

# LINEAR SOILS SURVEY AND RECOMMENDATIONS

Project NO. XA-SS-1-031(021)078

PCN 23324

County Morton & Oliver

HWY 31, RP 78.257 to 95.646



PREPARED BY: Riley McAdoo-Roesler

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION MATERIAL  
AND RESEARCH DIVISION

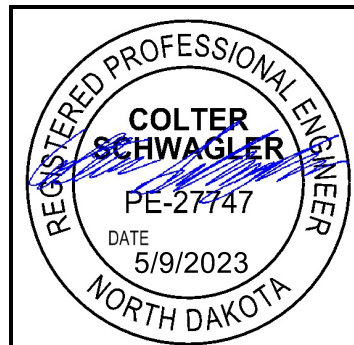
April 2023

**XA-SS-1-031(021)078**

**JCT I-94 to Hannover**

## ***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 05/09/2023 and the original document is stored at the North Dakota Department of Transportation.



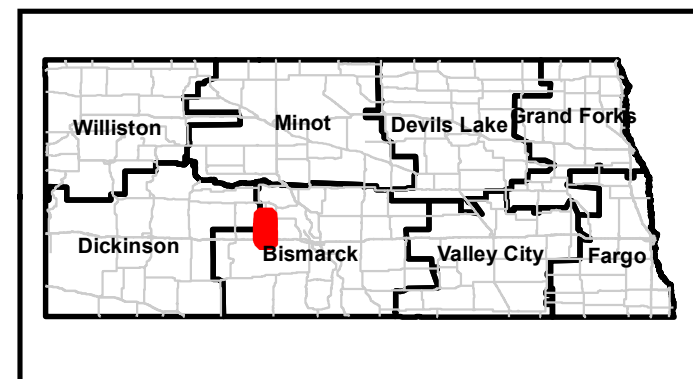
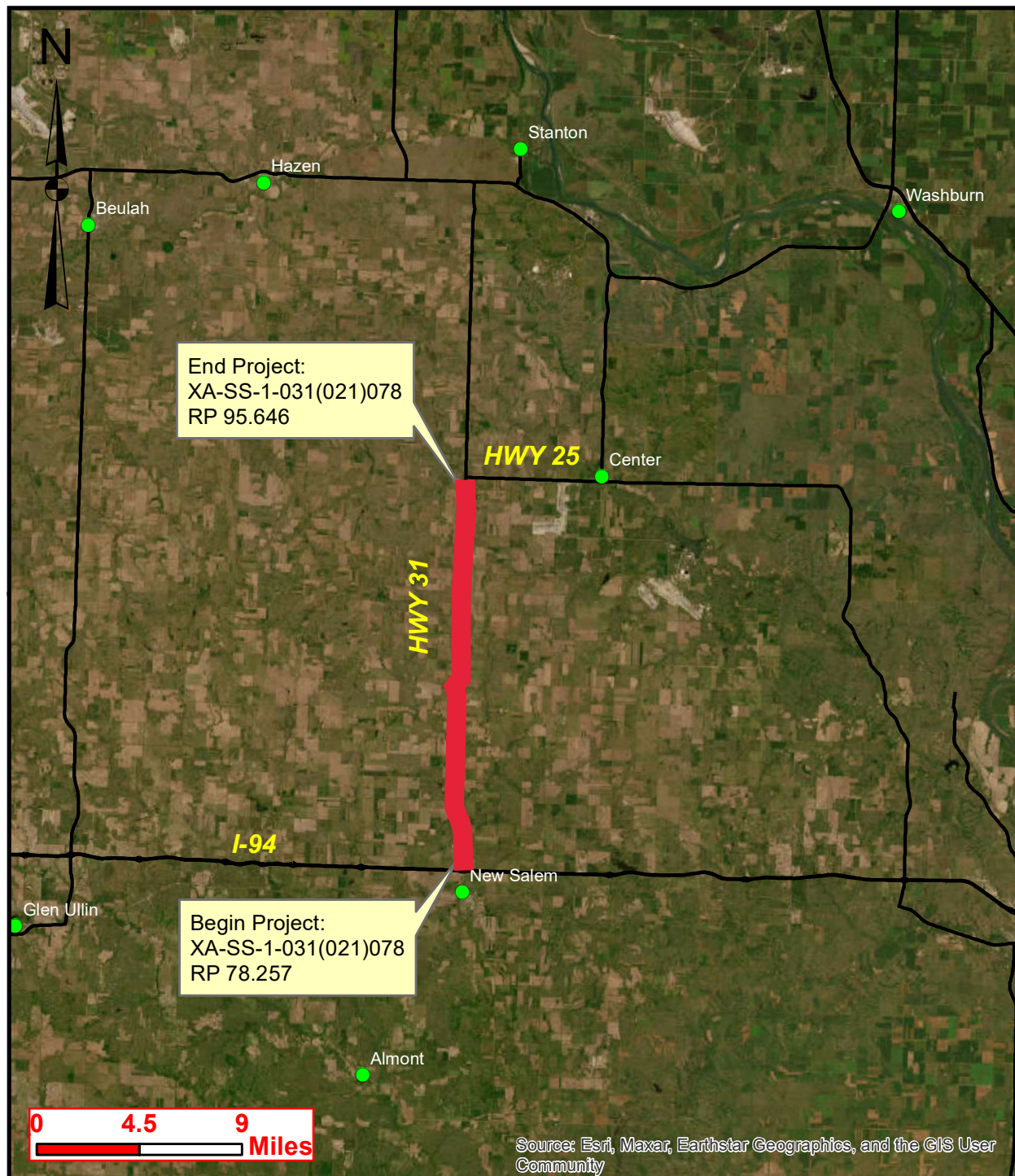
## Project Location

**Project:** XA-SS-1-031(021)078

**PCN:** 23324

**Scope:** Major Rehabilitation

**Location:** RP 78.257 to RP 95.646



## **Table of Contents**

|                                     |   |
|-------------------------------------|---|
| Introduction .....                  | 1 |
| Maintenance Review .....            | 1 |
| Summary of Soil Investigation ..... | 2 |
| Summary of Soil Analysis .....      | 3 |
| Soil Sample Distribution .....      | 3 |
| Design Recommendations .....        | 4 |
| Design Information .....            | 6 |
| Plan Notes .....                    | 7 |

## **List of Figures**

|                                           |   |
|-------------------------------------------|---|
| Figure 1 - Soil Sample Distribution ..... | 3 |
|-------------------------------------------|---|

## **List of Tables**

|                                              |   |
|----------------------------------------------|---|
| Table 1 - Identified Maintenance Areas ..... | 1 |
| Table 2 - Boring Locations Summary .....     | 2 |
| Table 3 - Subcut Recommendations .....       | 6 |
| Table 4 – Pavement Repair section .....      | 6 |

## **Appendices**

|                                                                    |  |
|--------------------------------------------------------------------|--|
| Appendix A – Soil Classification                                   |  |
| Appendix B – Maintenance Review and Subsurface Investigation Scope |  |
| Appendix C – Boring Locations                                      |  |
| Appendix D – Summary of Soils Analysis                             |  |
| Appendix E – Lab Results                                           |  |

## **Introduction**

Location: HWY 31, JCT I-94 to Hannover

Reference Points: 78.257 to 95.646

Project Length: 17.46 Miles

Proposed Project Scope: Major Rehabilitation – Widening and Overlay

Investigation Scope: 1 boring every mile and Identified Maintenance Areas

## **Maintenance Review**

Date of Maintenance Review: 07/28/2022

Materials and Research Person Conducting the Review: Jamie Naumann

Maintenance Person Conducting Review: Adam Vahn

Table 1 - Identified Maintenance Areas

| <b>Location<br/>RP + Feet</b> | <b>Distress Identified</b> | <b>Maintenance Comments</b>                                             | <b>Drilling<br/>Required</b> |
|-------------------------------|----------------------------|-------------------------------------------------------------------------|------------------------------|
| 83+2988                       | Bituminous Patch           | Pushing, wet area                                                       | Yes                          |
| 83+3272<br>to<br>83+3398      | Bituminous Patch           | Yearly to Biyearly depending<br>on rainfall                             | Yes                          |
| 84+1872                       | Bituminous Patch           | Yearly depending on rainfall,<br>no approach slab                       | Yes                          |
| 84+1948                       | Bituminous Patch           | Yearly depending on rainfall                                            | Yes                          |
| 84+3612<br>to<br>84+3649      | Rutting                    | Yearly depending on rainfall,<br>starting to show in<br>northbound lane | Yes                          |
| 86+0512<br>to<br>86+0549      | Bituminous Patch           | Yearly, hand<br>patch/rutting/raveling/weather<br>signed                | Yes                          |
| 89+4942                       | Culvert                    | Sealed last year, no issues<br>since                                    | Yes                          |
| 92+0345<br>to<br>93+0412      | Rutting                    | Scotch patched long ago                                                 | No                           |

## **Summary of Soil Investigation**

The soil investigation was completed on 10/10/2022. The investigation consisted of 32 borings.

Table 2 - Boring Locations Summary

| <b>Boring Location</b>   | <b>Pavement Distress</b> | <b>Justification for Boring</b> | <b>Boring Depth</b> | <b>Boring Locations/Comments</b>                                                                                               |
|--------------------------|--------------------------|---------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------|
| 78+1357<br>to<br>95+3410 | -                        | Major Rehabilitation            | 5 Feet              | Conduct borings at mile Intervals along the project limits. A total number of approximately 18 borings.                        |
| 83+2988                  | Bituminous Patch         | Identified Maintenance Area     | 10 Feet             | Conduct 1 boring in the distressed area and one boring on either side approximately 100 feet away. A total number of 3 borings |
| 83+3272<br>to<br>83+3398 | Bituminous Patch         | Identified Maintenance Area     | 10 Feet             | Conduct 2 boring in the distressed area and one boring on either side approximately 100 feet away. A total number of 4 borings |
| 84+1872                  | Bituminous Patch         | Identified Maintenance Area     | 10 Feet             | Conduct 1 boring in the identified area and one boring further south approximately 100' away. A total of 2 borings.            |
| 84+1948                  | Bituminous Patch         | Identified Maintenance Area     | 10 Feet             | Conduct 1 boring in the identified area and one boring further north approximately 100' away. A total of 2 borings.            |
| 84+3612<br>to<br>84+3649 | Rutting                  | Identified Maintenance Area     | 10 Feet             | Conduct 1 boring in the distressed area and one boring on either side approximately 100 feet away. A total number of 3 borings |
| 86+0512<br>to<br>86+0549 | Bituminous Patch         | Identified Maintenance Area     | 10 Feet             | Conduct 1 boring in the distressed area and one boring on either side approximately 100 feet away. A total number of 3 borings |

|         |         |                             |         |                                                                                                                                |
|---------|---------|-----------------------------|---------|--------------------------------------------------------------------------------------------------------------------------------|
| 89+4942 | Culvert | Identified Maintenance Area | 10 Feet | Conduct 1 boring in the 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 and included in Appendix E.

## **Summary of Soil Analysis**

### **Soil Sample Distribution**

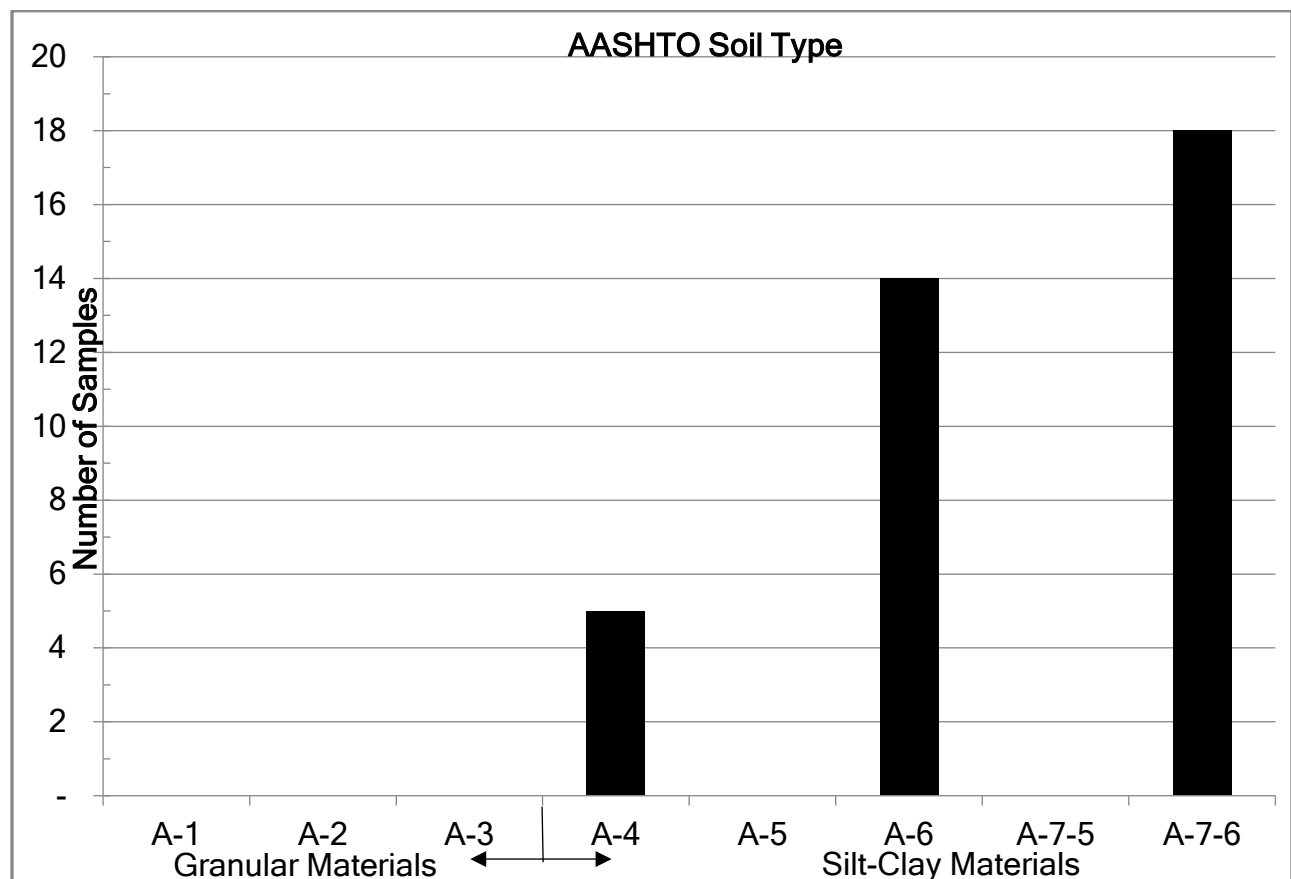


Figure 1 - Soil Sample Distribution

## **Design Recommendations**

**Project Limits – 78+1357 to 95+3410:** The soils within the project limits are a part of the Sentinel Butte formation. The soils found within Sentinel Butte formation are commonly grayish-brown sand and clay. The soils found on the project limits are primarily classified as lean clays with mixtures of sand present. The condition of these soils does not indicate subgrade mitigation is required or recommended. The proposed project scope should remediate the existing roadway distress.

