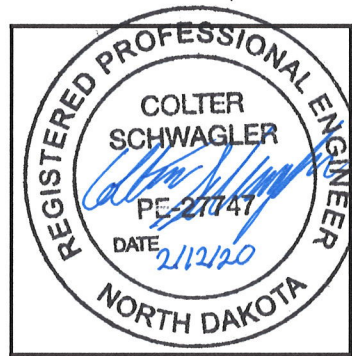
January 2020

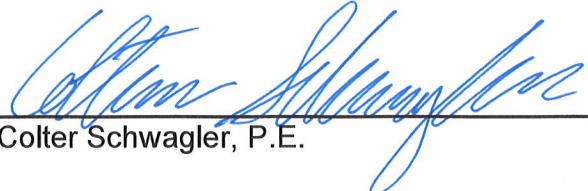
NHU-2-094(158)928

Interstate 94, Valley City Main Street West I-94 Ramp to 3rd Street SW

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 Schwagler, Registration number PE-27747 on 2/12/2020 and the original document is stored at the North Dakota Department of Transportation.





Colter Schwagler, P.E.

2/12/20

Date

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Introduction

Location: Valley City Main Street West I-94 Ramp to 3rd Street SW

Reference Points: 928.128 to 929.4407

Project Length: 1.3127 Miles

Proposed Project Scope: Minor Rehabilitation

Investigation Scope: Maintenance Areas

Maintenance Review

The Geotechnical Section was notified via email of two maintenance areas for this project. A formal Maintenance Review was not performed.

Table 1 – Identified Maintenance Areas

Location RP+Feet	Distress Identified	Maintenance Comments	Drilling Required
928+2500 928+2600	Emailed Location	Possible Subcut Location	Yes
929+1000 929+1050	Emailed Location	Possible Subcut Location (CDI Ready Mix Approach)	Yes

Summary of Soil Investigation

The soil investigation was completed on 5/22/2019 and 5/31/2019. The investigation consisted of 10 borings within the project limits.

Table 2 – Boring Locations Summary

Boring Location	Justification for Boring	Boring depth	Location
928+2444 to 928+2641	Possible Subcut Location	10 feet	Conduct 3 borings inside the maintenance area and 2 borings outside the maintenance area.
929+0966 to 929+1054	Possible Subcut Location (CDI Ready Mix Approach)	10 feet	Conduct 3 borings inside the maintenance area and 2 borings outside the maintenance area.

Maps of the boring locations are shown in Appendix C. The lab results are included in Appendix D and E.

Summary of Soil Analysis

Project Limits – RP 928.128 to 929.4407: All of the soils within the project limits are fat clays with AASHTO classifications of A-7-6. The optimum dry density of these soils ranged from about 104 to 109 lb/ft³ and the optimum water contents range from about 17 to 20%. The in-place moistures of the soils are on average more than 16% over optimum.