**Identified Maintenance Area – 83+2988:** The soils within the identified maintenance area are lean clays with sand. There is not a change in soil type, geology or water content that would indicate that the subgrade is causing the roadway distress at this location. It appears the subgrade is not the issue but rather the pavement section is deficient. It is recommended to replace the existing pavement and base with the appropriate pavement design section, see table 4 for specifications.

**Identified Maintenance Area – 83+3272 to 83+3398:** The soils within the identified maintenance area are lean clays with sand. There is not a change in soil type, geology or water content that would indicate that the subgrade is causing the roadway distress at this location. It appears the subgrade is not the issue but rather the pavement section is deficient. It is recommended to replace the existing pavement and base with the appropriate pavement design section, see table 4 for specifications.

**Identified Maintenance Area – 84+1872:** The soils within the identified maintenance area are sandy lean clays. There is not a change in soil type, geology or water content that would indicate that the subgrade is causing the roadway distress at this location. However, to facilitate construction and prevent further issues at the bridge ends it is recommended to conduct a pavement repair section one hundred feet at each end of the bridge. See table 4 for recommendations.

**Identified Maintenance Area – 84+1948:** The soils within the identified maintenance area are sandy lean clays. There is not a change in soil type, geology or water content that would indicate that the subgrade is causing the roadway distress at this location. However, to facilitate construction and prevent further issues at the bridge ends it is recommended to conduct a pavement repair section one hundred feet at each end of the bridge. See table 4 for recommendations.

**Identified Maintenance Area – 84+3612 to 84+3649:** The soils within the identified maintenance area are fat clays. There is a change in soil type from the surrounding area that would indicate that the subgrade is contributing to the roadway distress at this location. Therefore, it is recommended to subcut this maintenance area, see table 3 for subcut specifications.

**Identified Maintenance Area – 86+0512 to 86+0549:** The soils within the identified maintenance area are lean clays with sand. There is not a change in soil type, geology or water content that would indicate that the subgrade is causing the roadway distress at this location. It appears the subgrade is not the issue but rather the pavement section is deficient. It is recommended to replace the existing pavement and base with the appropriate pavement design section, see table 4 for specifications.

**Identified Maintenance Area – 89+4942:** The soils within the identified maintenance area are sandy lean clays. There is not a change in soil type, geology or water content that would indicate that the subgrade is causing the roadway distress at this location. It appears the subgrade is not the issue; however, it is believed that the cattle pass may be damaged and not performing as expected. It is recommended that a pipe survey be conducted to determine the condition of the existing cattle pass and to determine if any mitigation strategy is required, including to remove, repair, or replace the cattle pass at this location. Contact the Geotechnical section when the condition of the cattle pass is determined.

## **Design Information**

**Pipe Replacement:** The existing culvert at approximately RP+feet 89+4942 needs to be evaluated to determine if the pipe is separated or damaged. Contact the Geotechnical section when the condition of the pipe is determined.

**Compaction Method:** T-180

**Subgrade Prep:** None

### **Subcut Recommendations:**

| <b>Location<br/>RP + Feet</b> | <b>Length</b> | <b>Depth</b> |
|-------------------------------|---------------|--------------|
| 84+3560 to 84+3700            | 140'          | 24"          |

Table 3 - Subcut Recommendations

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 proposed pavement. Replace the removed material with Class 5 aggregate and line the excavation with Geosynthetic Geogrid (Type G) in accordance with NDDOT Specification 709. Do not scarify the bottom of the subcut.

### **Pavement Repair Section:**

| <b>Location<br/>RP + Feet</b> | <b>Length</b> |
|-------------------------------|---------------|
| 83+2940 to 83+3040            | 100'          |
| 83+3220 to 83+3450            | 230'          |
| 84+1772 to 84+1872            | 100'          |
| 84+1948 to 84+2048            | 100'          |
| 86+0460 to 86+0600            | 140'          |

Table 4 – Pavement Repair section

**Remarks:** It is recommended to repair the distress areas according to the pavement design recommendation. See NDDOT Filenet for the pavement recommendations.

**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<br>(35% or less passing No. 200 Sieve (0.075 mm)) |        |           |                             |        |        |        | Silt-clay Materials<br>More than 35% passing No. 200 Sieve<br>(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<br>A-7-6 |
| (a) Sieve Analysis:<br>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<br>fraction passing<br>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<br>significant<br>Constituent materials      | Stone Fragments<br>Gravel and sand                                   |        | Fine Sand | Silty or Clayey Gravel Sand |        |        |        | Silty Soils                                                              |        | Clayey Soils |                |
| (d) General rating as<br>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<br>More than 50% of retained on No. 200 sieve | Gravels<br>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 <sup>a</sup>    | $C_u < 4$ and/or $1 > C_c > 3^c$                                                                                          | GP           |
|                                                                    |                                                                     | Gravels with Fines                 | $PI < 4$ or plots below "A" line (Figure 5.3)                                                                             | GM           |
|                                                                    |                                                                     | More than 12% fines <sup>a,d</sup> | $PI > 7$ and plots on or above "A" line (Figure 5.3)                                                                      | GC           |
|                                                                    | Sands<br>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 <sup>b</sup>    | $C_u < 6$ 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 <sup>b,d</sup> | $PI > 7$ and plots on or above "A" line (Figure 5.3)                                                                      | SC           |
| Fine-grained soils<br>50% or more passes No. 200 sieve             | Silts and clays<br>Liquid limit less than 50                        | Inorganic                          | $PI > 7$ and plots on or above "A" line (Figure 5.3) <sup>e</sup>                                                         | CL           |
|                                                                    |                                                                     |                                    | $PI < 4$ or plots below "A" line (Figure 5.3) <sup>e</sup>                                                                | ML           |
|                                                                    |                                                                     | Organic                            | $\frac{\text{Liquid limit} - \text{oven dried}}{\text{Liquid limit} - \text{not dried}} < 0.75$ ; see Figure 5.3; OL zone | OL           |
|                                                                    |                                                                     |                                    | $PI$ plots on or above "A" line (Figure 5.3)                                                                              | CH           |
|                                                                    | Silts and clays<br>Liquid limit 50 or more                          | Inorganic                          | $PI$ plots below "A" line (Figure 5.3)                                                                                    | MH           |
|                                                                    |                                                                     | Organic                            | $\frac{\text{Liquid limit} - \text{oven dried}}{\text{Liquid limit} - \text{not dried}} < 0.75$ ; see Figure 5.3; OH zone | OH           |
| Highly Organic Soils                                               | Primarily organic matter, dark in color, and organic odor           |                                    |                                                                                                                           | Pt           |

<sup>a</sup>Gravels with 5 to 12% fine require dual symbols: GW-GM, GW-GC, GP-GM, GP-GC.

<sup>b</sup>Sands with 5 to 12% fines require dual symbols: SW-SM, SW-SC, SP-SM, SP-SC.

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

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

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

## Plasticity Chart :

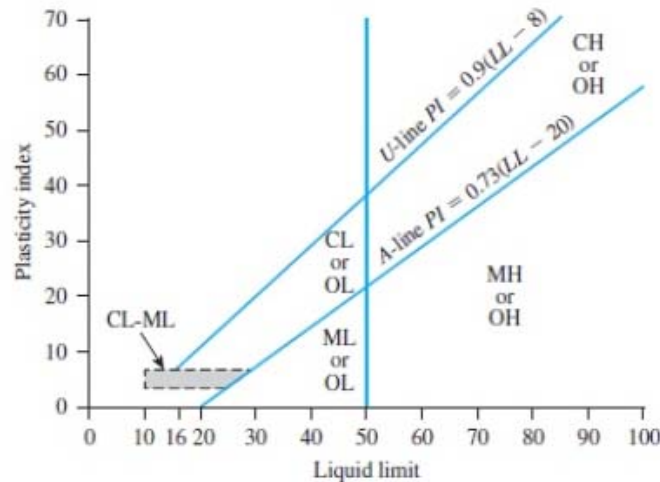


**Table 7-12. Frost susceptibility classification of soils (NCHRP 1-37A).**

| 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              |

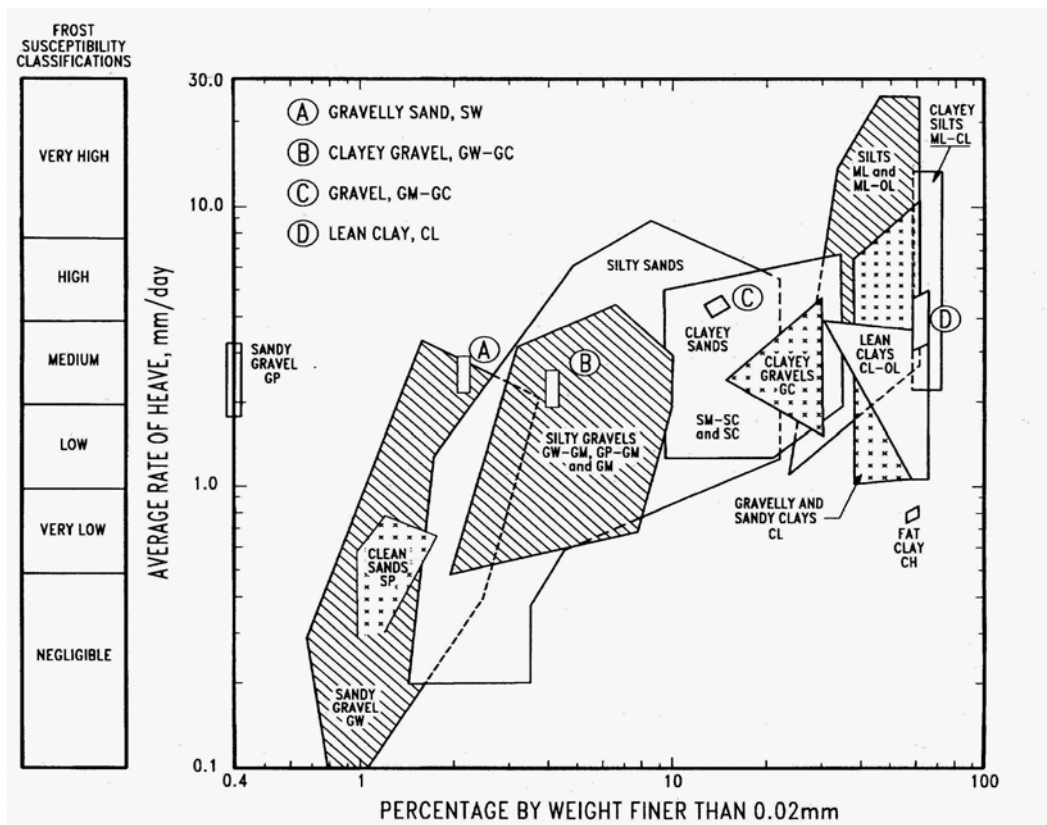


Figure 7-20. Average rate of heave versus % fines for natural soil gradations (Kaplar, 1974).

# Frost Depth Map



\*Values shown are in meters

## **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)

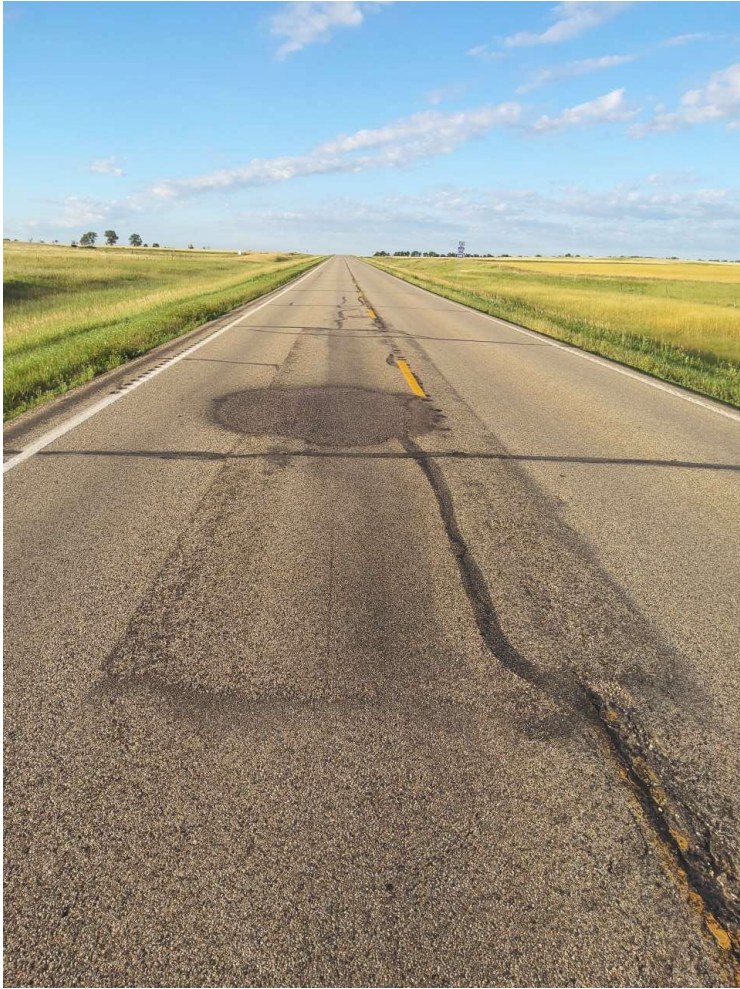
Sheet

1 of 1

|                                          |              |                               |
|------------------------------------------|--------------|-------------------------------|
| Project Number<br>SS-1-031(021)078       | PCN<br>23324 | Date of Survey<br>07/28/2022  |
| Section Maintenance Contact<br>Adam Vahn |              | Completed By<br>Jamie Naumann |

| Highway Reference Points<br>78+1357 to 95+3410 |                   | Surface Types<br>Asphalt                       |                                                                       |                |                   |
|------------------------------------------------|-------------------|------------------------------------------------|-----------------------------------------------------------------------|----------------|-------------------|
| Location                                       | Pavement Distress | Description                                    | Maintenance Comment                                                   | Picture Number | Drilling Required |
| 83+2988                                        | Bituminous Patch  | Patch                                          | Pushing, wet area                                                     | 1              | Yes               |
| 83+3272 to<br>83+3398                          | Bituminous Patch  | Blade patch/hand patch                         | Yearly to biyearly depending on rainfall                              | 2              | Yes               |
| 84+1872                                        | Bituminous Patch  | Patch                                          | Yearly depending on rainfall, no approach slab                        | 3-4            | Yes               |
| 84+1948                                        | Bituminous Patch  | Patch                                          | Yearly depending on rainfall                                          | 5-6            | Yes               |
| 84+3612 to<br>84+3649                          | Rutting           | Pushing                                        | Yearly depending on rainfall, Starting to show in the northbound lane | 7-9            | Yes               |
| 86+0512 to<br>86+0549                          | Bituminous Patch  | (Hand Patch/Rutting/Raveling & Weather) Signed | Yearly                                                                | 10-11          | Yes               |
| 89+4942                                        | Culvert           | Dip on both sides                              | Sealed last year, no issues since                                     | 12-13          | Yes               |
| 92+0345 to<br>93+0412                          | Rutting           |                                                | Scotch patched long ago                                               | 14-16          | No                |
|                                                |                   |                                                |                                                                       |                |                   |

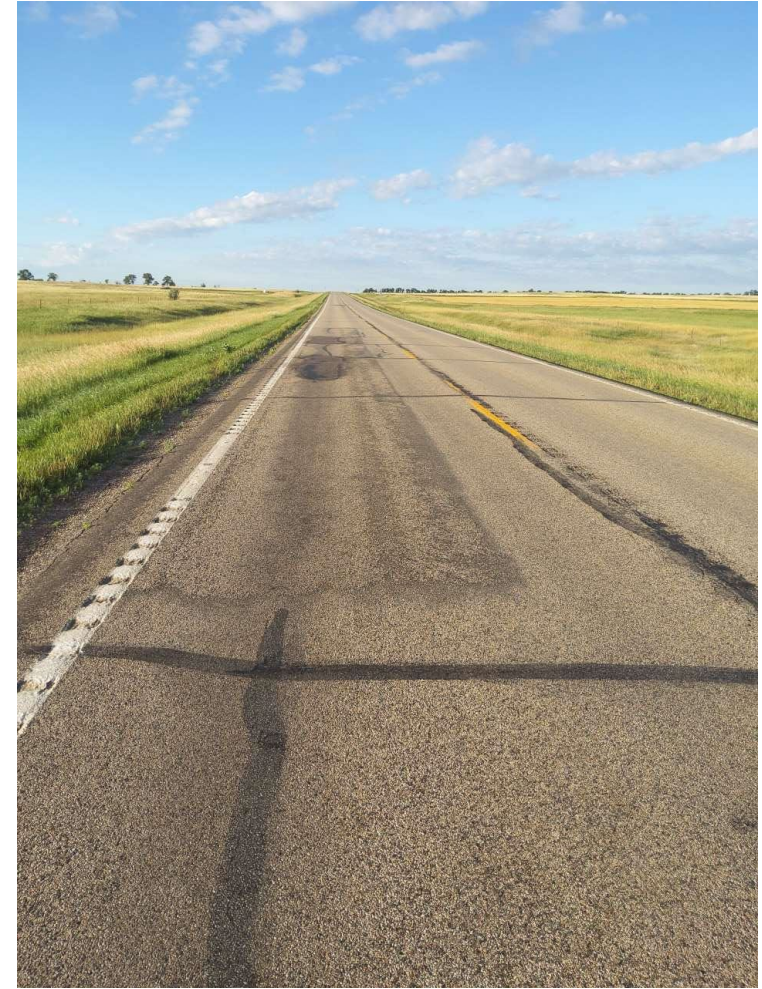
Comments



1

83+2988

Patched every other year,  
yearly before drought

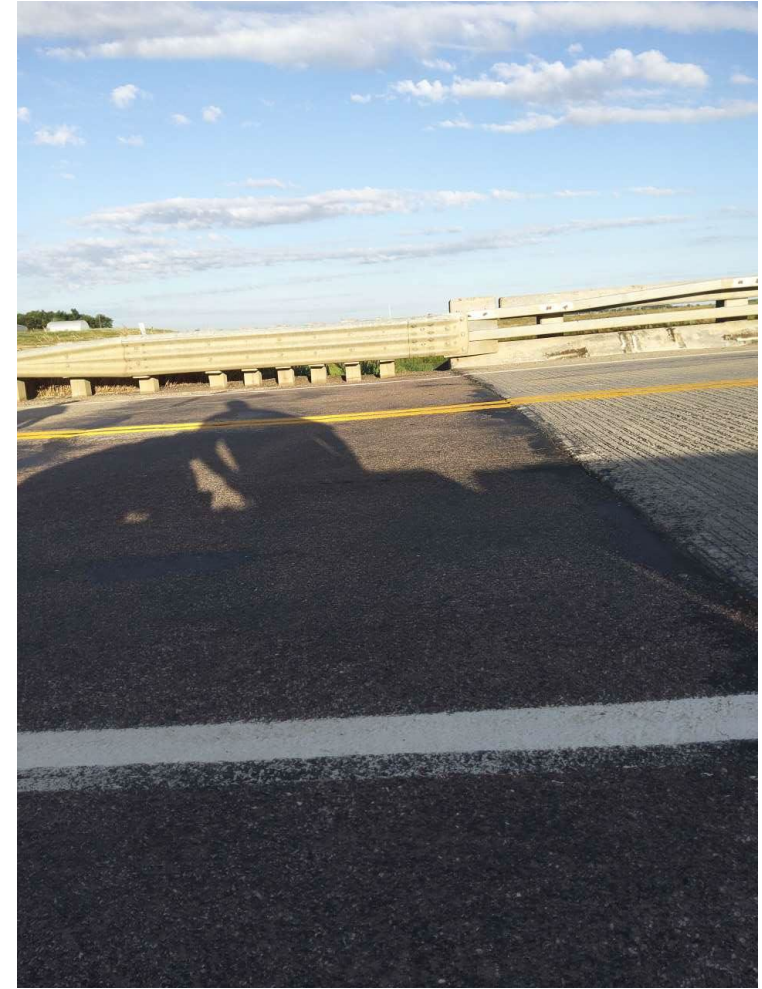


2

83+3272 to 83+3398



3  
84+1872  
South end of bridge



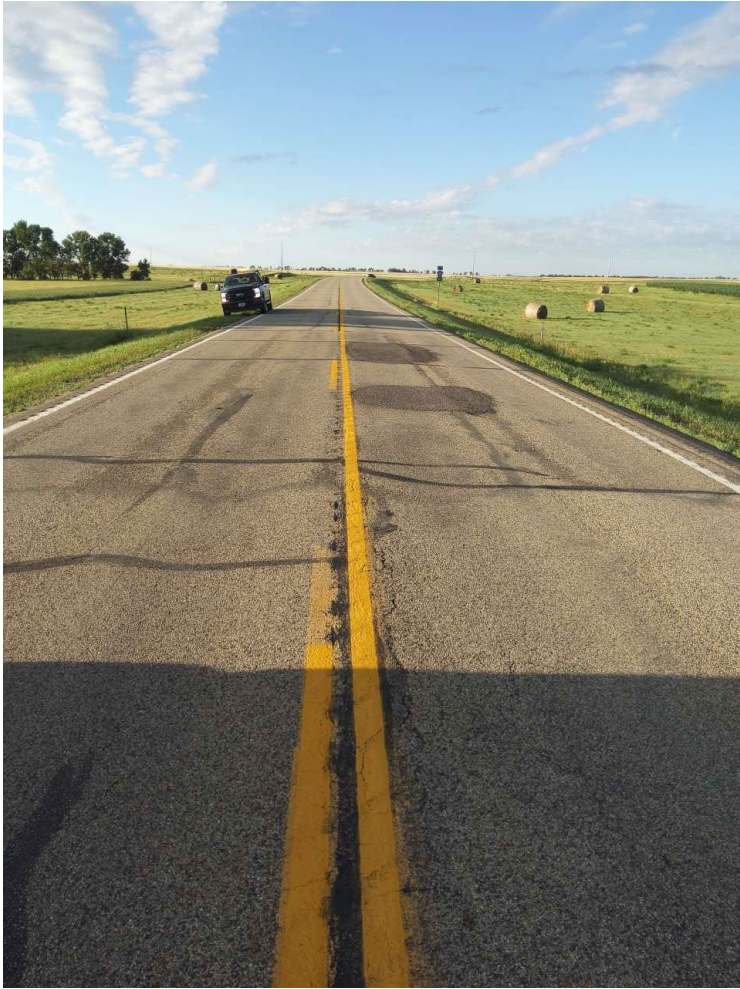
4  
84+1872



5  
84+1948  
North end of bridge

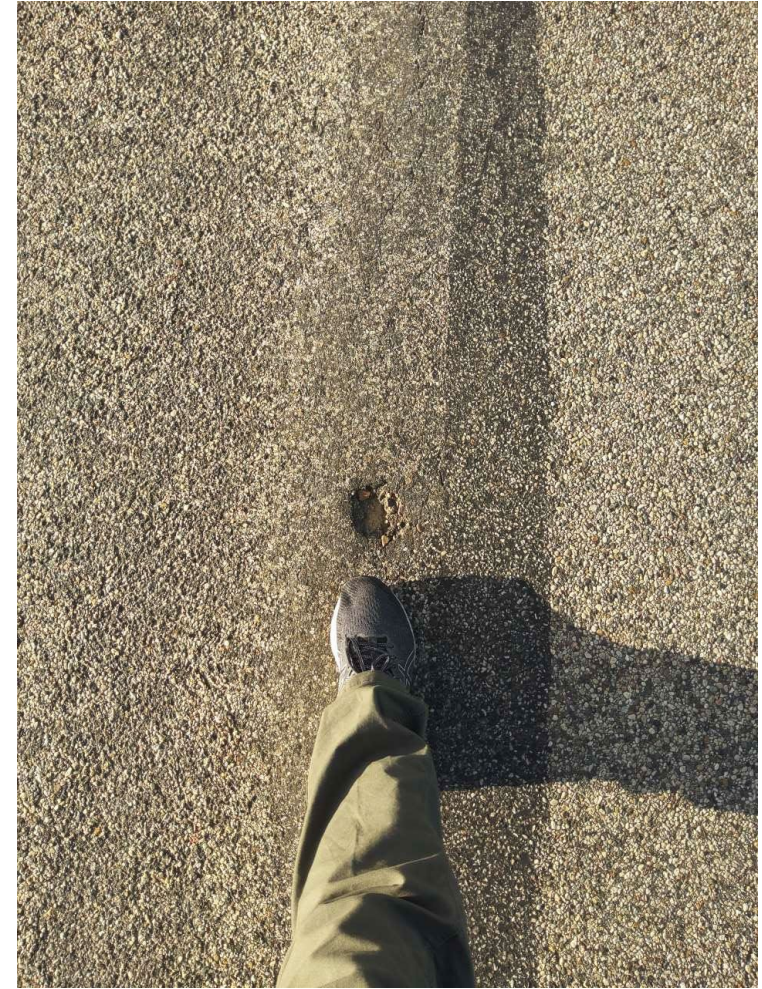


6  
84+1948



7

84+3612 to 84+3649

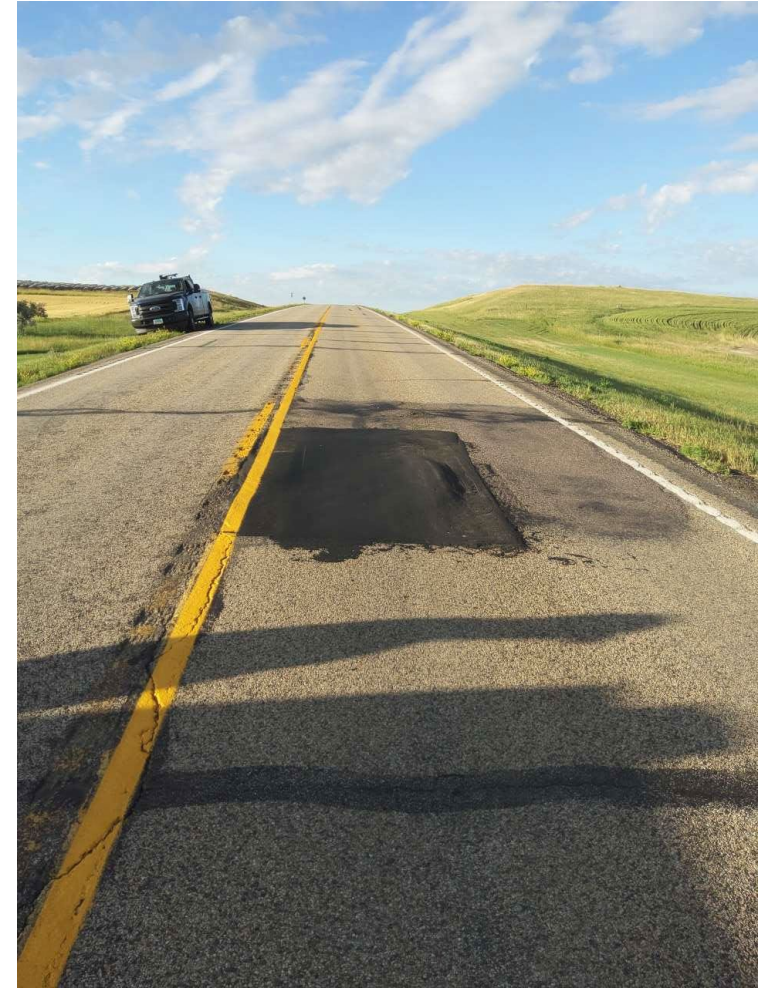


8

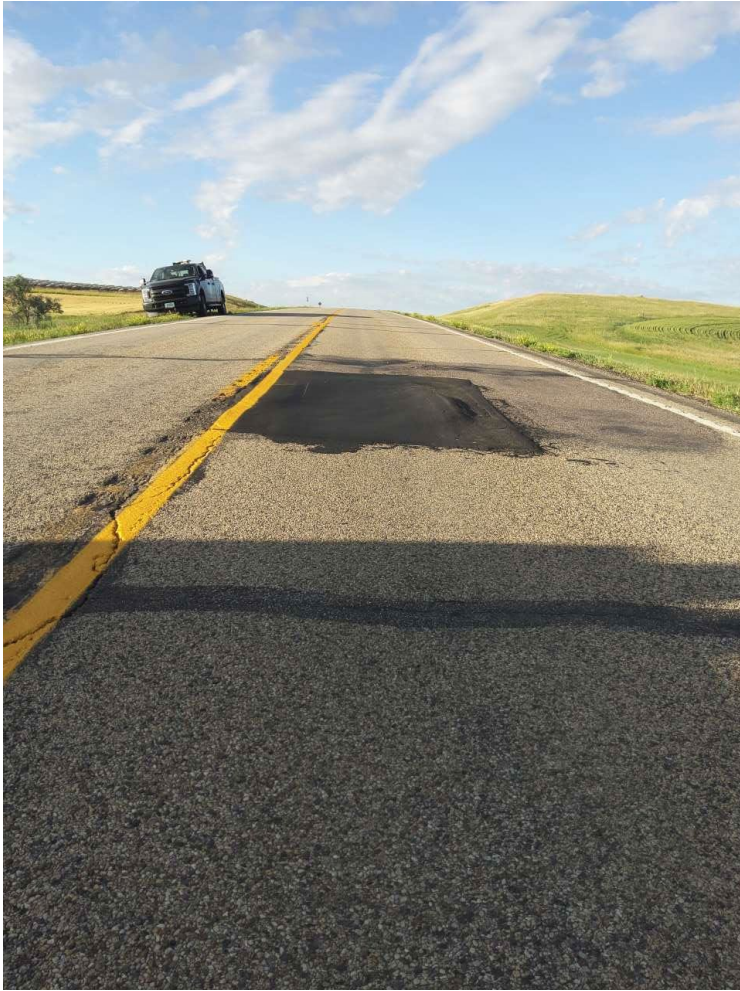
84+3612 to 84+3649



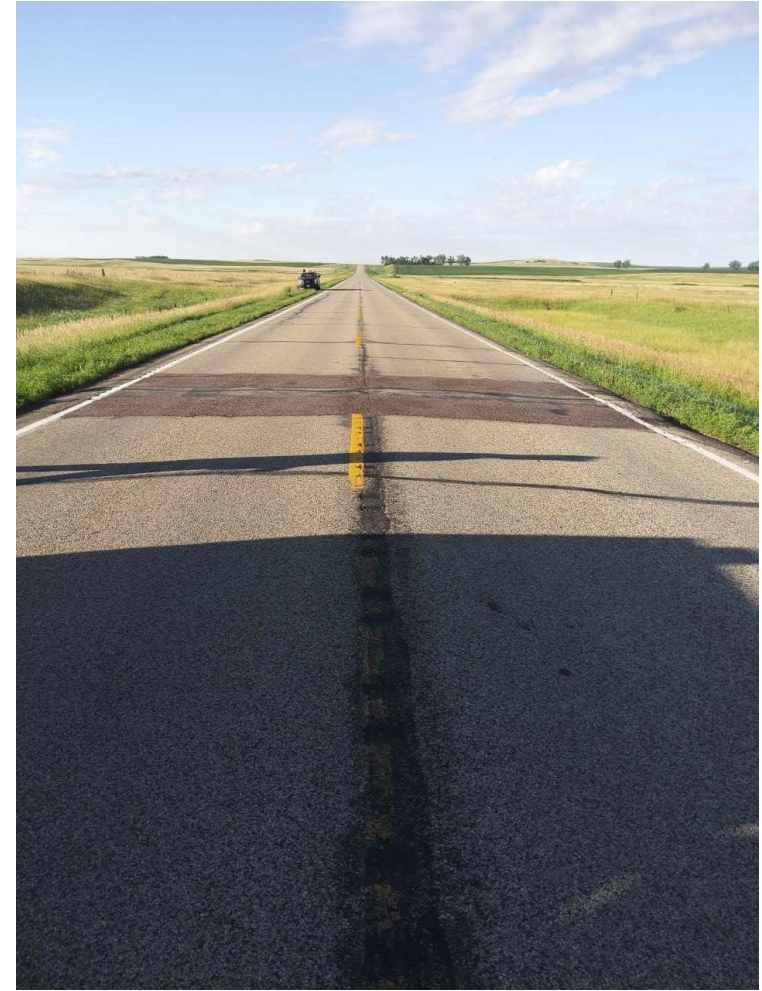
9  
84+3612 to 84+3649



10  
86+0512 to 86+0549  
Mastec patch first  
application



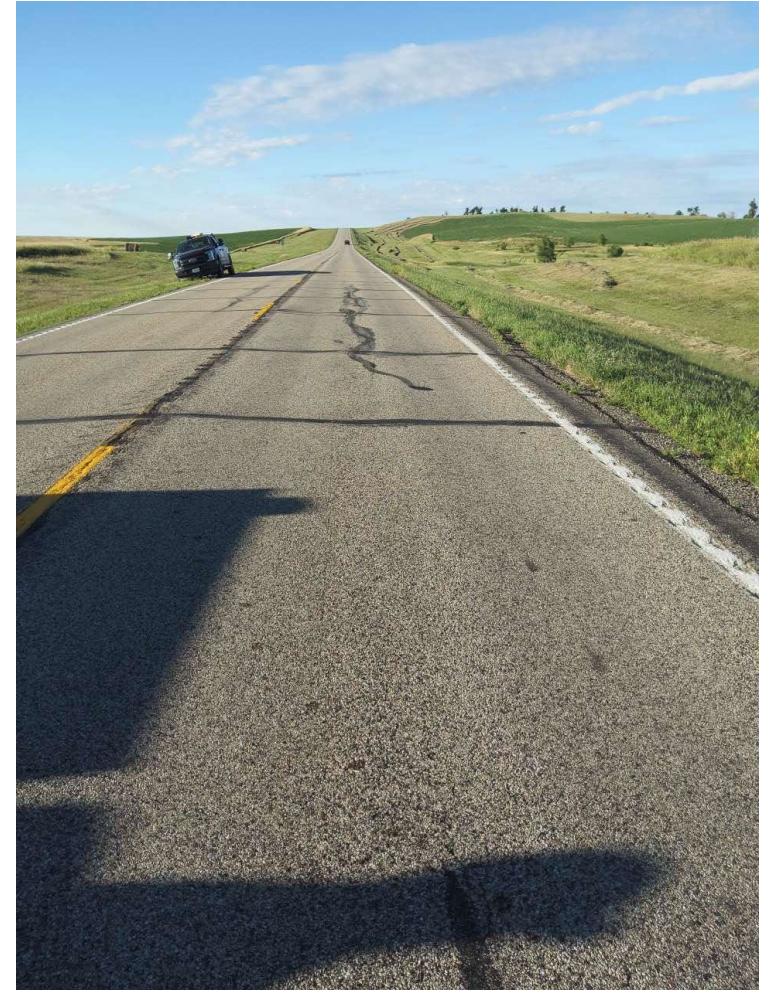
11  
86+0512 to 86+0549



12  
89+4942  
Cattle pass not in use



13  
89+4942



14  
92+0345 to 93+0412



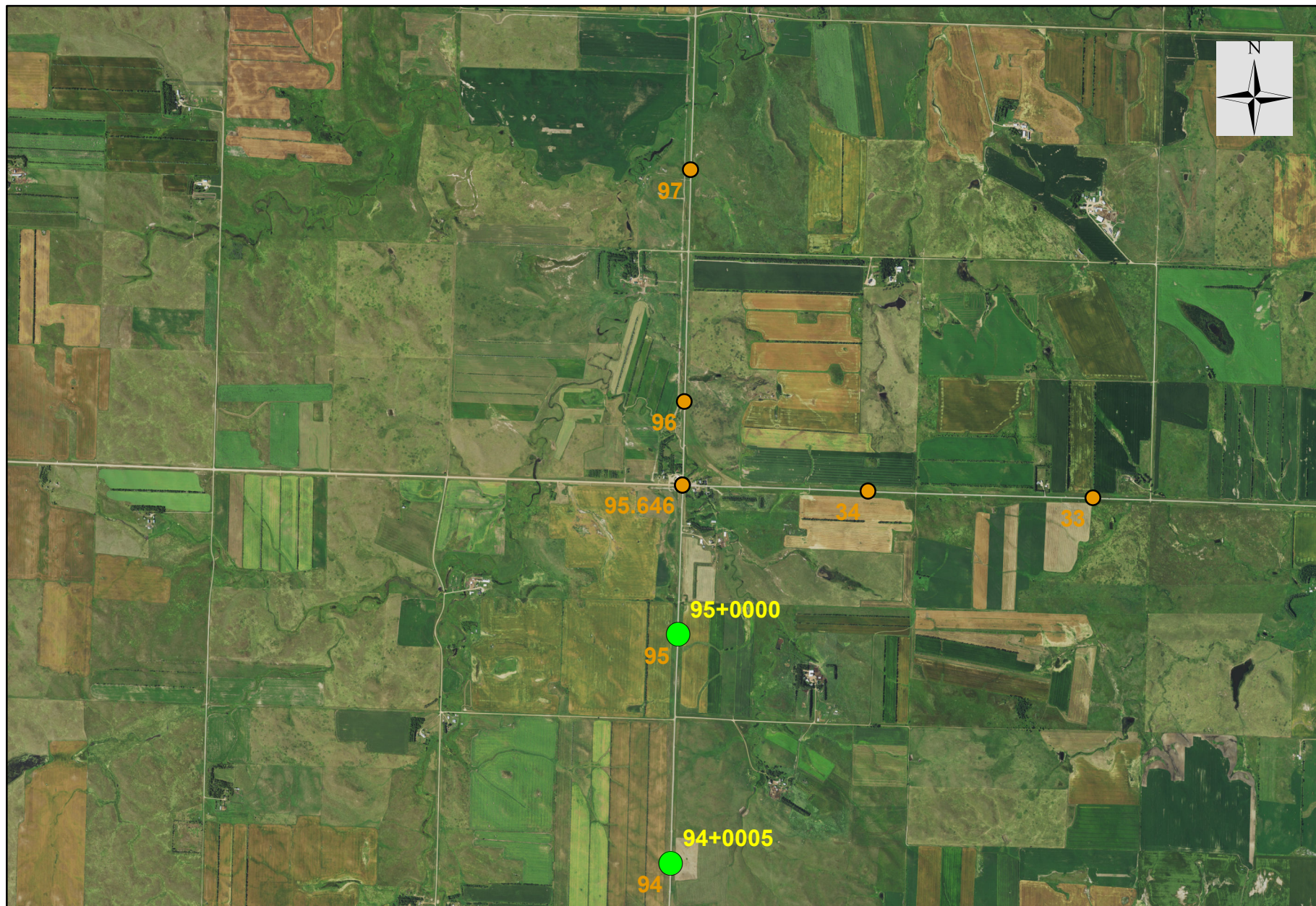
15  
92+0345 to 93+0412



16  
92+0345 to 93+0412

**APPENDIX C**

**BORING LOCATIONS**



# Legend

- Reference Point
- Boring Locations



Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 3,750 7,500  
Feet

Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 3,750 7,500  
Feet

Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 375 750  
Feet

Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations



Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 375 750  
Feet

Project Number: XA-SS-1-031(021)078

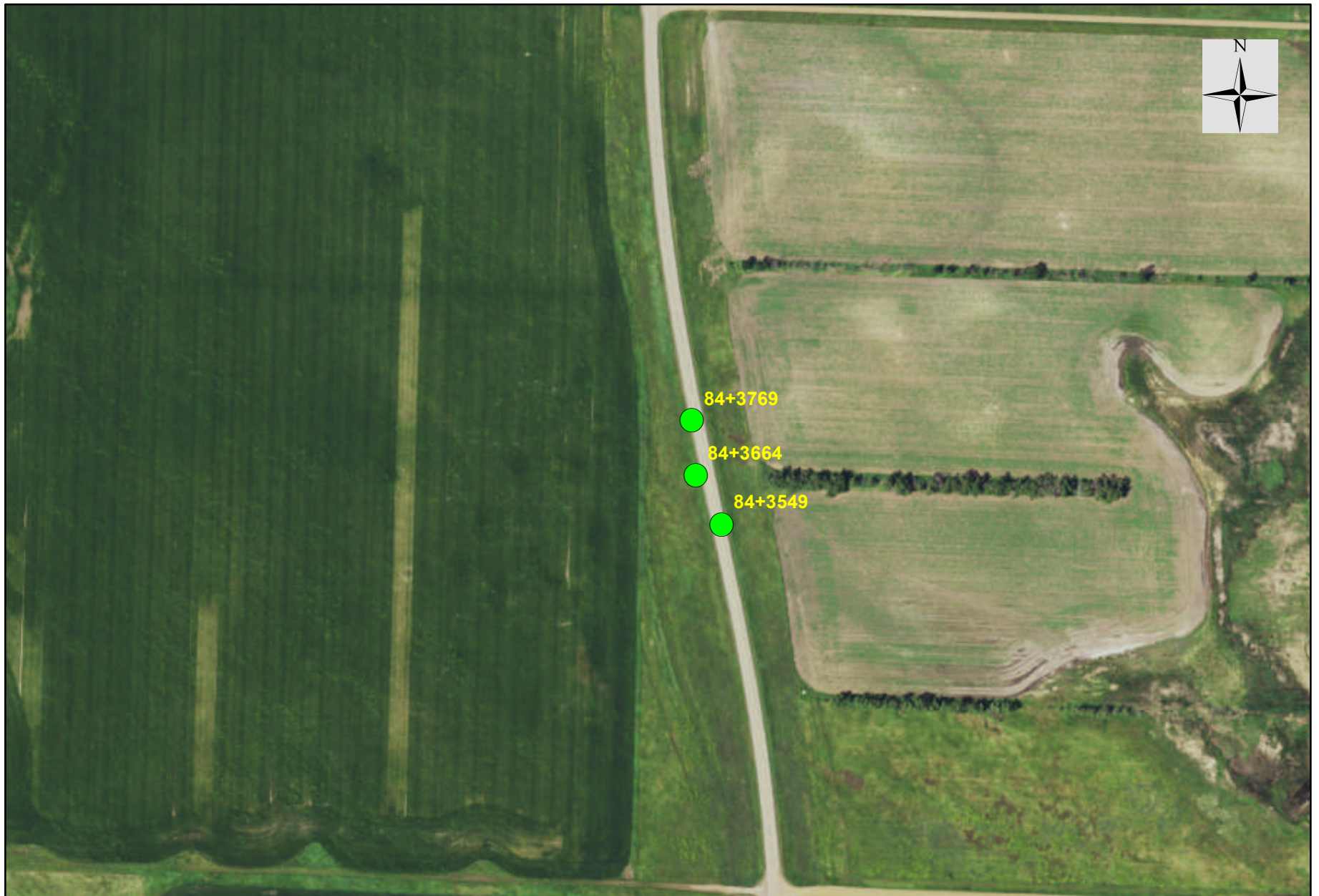


# Legend

- Reference Point
- Boring Locations



Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 375 750  
Feet

Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 375 750  
Feet

Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 375 750  
Feet

Project Number: XA-SS-1-031(021)078



## Legend

- Reference Point
- Boring Locations

0 3,750 7,500  
Feet

Project Number: XA-SS-1-031(021)078

**APPENDIX D**

**SUMMARY OF SOILS ANALYSIS**

NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 14:56 - F:\LAB\PROJECTS\GINT11-031(021)078.GPJ