Soil Sample Distribution

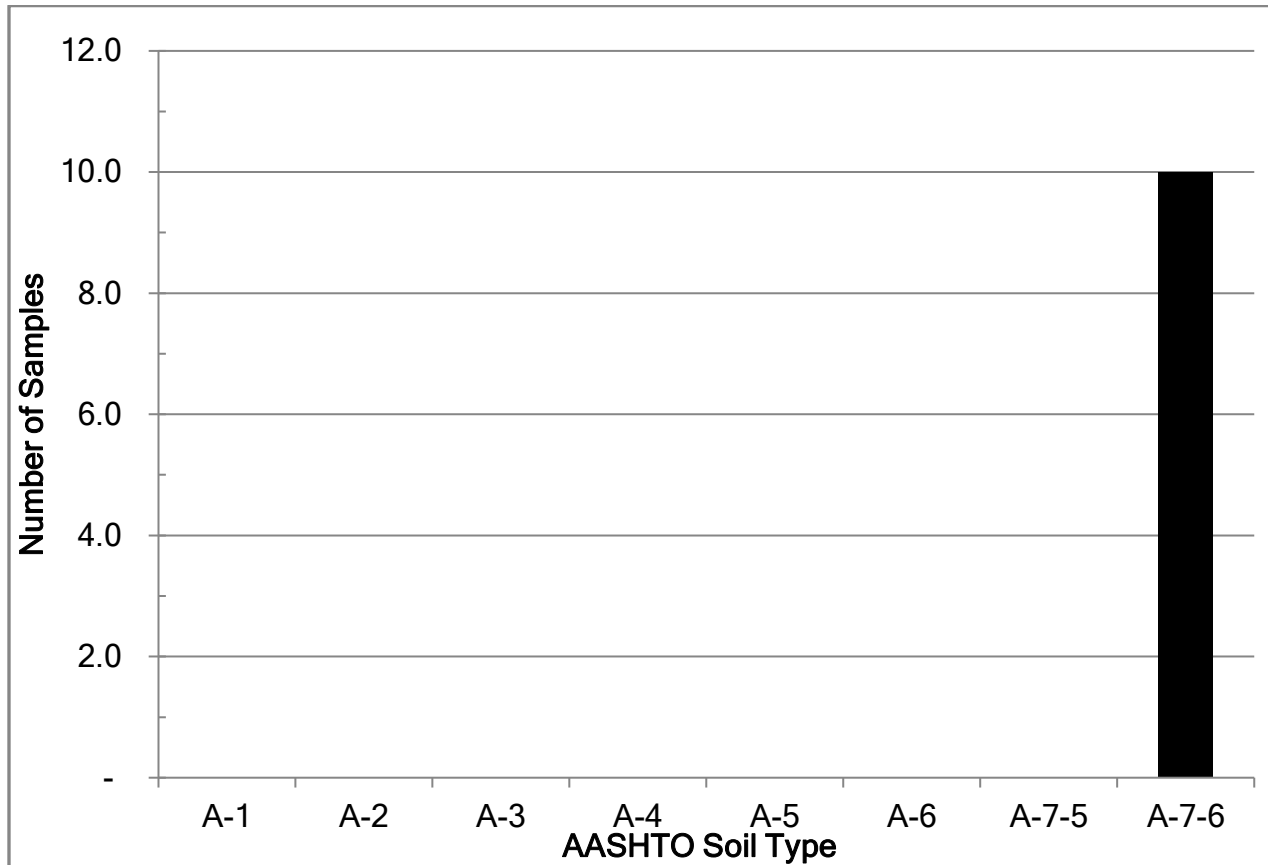


Figure 1 - Soil Sample Distribution

Design Recommendations

Maintenance Area – RP 928+2444 to 928+2641: All of the soils within the project limits are fat clays with AASHTO classifications of A-7-6. The optimum dry density of these soils ranged from about 104 to 109 lb/ft³ and the optimum water contents range from about 17 to 20%. The in-place moistures of the soils are on average more than 16% over optimum. The in-place soils have moisture contents higher than their plastic limits. See the Design information for details.

Maintenance Area – RP 929+0966 to 929+1054 (CDI Ready Mix Approach): All of the soils within the project limits are fat clays with AASHTO classifications of A-7-6. The optimum dry density of these soils ranged from about 104 to 109 lb/ft³ and the optimum water contents range from about 17 to 20%. The in-place moistures of the soils are on average more than 16% over optimum. The in-place soils have moisture contents higher than their plastic limits. The distress in this area appears to be limited to the approach to the CDI Ready Mix Plant. See the Design information for details.

Design Information

Pipe Replacement: NA

Compaction Method: T-180

Subgrade Prep: None

Subcut Recommendations:

Table 3 – Subcut Recommendations

Location RP + Feet	Length	Depth
928+2435 to 928+2650	215'	36"
929+0955 to 929+1065 (CDI Ready Mix Approach)	60'	36"

Calculate the subcut quantity based on the lengths and depths as shown in Table 3 above and adhere to the guidelines stated below.

Remarks: Subcut from the top of existing pavement. Place Geosynthetic Geogrid (Type G) at the bottom of all subcut excavations and backfill with Class 5 aggregate. Place 10" of aggregate on the geogrid prior to compacting. Do not scarify the bottom of the subcut.

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

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) 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.

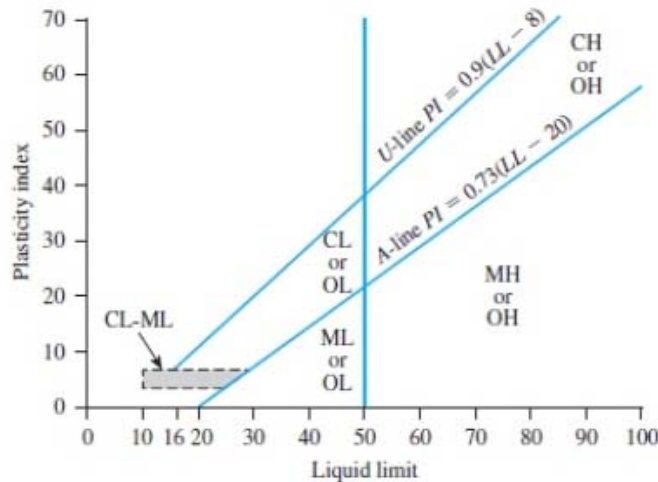
^bSands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.

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

^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
- Boring Locations



Project Number: NHU-2-094(158)928



Legend

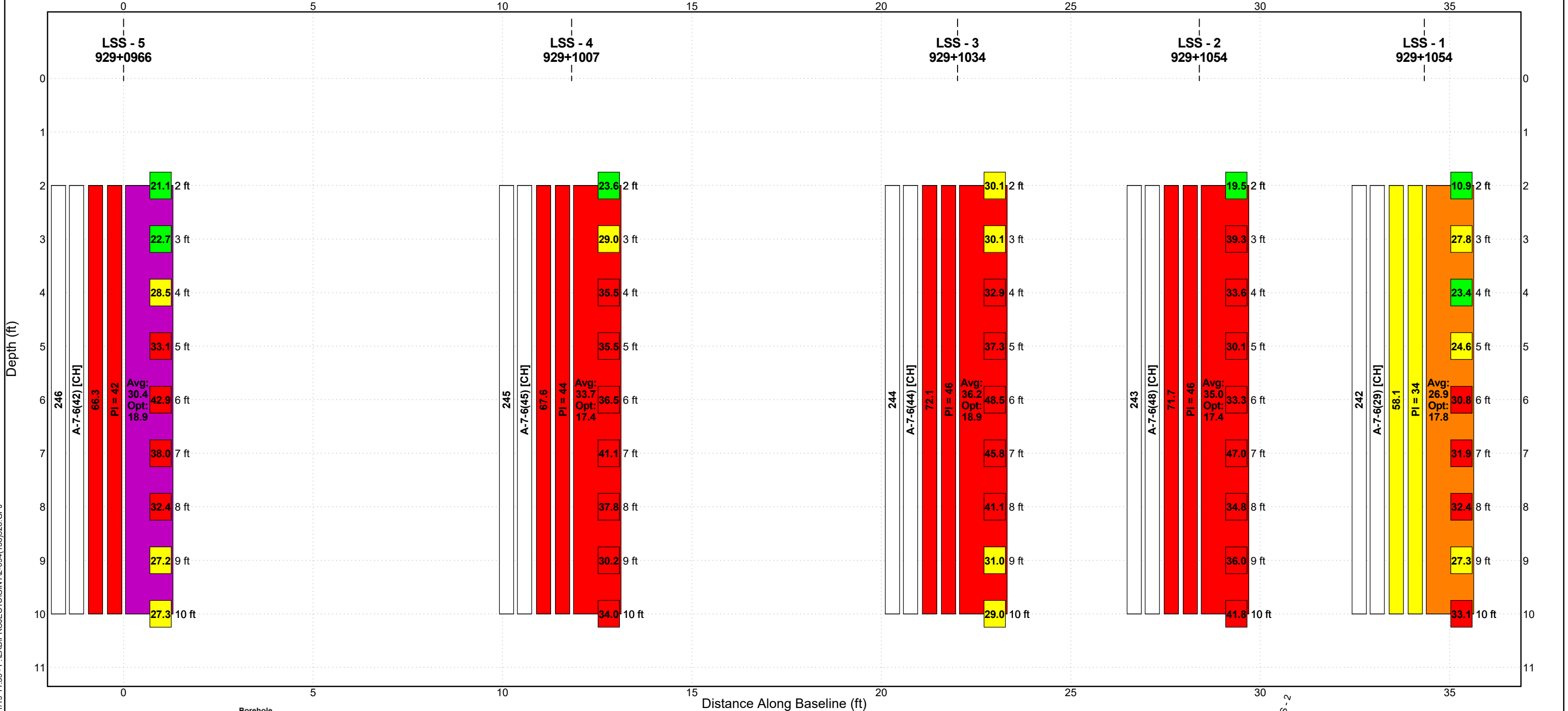
- Reference Point
- Boring Locations



Project Number: NHU-2-094(158)928

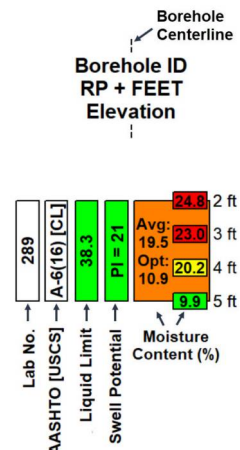
APPENDIX C

SUMMARY OF SOILS ANALYSIS

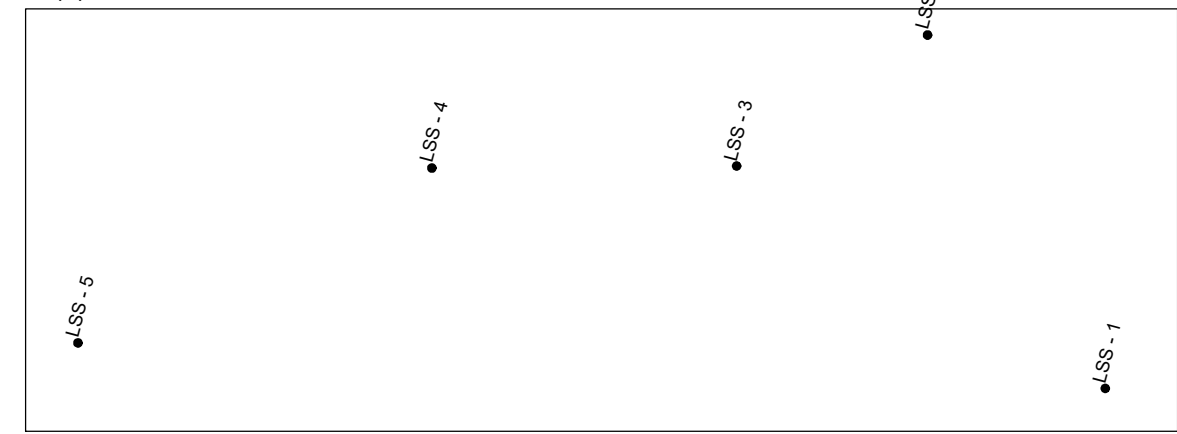


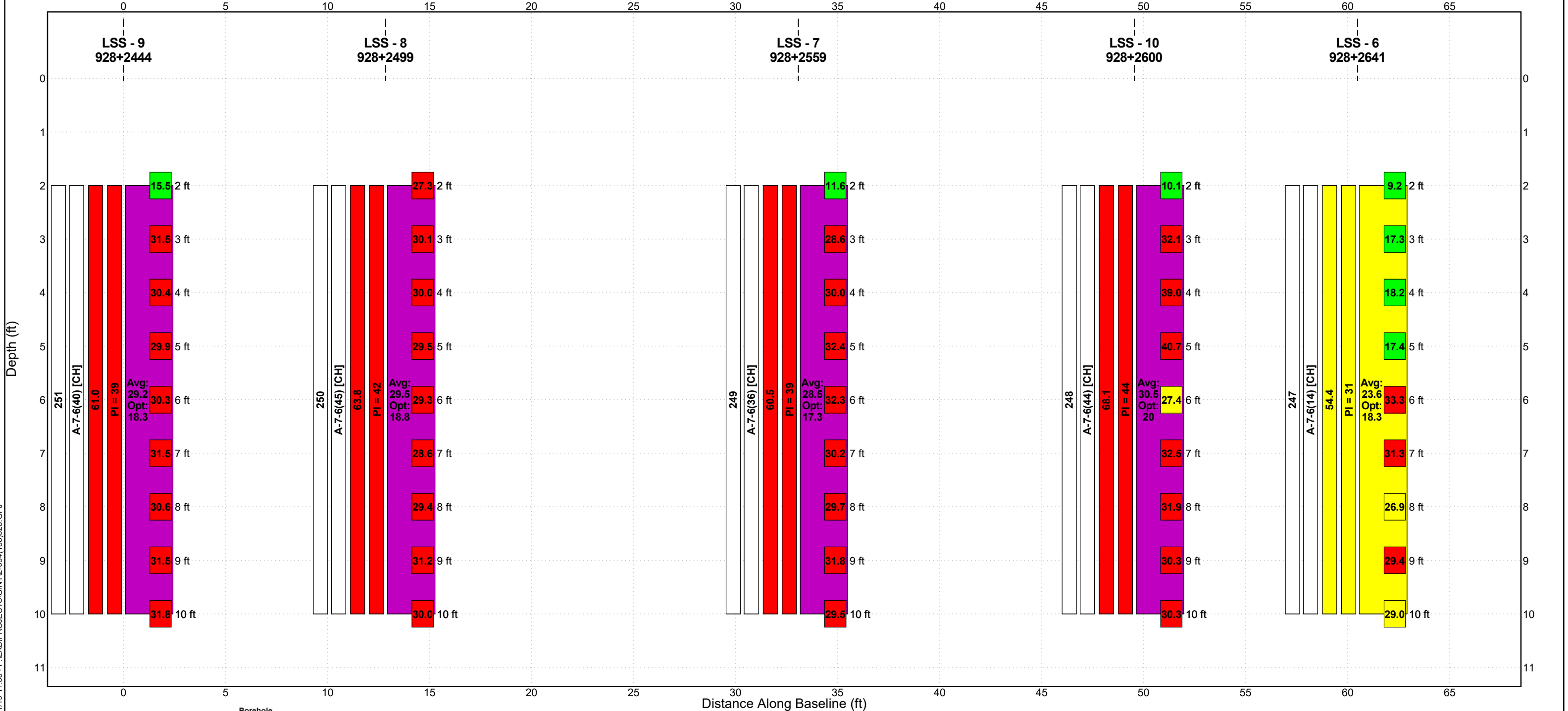
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LEGEND