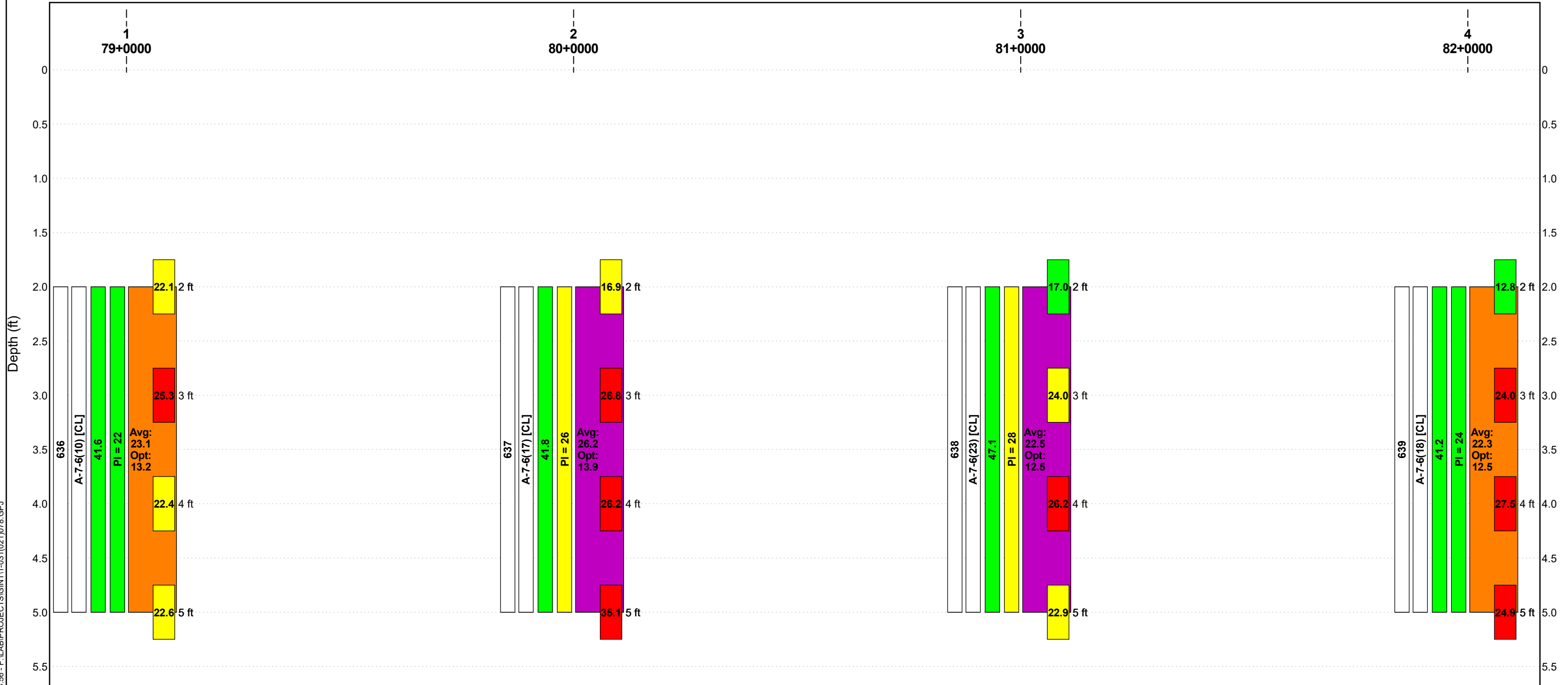


NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

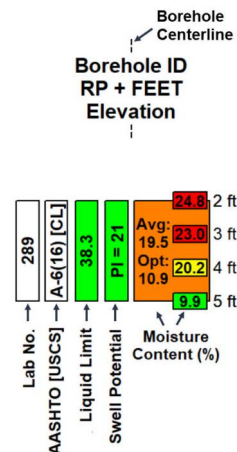
PCN 23324

LOCATION Morton & Oliver

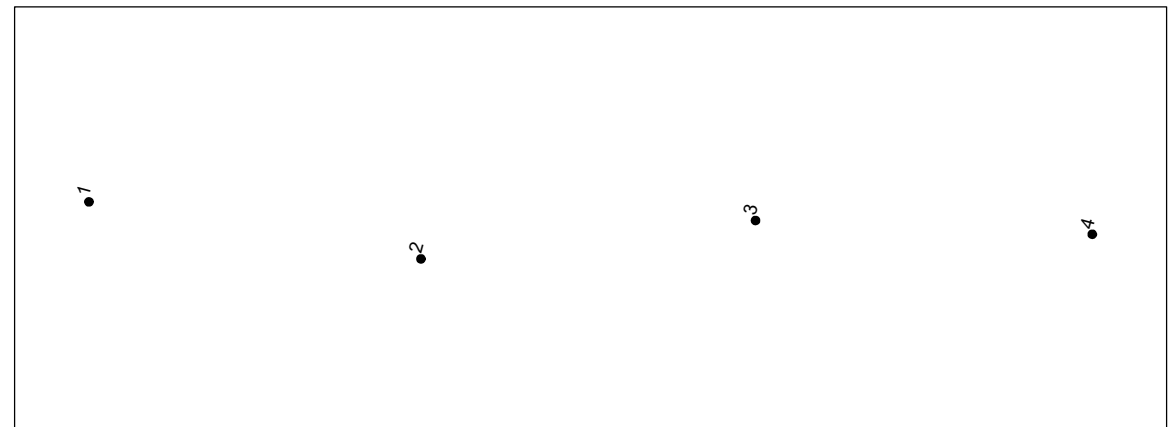


Boreholes Equally Spaced (0 to 5000 ft)

### LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 14:57 - F:\LAB\PROJECTS\GINT11-031\021\078.GPJ

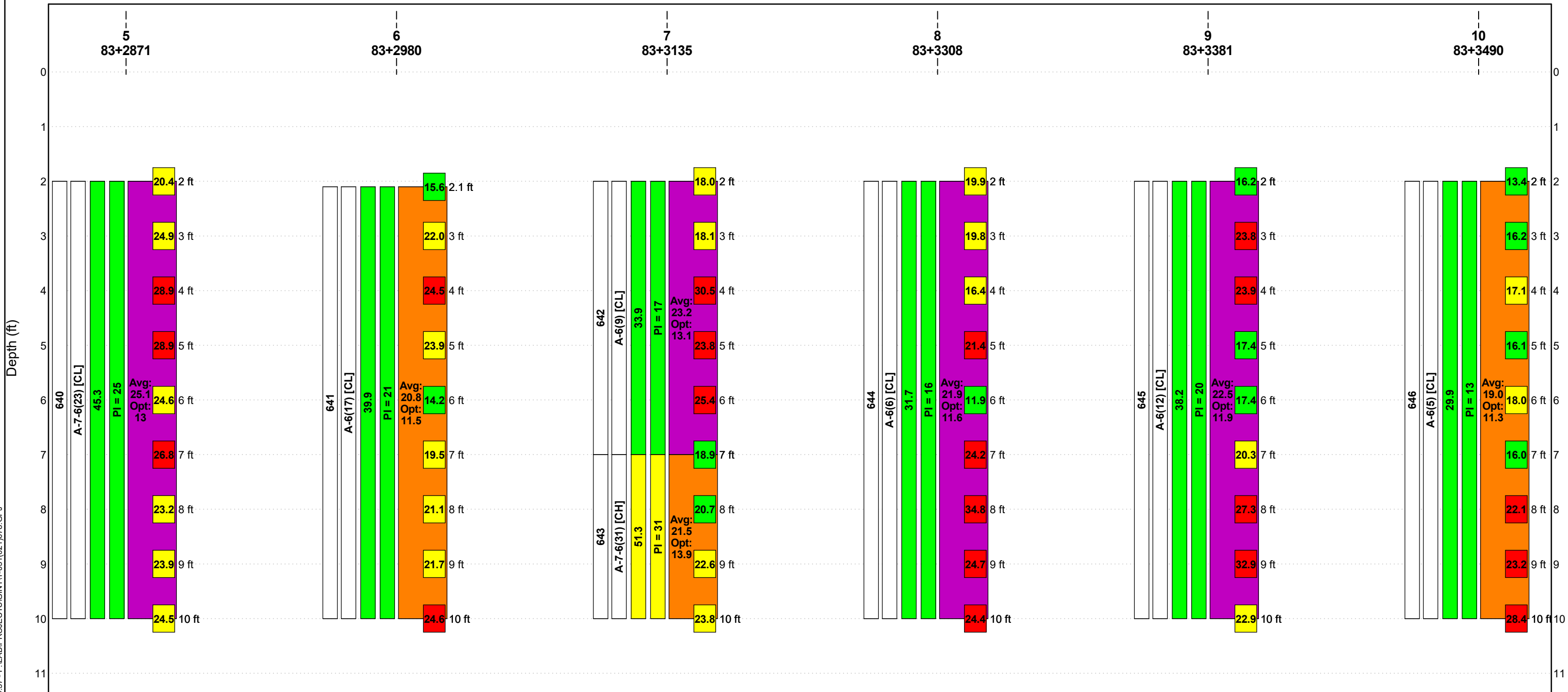


NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

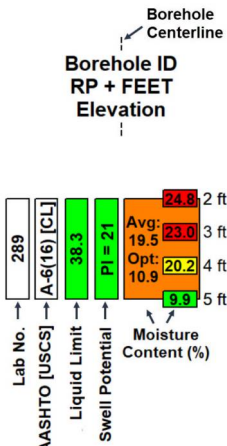
PCN 23324

LOCATION Morton & Oliver

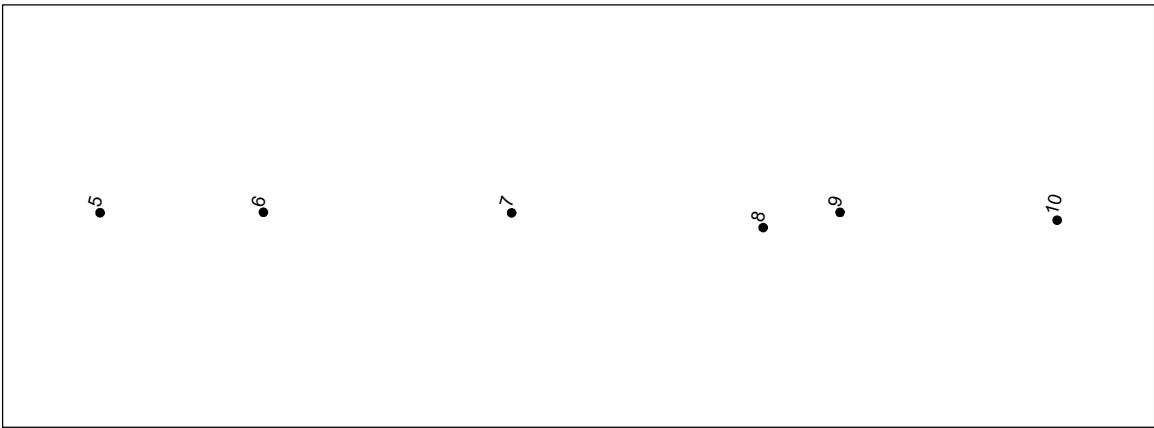


Boreholes Equally Spaced (0 to 220 ft)

LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 14:58 - F:\LAB\PROJECTS\GINT\11-031\021\078.GPJ

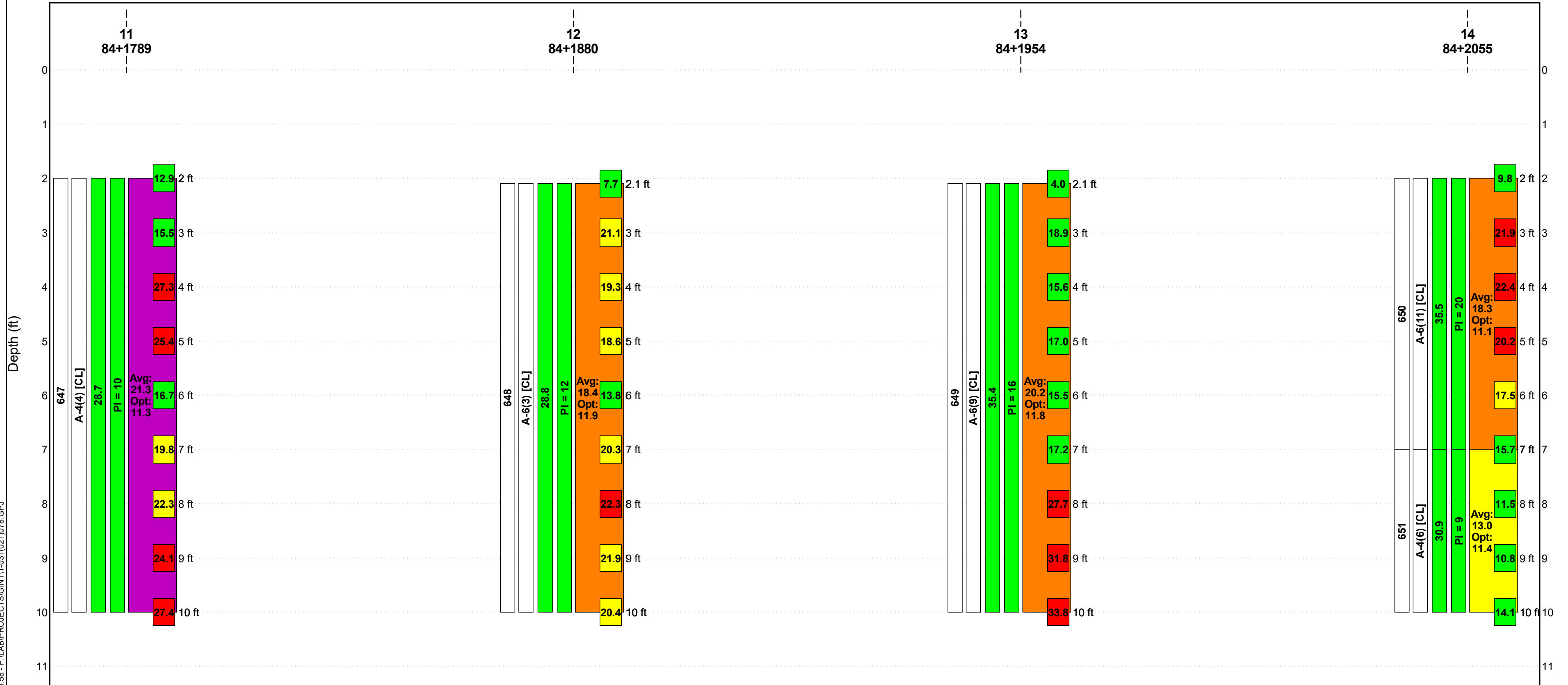


NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

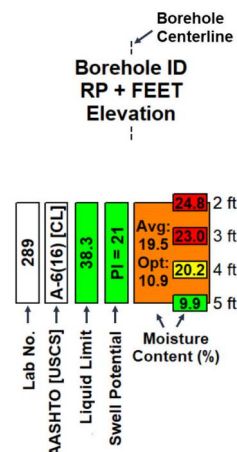
PCN 23324

LOCATION Morton & Oliver

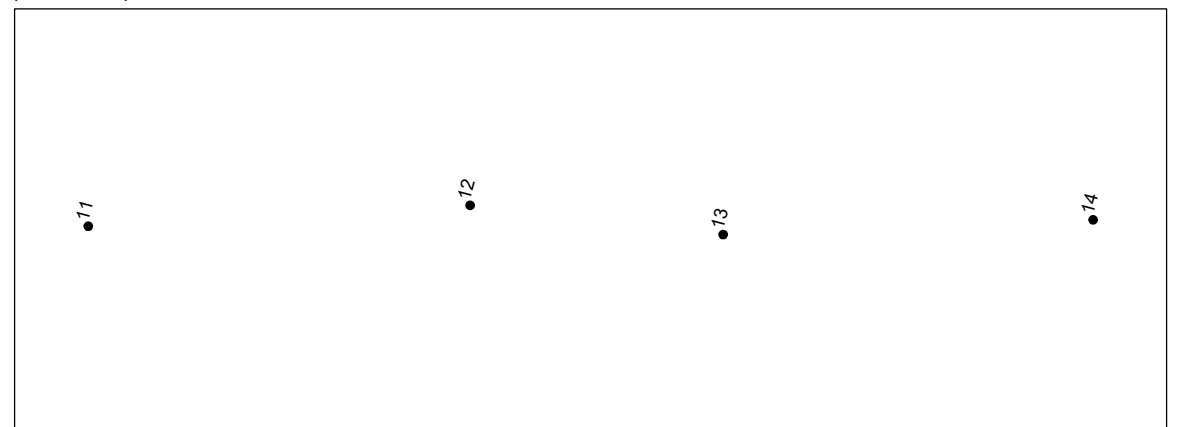


Boreholes Equally Spaced (0 to 90 ft)

LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 14:59 - F:\LAB\PROJECTS\GINT11-031(021)078.GPJ

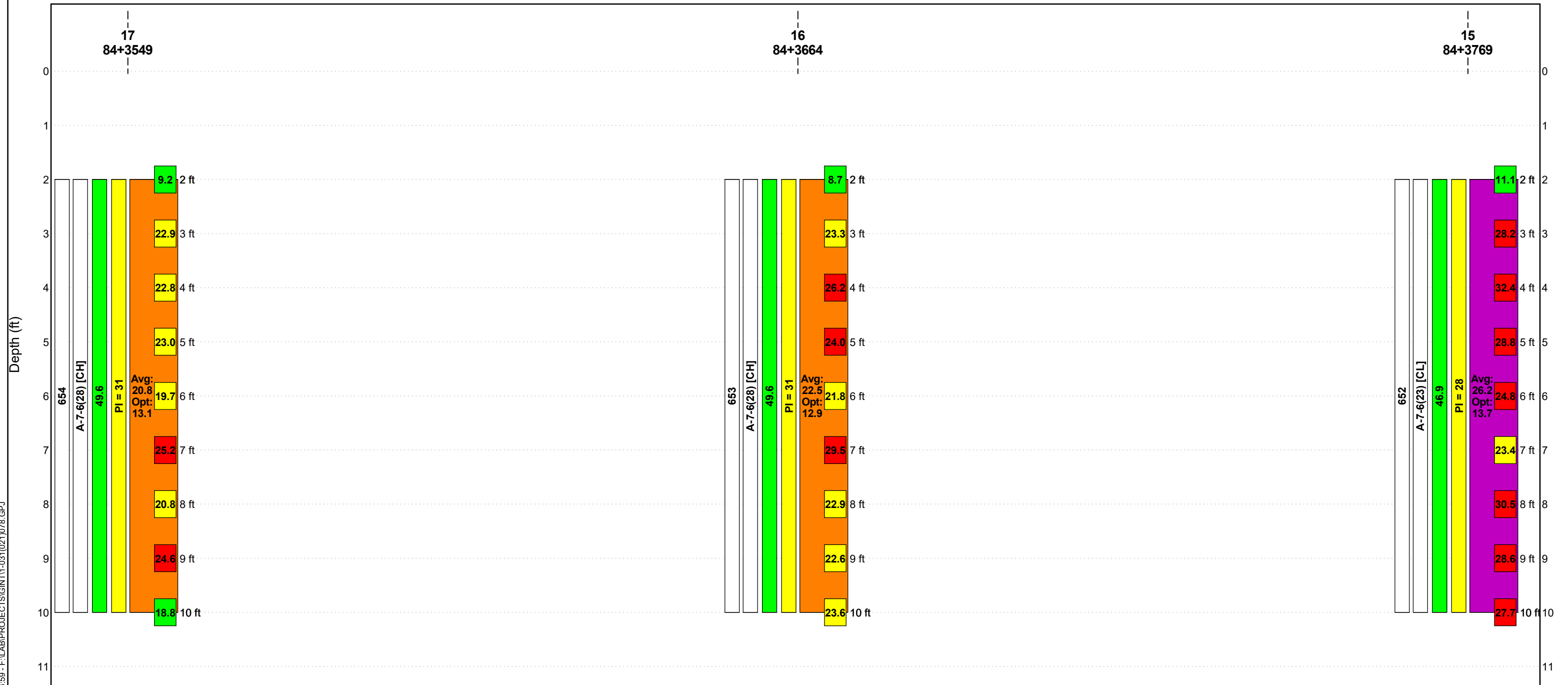


NORTH DAKOTA DEPARTMENT OF TRANSPORATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

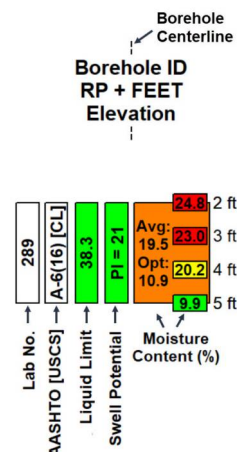
PCN 23324

LOCATION Morton & Oliver

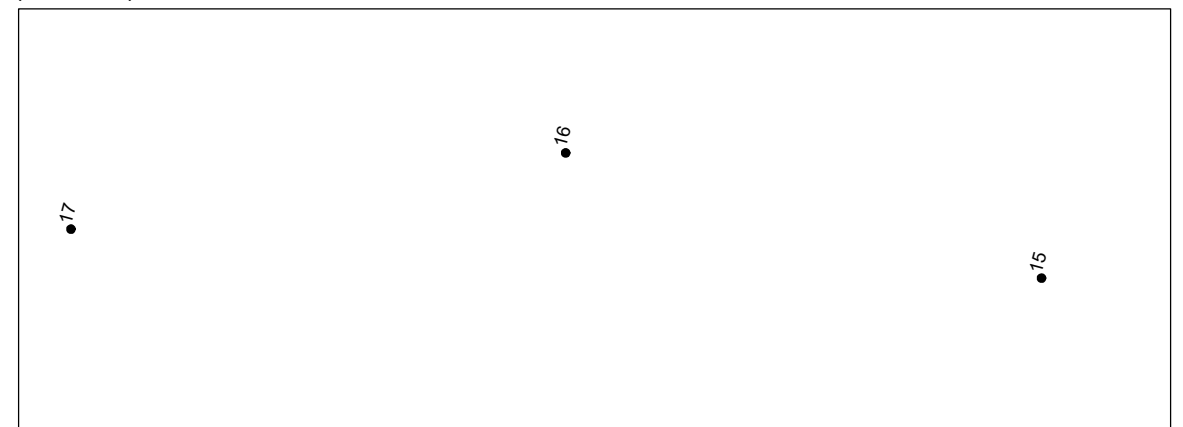


Boreholes Equally Spaced (0 to 80 ft)

LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 15:00 - F:\LAB\PROJECTS\GINT\11-031(021)078.GPJ

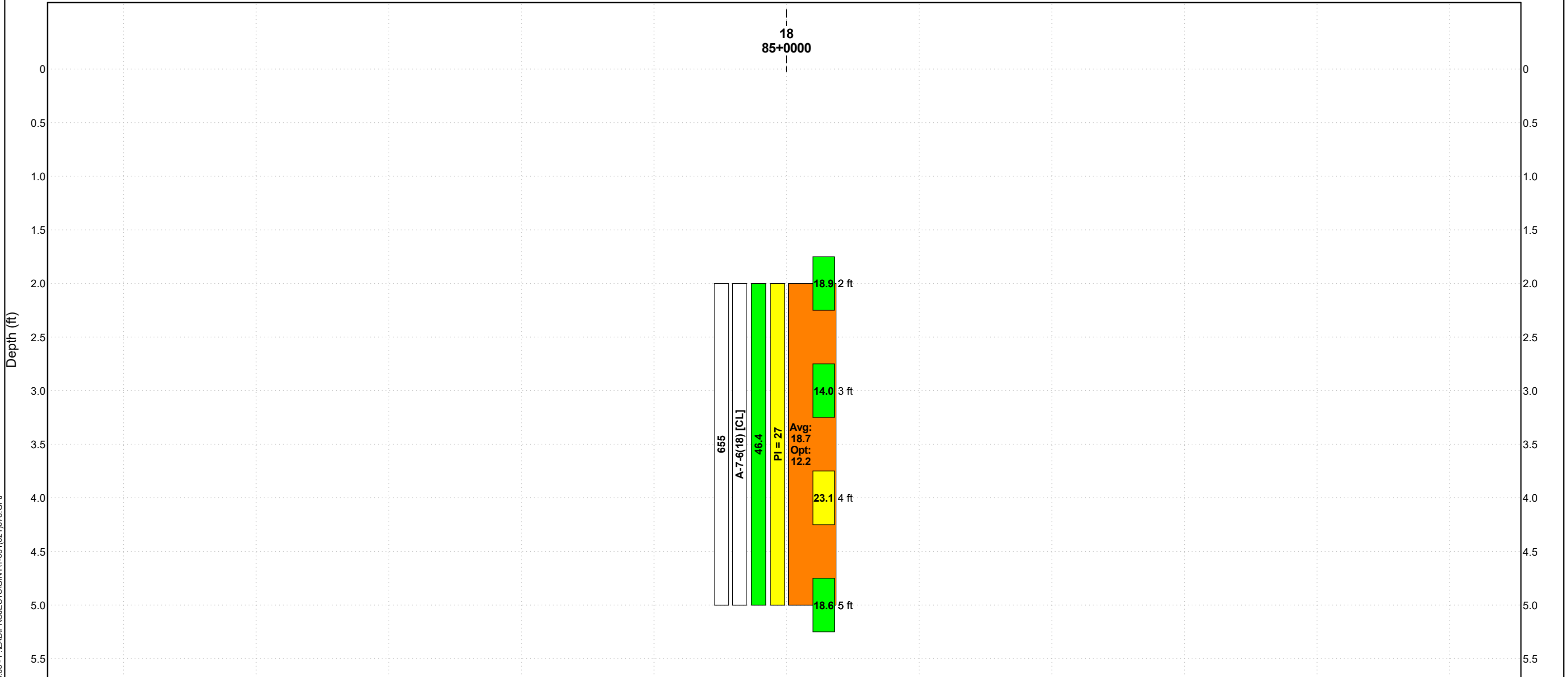


NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

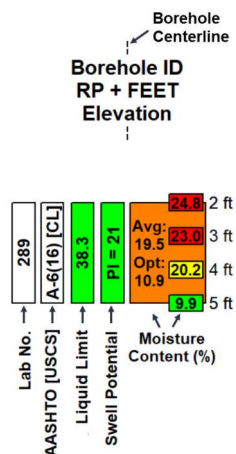
PCN 23324

LOCATION Morton & Oliver

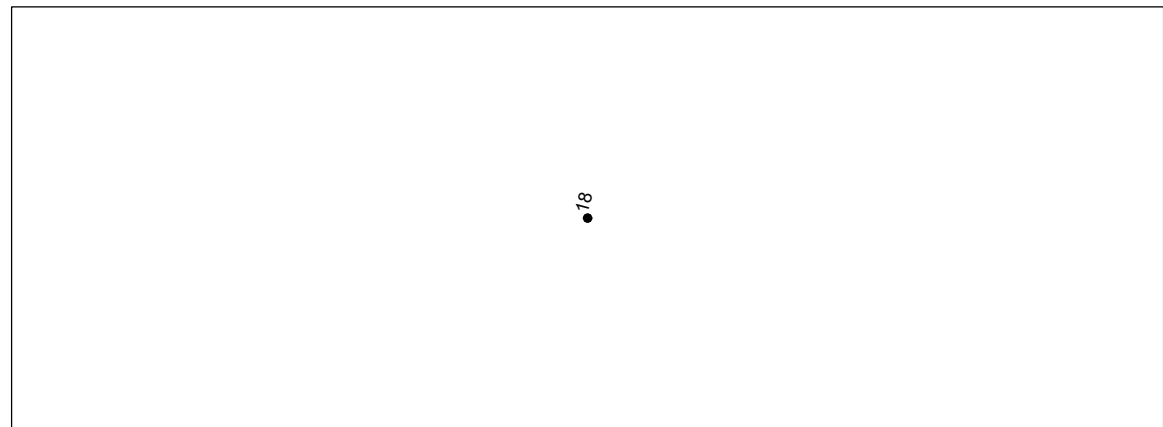


Boreholes Equally Spaced (0 to 2 ft)

LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 15:01 - F:\LAB\PROJECTS\GINT11-031(021)078.GPJ