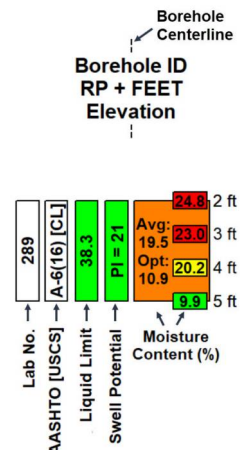


Liquid Limit	LL < 50	50 ≤ LL < 60	LL ≥ 60		
Swell Potential	Low	Marginal	High		
Moisture Content	Below PL	0-5% Over PL	>5% Over PL	Non-Plastic	
Avg. In-Place Moisture Content	MC < Opt	0 ≤ MC < 6% Over Opt	6 ≤ MC < 10% Over Opt	10 ≤ MC < 16% Over Opt	MC > 16% Over Opt

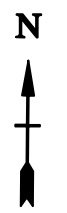
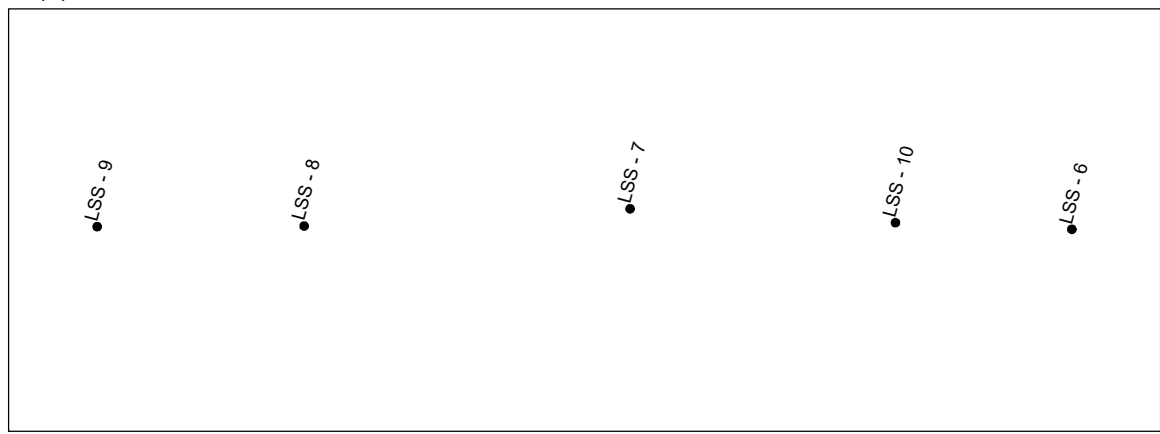