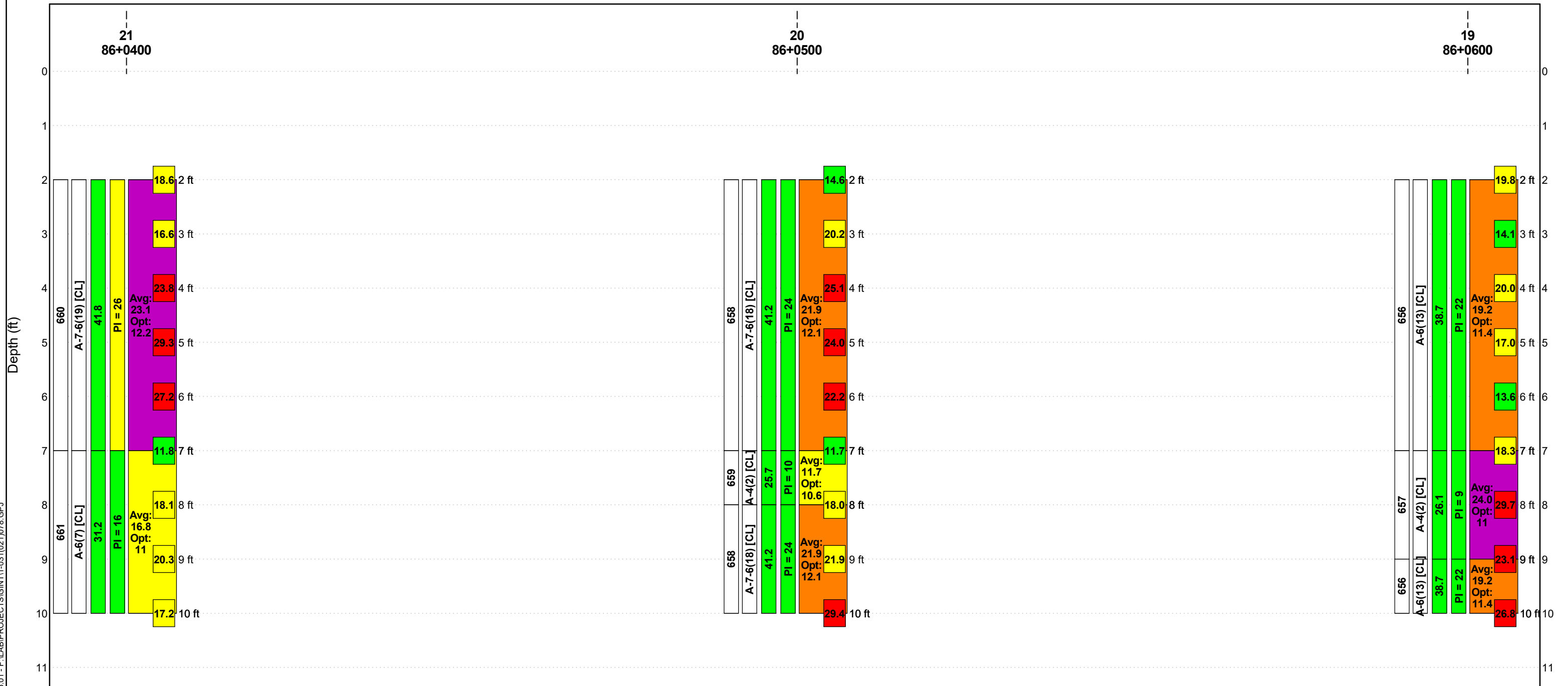


NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

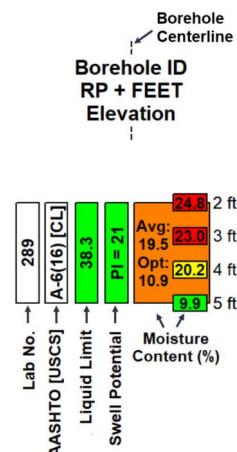
PCN 23324

LOCATION Morton & Oliver

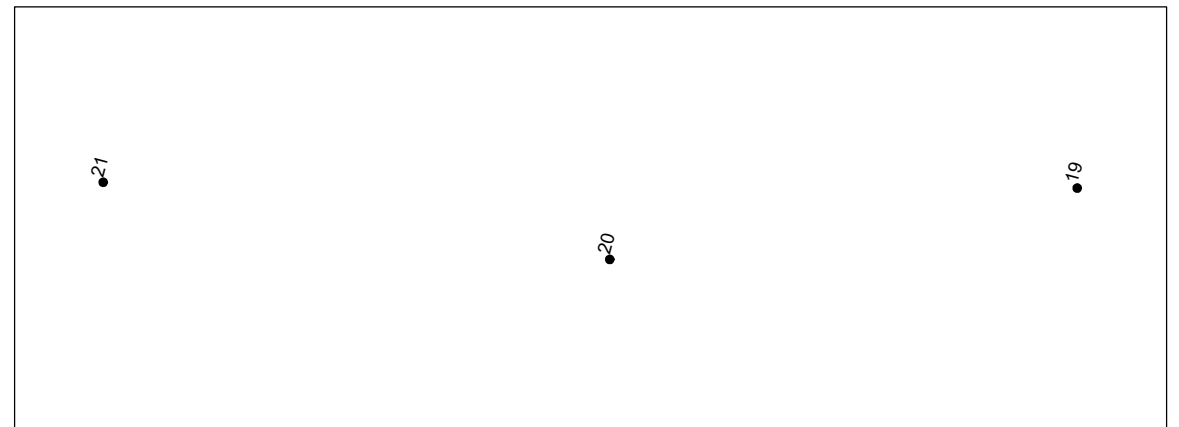


Boreholes Equally Spaced (0 to 60 ft)

LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 15:01 - F:\LAB\PROJECTS\GINT11-031(021)078.GPJ

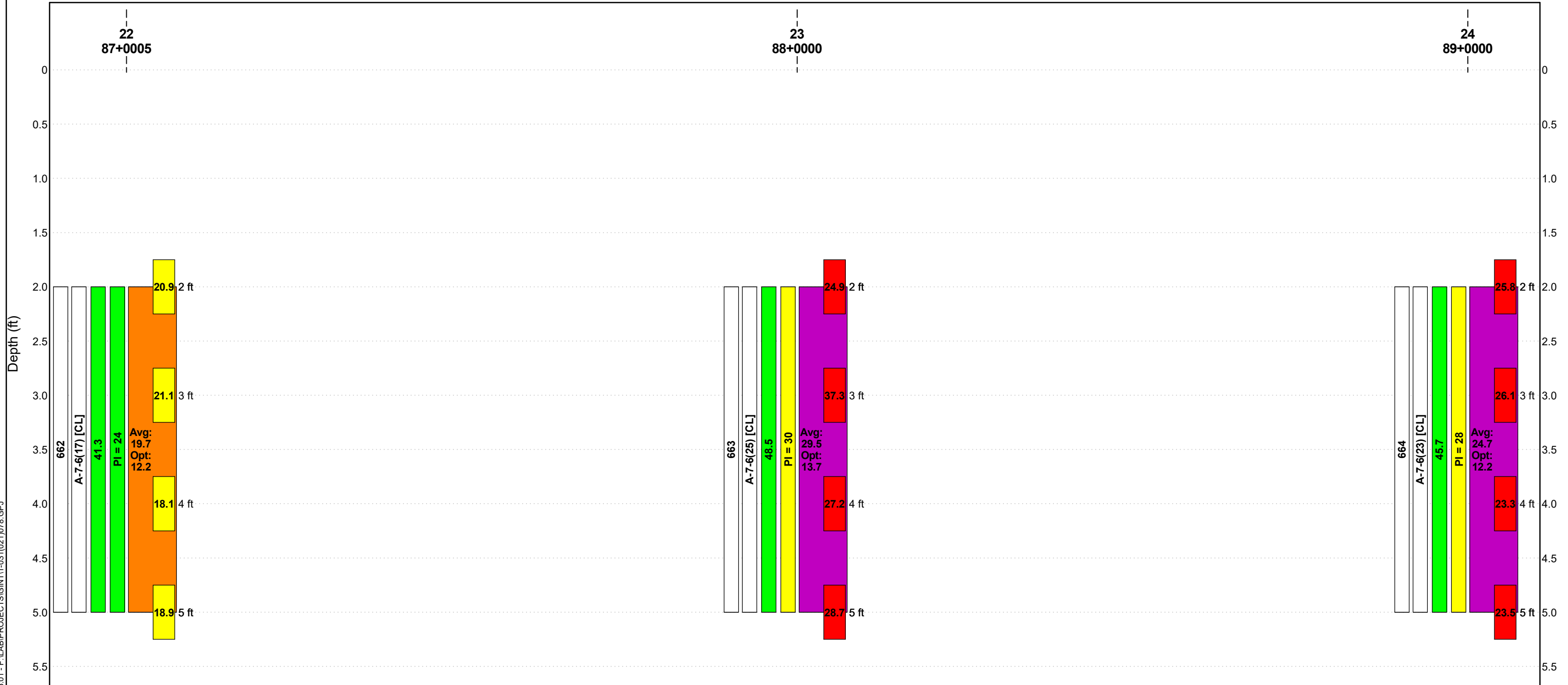


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300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

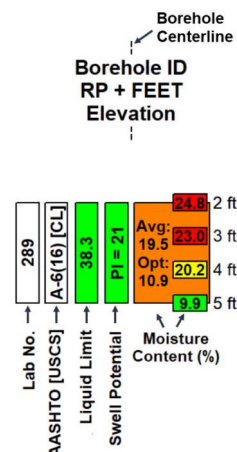
PCN 23324

LOCATION Morton & Oliver

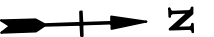
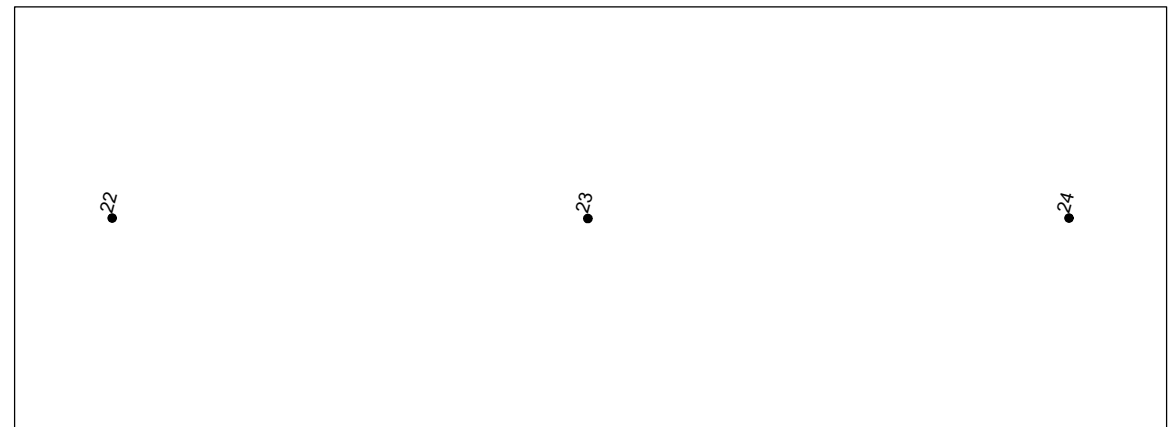


Boreholes Equally Spaced (0 to 3500 ft)

### LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 15:03 - F:\LAB\PROJECTS\GINT11-031(021)078.GPJ

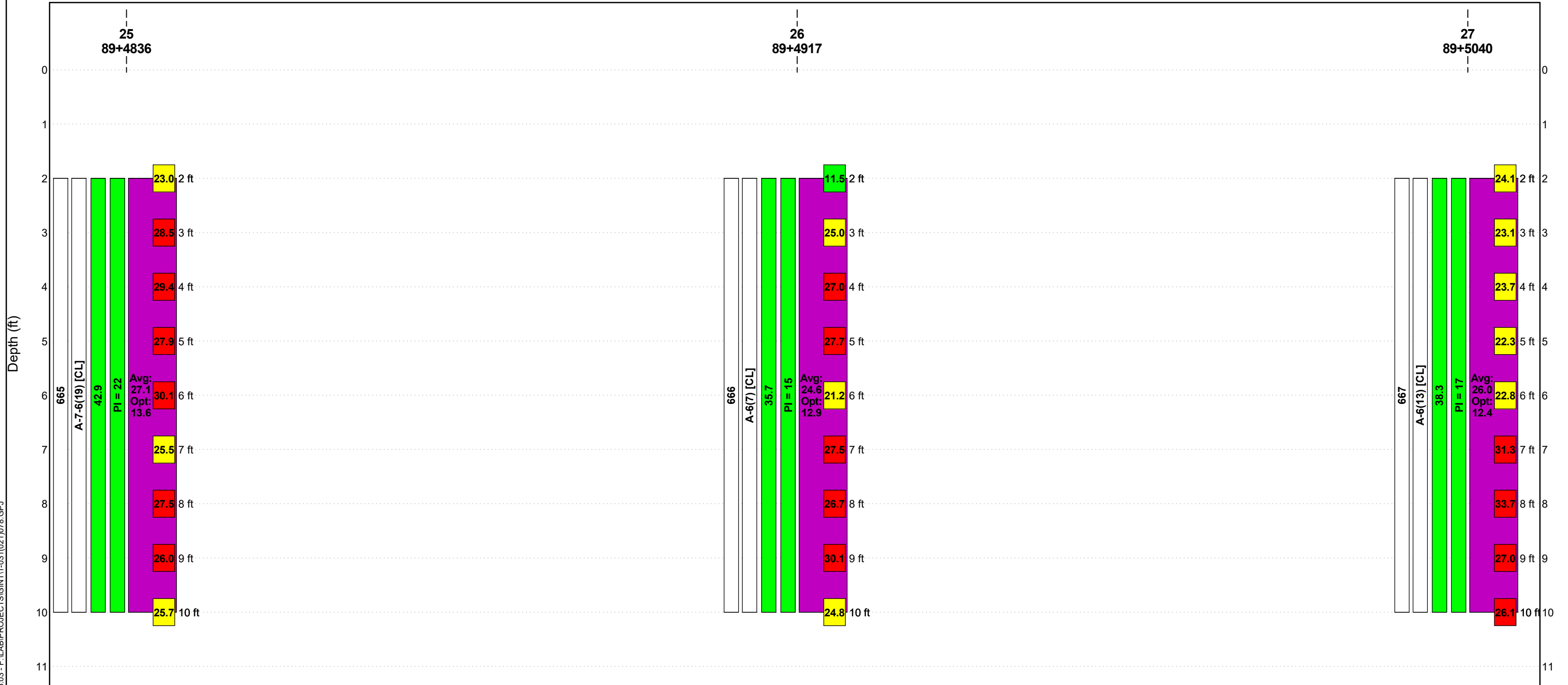


NORTH DAKOTA DEPARTMENT OF TRANSPORATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

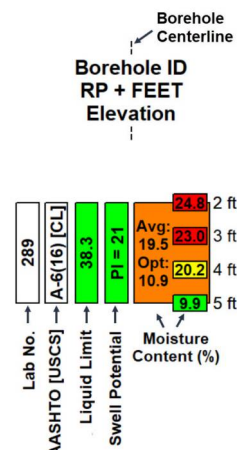
PCN 23324

LOCATION Morton & Oliver

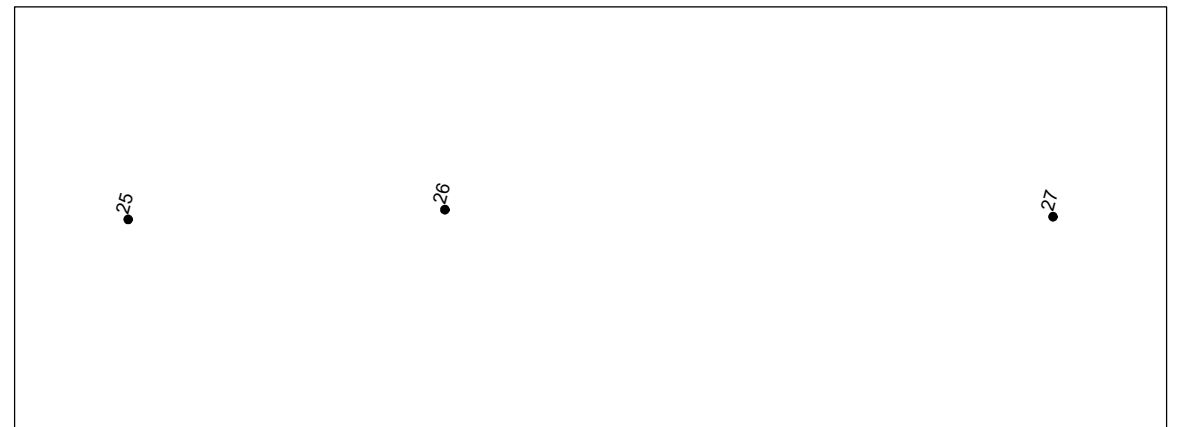


Boreholes Equally Spaced (0 to 80 ft)