LEGEND



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 D
LAB RESULTS

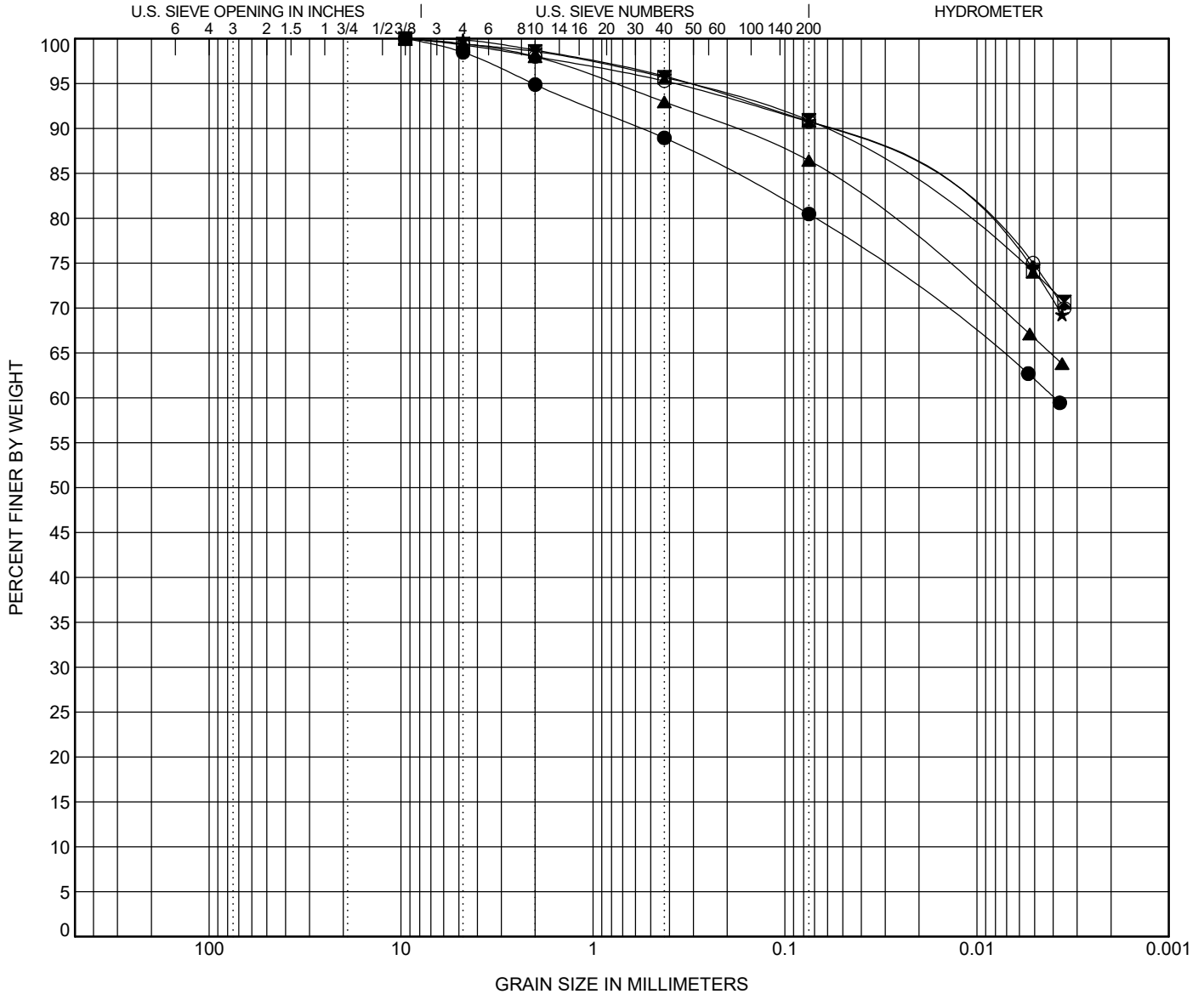


GRAIN SIZE DISTRIBUTION

PROJECT NUMBER NHU-2-094(158)928

LOCATION Barnes 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 (29)	CH			58	24	34		
☒ LSS - 2	2.0	A-7-6 (48)	CH			72	25	47		
▲ LSS - 3	2.0	A-7-6 (44)	CH			72	26	46		
★ LSS - 4	2.0	A-7-6 (45)	CH			68	24	44		
◎ LSS - 5	2.0	A-7-6 (42)	CH			66	25	41		

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LSS - 1	2.0	9.5	0.004			1.5	18.0	18.4	62.0
☒ LSS - 2	2.0	9.5				0.6	8.5	17.0	73.9
▲ LSS - 3	2.0	9.5				0.6	13.0	19.8	66.6
★ LSS - 4	2.0	9.5				0.1	9.1	16.7	74.1
◎ LSS - 5	2.0	9.5				0.7	8.6	16.0	74.8

GRAIN SIZE - 20171219.GDT - 8/21/19 11:40 - F:\LAB\PROJECTS\GINT2-094(158)928.GPJ



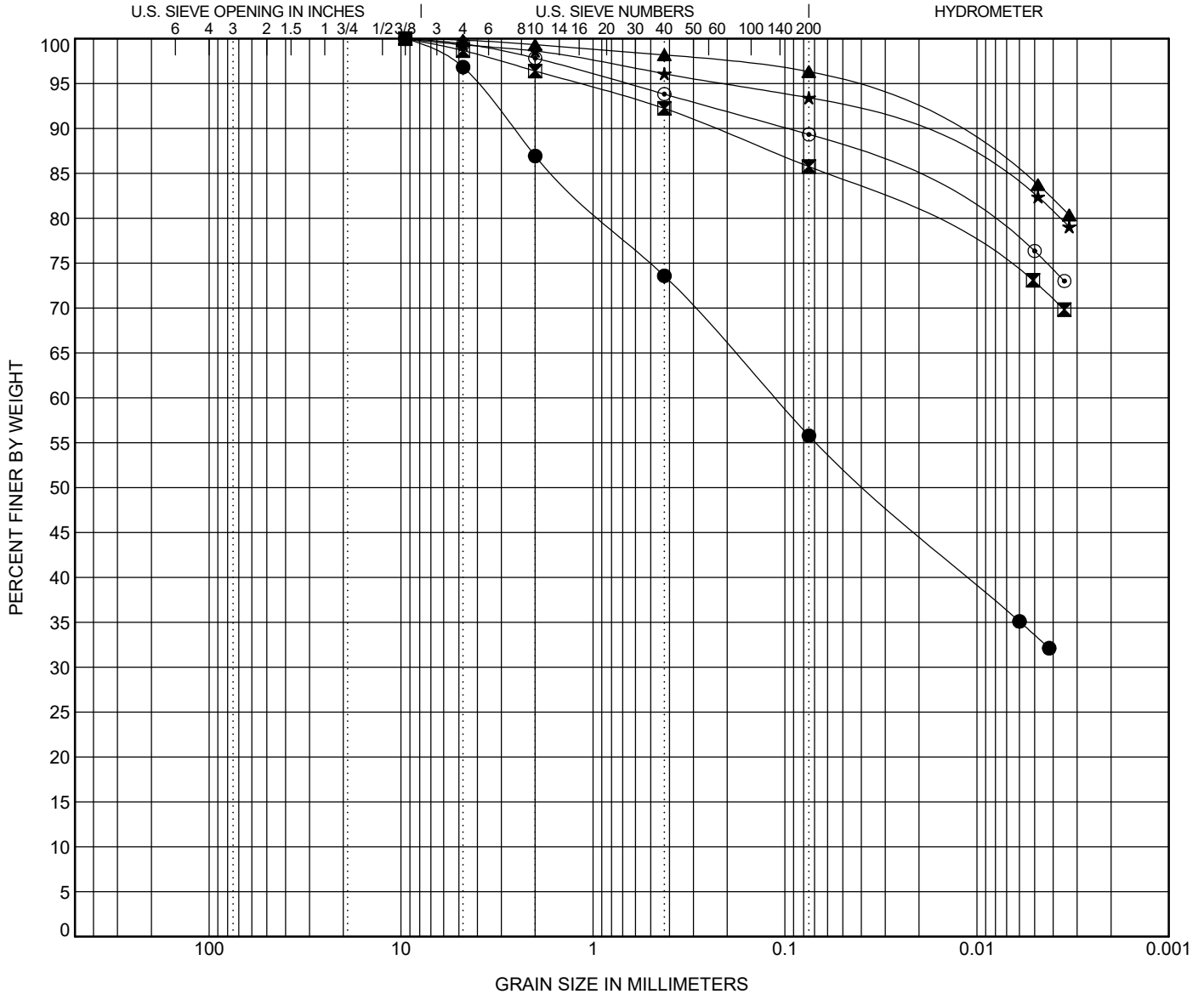
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
300 AIRPORT ROAD
BISMARCK, ND 58504

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER NHU-2-094(158)928

LOCATION Barnes County

PCN 22173



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	Cc	Cu
● LSS - 6	2.0	A-7-6 (14)	CH	54	24	30		
☒ LSS - 7	2.0	A-7-6 (36)	CH	60	21	39		
▲ LSS - 8	2.0	A-7-6 (45)	CH	64	22	42		
★ LSS - 9	2.0	A-7-6 (40)	CH	61	22	39		
◎ LSS - 10	2.0	A-7-6 (44)	CH	68	24	44		

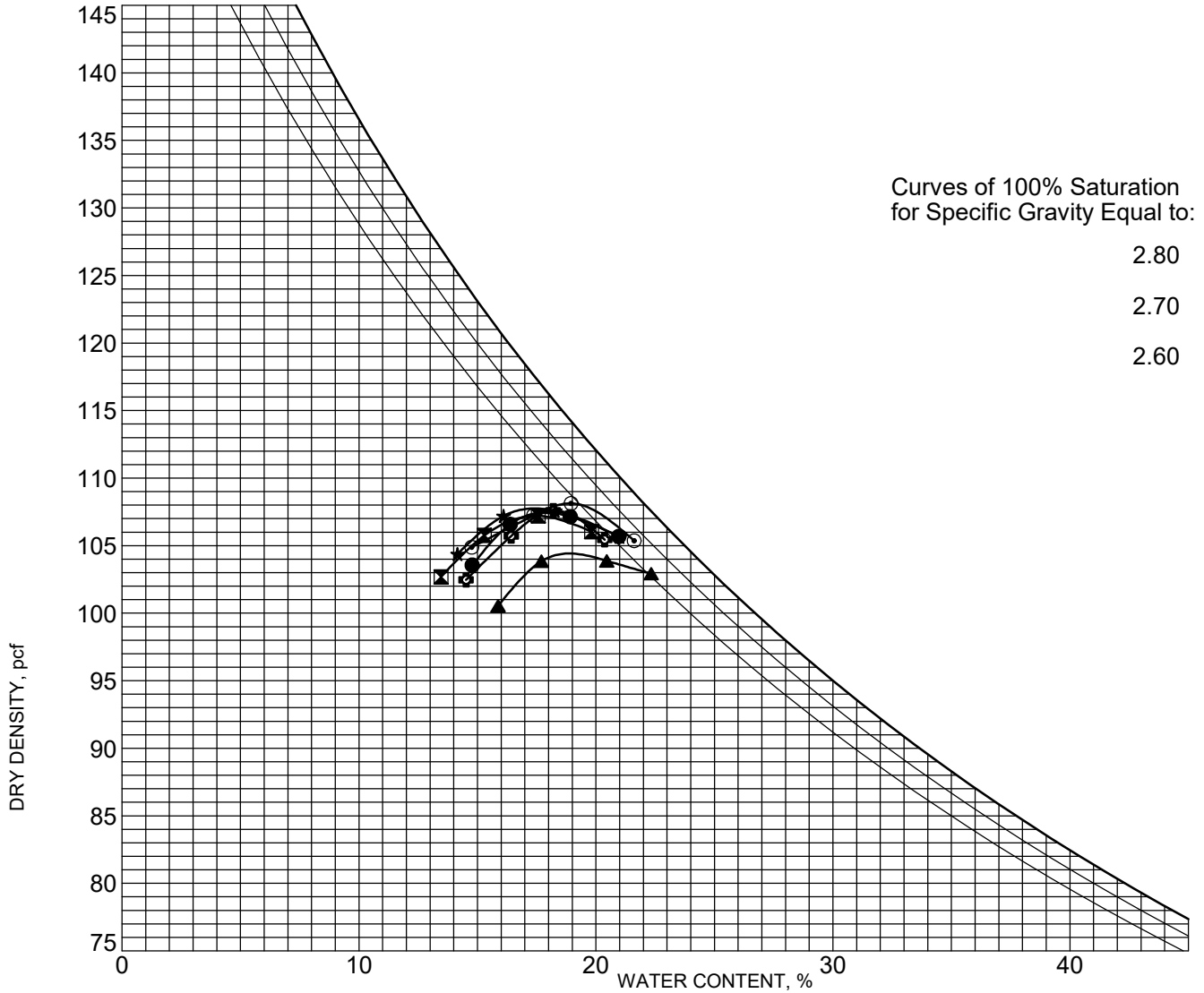
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● LSS - 6	2.0	9.5	0.113			3.2	41.1	22.2	33.6
☒ LSS - 7	2.0	9.5				1.3	12.9	12.8	72.9
▲ LSS - 8	2.0	9.5				0.2	3.5	12.4	83.9
★ LSS - 9	2.0	9.5				0.7	5.9	10.9	82.5
◎ LSS - 10	2.0	9.5				0.6	10.1	13.0	76.4

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LOCATION Barnes County

PCN 22173



BOREHOLE	DEPTH	AASHTO Classification	USCS Description
● LSS - 1	2.0	A-7-6 (29)	FAT CLAY with SAND(CH)
☒ LSS - 2	2.0	A-7-6 (48)	FAT CLAY(CH)
▲ LSS - 3	2.0	A-7-6 (44)	FAT CLAY(CH)
★ LSS - 4	2.0	A-7-6 (45)	FAT CLAY(CH)
⊙ LSS - 5	2.0	A-7-6 (42)	FAT CLAY(CH)
⊕ LSS - 6	2.0	A-7-6 (14)	SANDY FAT CLAY(CH)

BOREHOLE	DEPTH	Test Method	LL	PL	PI	Max DD	Optimum WC
● LSS - 1	2.0	AASHTO T-180 Method A	58	24	34	107.4 PCF	17.8 %
☒ LSS - 2	2.0	AASHTO T-180 Method A	72	25	47	107.2 PCF	17.4 %
▲ LSS - 3	2.0	AASHTO T-180 Method A	72	26	46	104.4 PCF	18.9 %
★ LSS - 4	2.0	AASHTO T-180 Method A	68	24	44	107.8 PCF	17.4 %
⊙ LSS - 5	2.0	AASHTO T-180 Method A	66	25	41	108.1 PCF	18.9 %
⊕ LSS - 6	2.0	AASHTO T-180 Method A	54	24	30	107.6 PCF	18.3 %

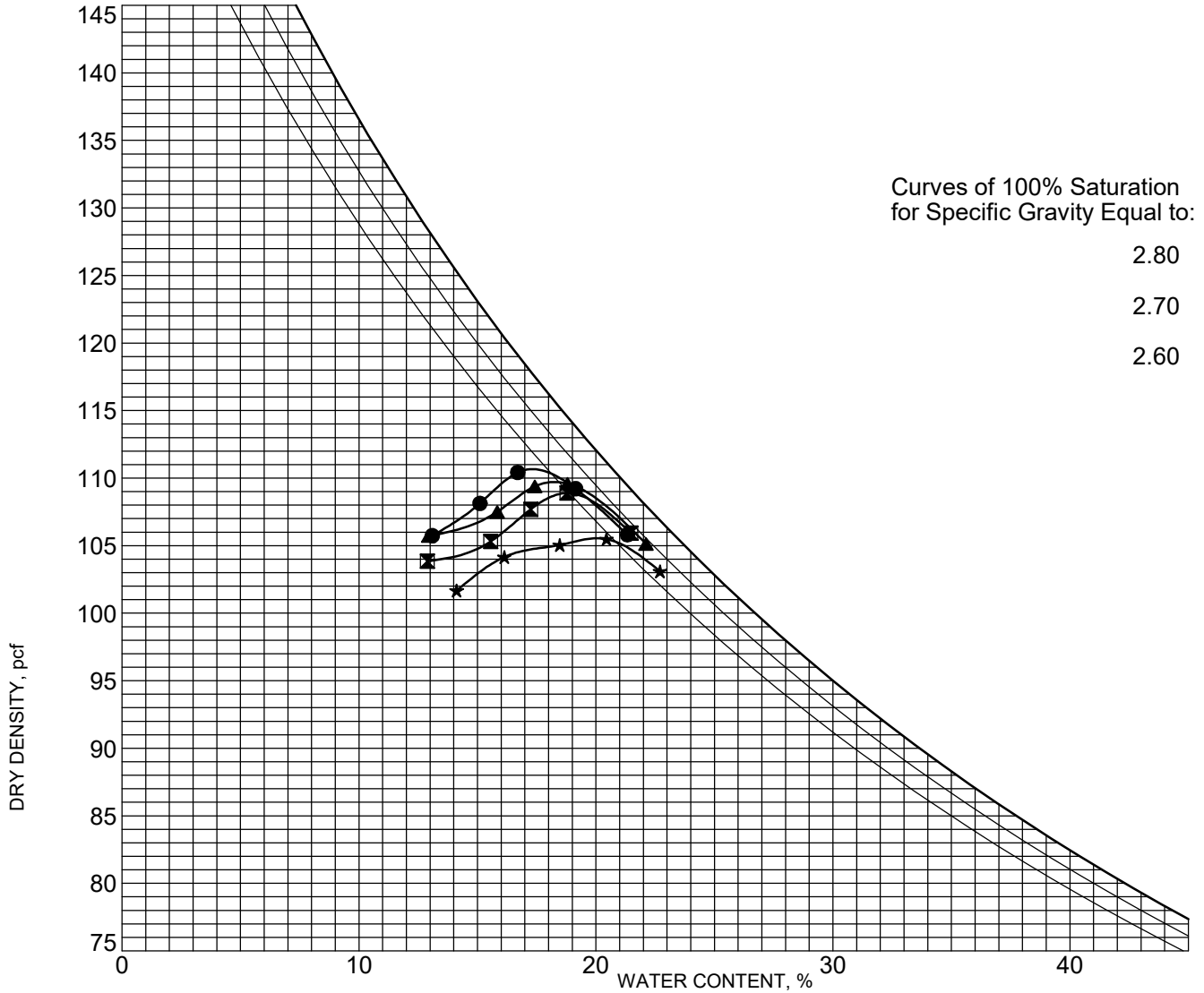


MOISTURE-DENSITY RELATIONSHIP

PROJECT NUMBER NHU-2-094(158)928

LOCATION Barnes County

PCN 22173



BOREHOLE	DEPTH	AASHTO Classification	USCS Description
● LSS - 7	2.0	A-7-6 (36)	FAT CLAY(CH)
☒ LSS - 8	2.0	A-7-6 (45)	FAT CLAY(CH)
▲ LSS - 9	2.0	A-7-6 (40)	FAT CLAY(CH)
★ LSS - 10	2.0	A-7-6 (44)	FAT CLAY(CH)

BOREHOLE	DEPTH	Test Method	LL	PL	PI	Max DD	Optimum WC
● LSS - 7	2.0	AASHTO T-180 Method A	60	21	39	110.7 PCF	17.3 %
☒ LSS - 8	2.0	AASHTO T-180 Method A	64	22	42	108.9 PCF	18.8 %
▲ LSS - 9	2.0	AASHTO T-180 Method A	61	22	39	109.7 PCF	18.3 %
★ LSS - 10	2.0	AASHTO T-180 Method A	68	24	44	105.5 PCF	20.0 %



SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER NHU-2-094(158)928

LOCATION Barnes County

PCN 22173

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	58	24	34	9.5	80	A-7-6 (29)	CH	10.9	26.9			
LSS - 1	3.0								27.8	26.9			
LSS - 1	4.0								23.4	26.9			
LSS - 1	5.0								24.6	26.9			
LSS - 1	6.0								30.8	26.9			
LSS - 1	7.0								31.9	26.9			
LSS - 1	8.0								32.4	26.9			
LSS - 1	9.0								27.3	26.9			
LSS - 1	10.0								33.1	26.9			
LSS - 2	2.0	72	25	47	9.5	91	A-7-6 (48)	CH	19.5	35.0			
LSS - 2	3.0								39.3	35.0			
LSS - 2	4.0								33.6	35.0			
LSS - 2	5.0								30.1	35.0			
LSS - 2	6.0								33.3	35.0			
LSS - 2	7.0								47.0	35.0			
LSS - 2	8.0								34.8	35.0			
LSS - 2	9.0								36.0	35.0			
LSS - 2	10.0								41.8	35.0			
LSS - 3	2.0	72	26	46	9.5	86	A-7-6 (44)	CH	30.1	36.2			
LSS - 3	3.0								30.1	36.2			
LSS - 3	4.0								32.9	36.2			
LSS - 3	5.0								37.3	36.2			
LSS - 3	6.0								48.5	36.2			
LSS - 3	7.0								45.8	36.2			
LSS - 3	8.0								41.1	36.2			
LSS - 3	9.0								31.0	36.2			
LSS - 3	10.0								29.0	36.2			
LSS - 4	2.0	68	24	44	9.5	91	A-7-6 (45)	CH	23.6	33.7			
LSS - 4	3.0								29.0	33.7			
LSS - 4	4.0								35.5	33.7			
LSS - 4	5.0								35.5	33.7			
LSS - 4	6.0								36.5	33.7			
LSS - 4	7.0								41.1	33.7			
LSS - 4	8.0								37.8	33.7			
LSS - 4	9.0								30.2	33.7			
LSS - 4	10.0								34.0	33.7			
LSS - 5	2.0	66	25	41	9.5	91	A-7-6 (42)	CH	21.1	30.4			
LSS - 5	3.0								22.7	30.4			
LSS - 5	4.0								28.5	30.4			
LSS - 5	5.0								33.1	30.4			
LSS - 5	6.0								42.9	30.4			
LSS - 5	7.0								38.0	30.4			
LSS - 5	8.0								32.4	30.4			

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SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER NHU-2-094(158)928

LOCATION Barnes County

PCN 22173

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								27.2	30.4			
LSS - 5	10.0								27.3	30.4			
LSS - 6	2.0	54	24	30	9.5	56	A-7-6 (14)	CH	9.2	23.6			
LSS - 6	3.0								17.3	23.6			
LSS - 6	4.0								18.2	23.6			
LSS - 6	5.0								17.4	23.6			
LSS - 6	6.0								33.3	23.6			
LSS - 6	7.0								31.3	23.6			
LSS - 6	8.0								26.9	23.6			
LSS - 6	9.0								29.4	23.6			
LSS - 6	10.0								29.0	23.6			
LSS - 7	2.0	60	21	39	9.5	86	A-7-6 (36)	CH	11.6	28.5			
LSS - 7	3.0								28.6	28.5			
LSS - 7	4.0								30.0	28.5			
LSS - 7	5.0								32.4	28.5			
LSS - 7	6.0								32.3	28.5			
LSS - 7	7.0								30.2	28.5			
LSS - 7	8.0								29.7	28.5			
LSS - 7	9.0								31.8	28.5			
LSS - 7	10.0								29.5	28.5			
LSS - 8	2.0	64	22	42	9.5	96	A-7-6 (45)	CH	27.3	29.5			
LSS - 8	3.0								30.1	29.5			
LSS - 8	4.0								30.0	29.5			
LSS - 8	5.0								29.5	29.5			
LSS - 8	6.0								29.3	29.5			
LSS - 8	7.0								28.6	29.5			
LSS - 8	8.0								29.4	29.5			
LSS - 8	9.0								31.2	29.5			
LSS - 8	10.0								30.0	29.5			
LSS - 9	2.0	61	22	39	9.5	93	A-7-6 (40)	CH	15.5	29.2			
LSS - 9	3.0								31.5	29.2			
LSS - 9	4.0								30.4	29.2			
LSS - 9	5.0								29.9	29.2			
LSS - 9	6.0								30.3	29.2			
LSS - 9	7.0								31.5	29.2			
LSS - 9	8.0								30.6	29.2			
LSS - 9	9.0								31.5	29.2			
LSS - 9	10.0								31.8	29.2			
LSS - 10	2.0	68	24	44	9.5	89	A-7-6 (44)	CH	10.1	30.5			
LSS - 10	3.0								32.1	30.5			
LSS - 10	4.0								39.0	30.5			
LSS - 10	5.0								40.7	30.5			
LSS - 10	6.0								27.4	30.5			

LAB SUMMARY - 20171219.GDT - 8/21/19 11:42 - F:\LAB\PROJECTS\GINT\2-094(158)928.GPJ



SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER NHU-2-094(158)928

LOCATION Barnes County

PCN 22173

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 - 10	7.0								32.5	30.5			
LSS - 10	8.0								31.9	30.5			
LSS - 10	9.0								30.3	30.5			
LSS - 10	10.0								30.3	30.5			