### LEGEND



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



NDDOT\_LINEARCOLORFENCE\_DEPTH - 20171219.GDT - 4/11/23 15:04 - F:\LAB\PROJECTS\GINT11-031(021)078.GPJ

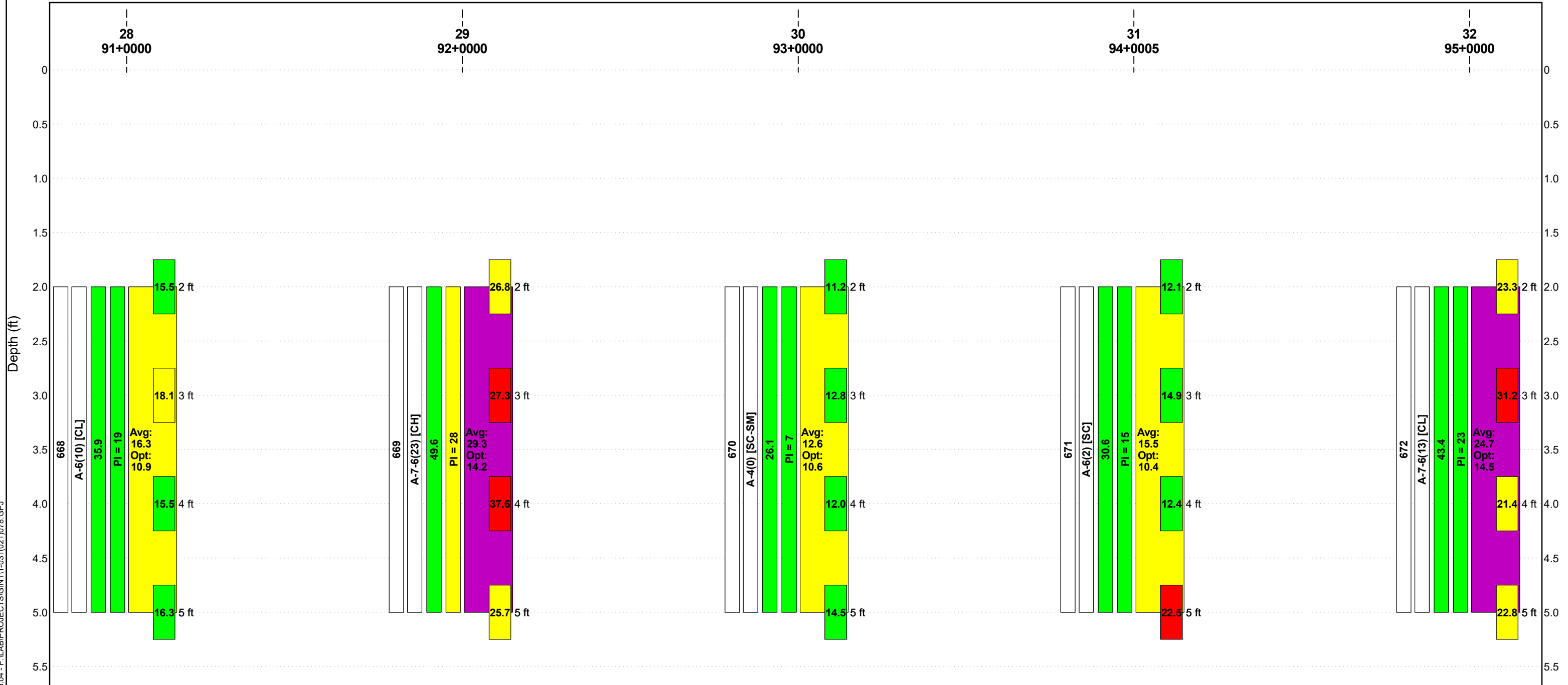


NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

PROJECT NUMBER XA-SS-1-031(021)078

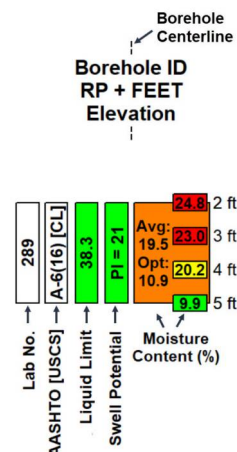
PCN 23324

LOCATION Morton & Oliver

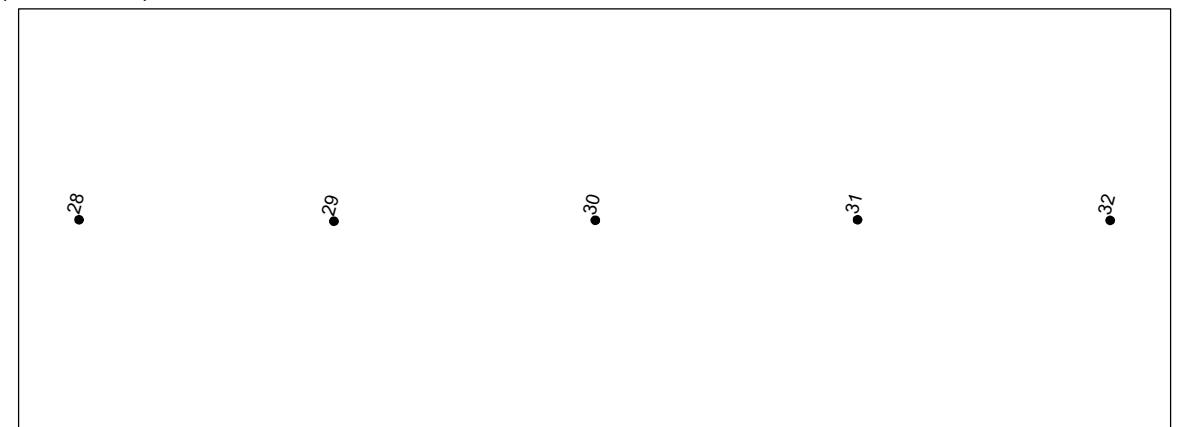


Boreholes Equally Spaced (0 to 6500 ft)

### LEGEND



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



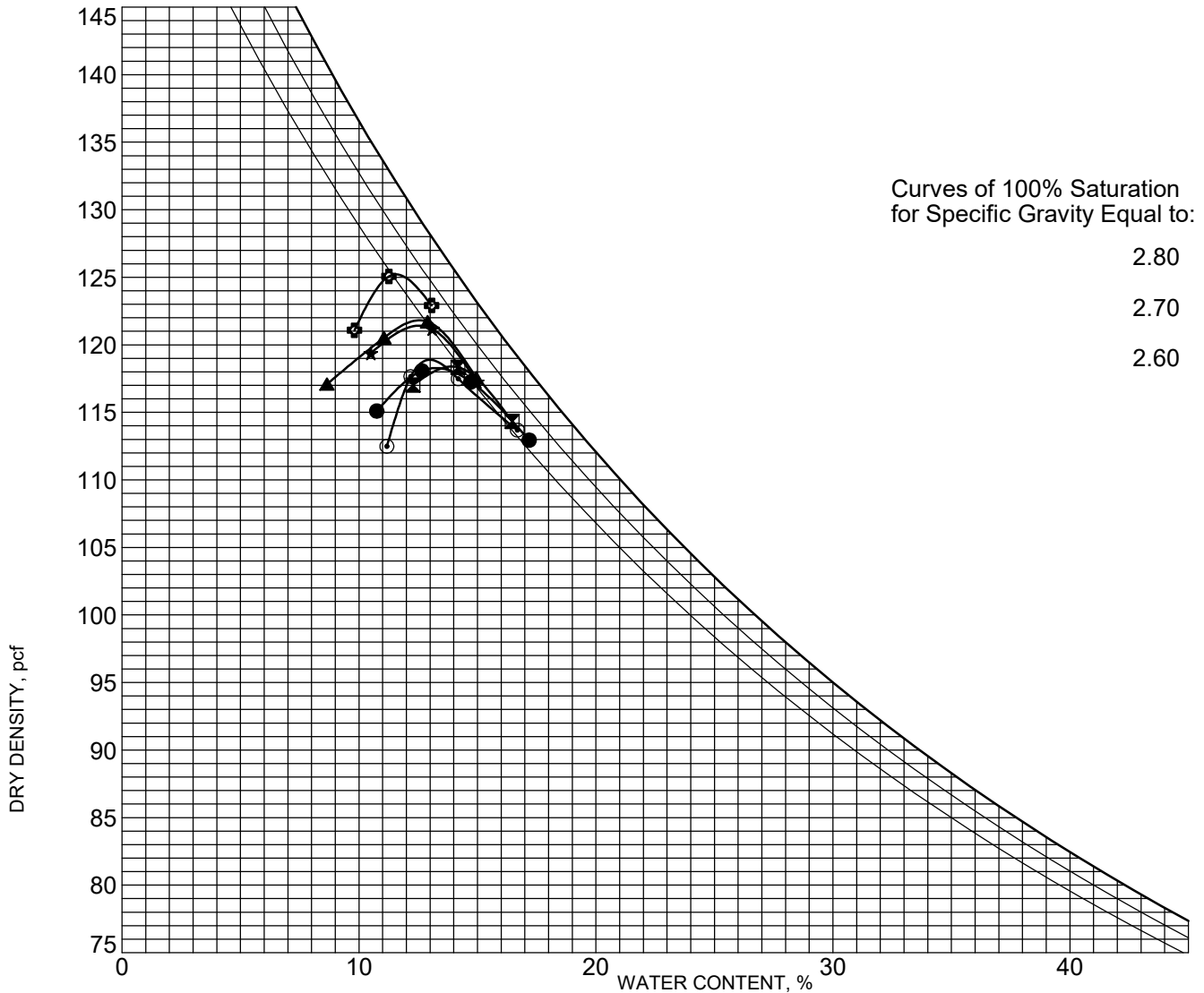
# **APPENDIX E**

## **LAB RESULTS**

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



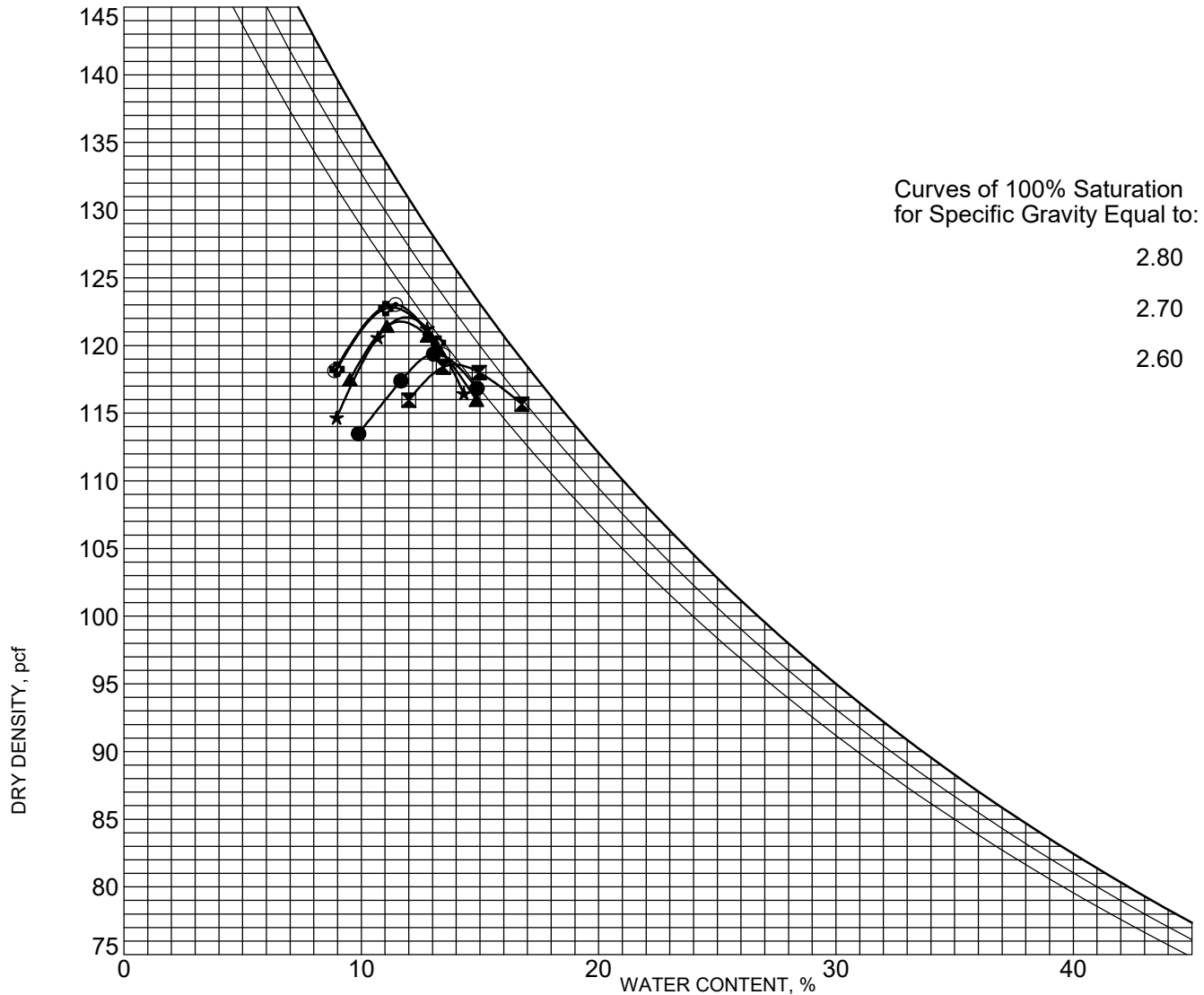
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description        |
|----------|-------|-----------------------|-------------------------|
| ● 1      | 2.0   | A-7-6 (10)            | SANDY LEAN CLAY(CL)     |
| ⊠ 2      | 2.0   | A-7-6 (17)            | LEAN CLAY with SAND(CL) |
| ▲ 3      | 2.0   | A-7-6 (23)            | LEAN CLAY with SAND(CL) |
| ★ 4      | 2.0   | A-7-6 (18)            | LEAN CLAY with SAND(CL) |
| ⊙ 5      | 2.0   | A-7-6 (23)            | LEAN CLAY(CL)           |
| ⊕ 6      | 2.1   | A-6 (17)              | LEAN CLAY with SAND(CL) |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 1      | 2.0   | AASHTO T-180 Method A | 42 | 19 | 23 | 118.3 PCF | 13.2 %     |
| ⊠ 2      | 2.0   | AASHTO T-180 Method A | 42 | 16 | 26 | 118.4 PCF | 13.9 %     |
| ▲ 3      | 2.0   | AASHTO T-180 Method A | 47 | 19 | 28 | 121.8 PCF | 12.5 %     |
| ★ 4      | 2.0   | AASHTO T-180 Method A | 41 | 18 | 23 | 121.4 PCF | 12.5 %     |
| ⊙ 5      | 2.0   | AASHTO T-180 Method A | 45 | 20 | 25 | 118.9 PCF | 13.0 %     |
| ⊕ 6      | 2.1   | AASHTO T-180 Method A | 40 | 19 | 21 | 125.2 PCF | 11.5 %     |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



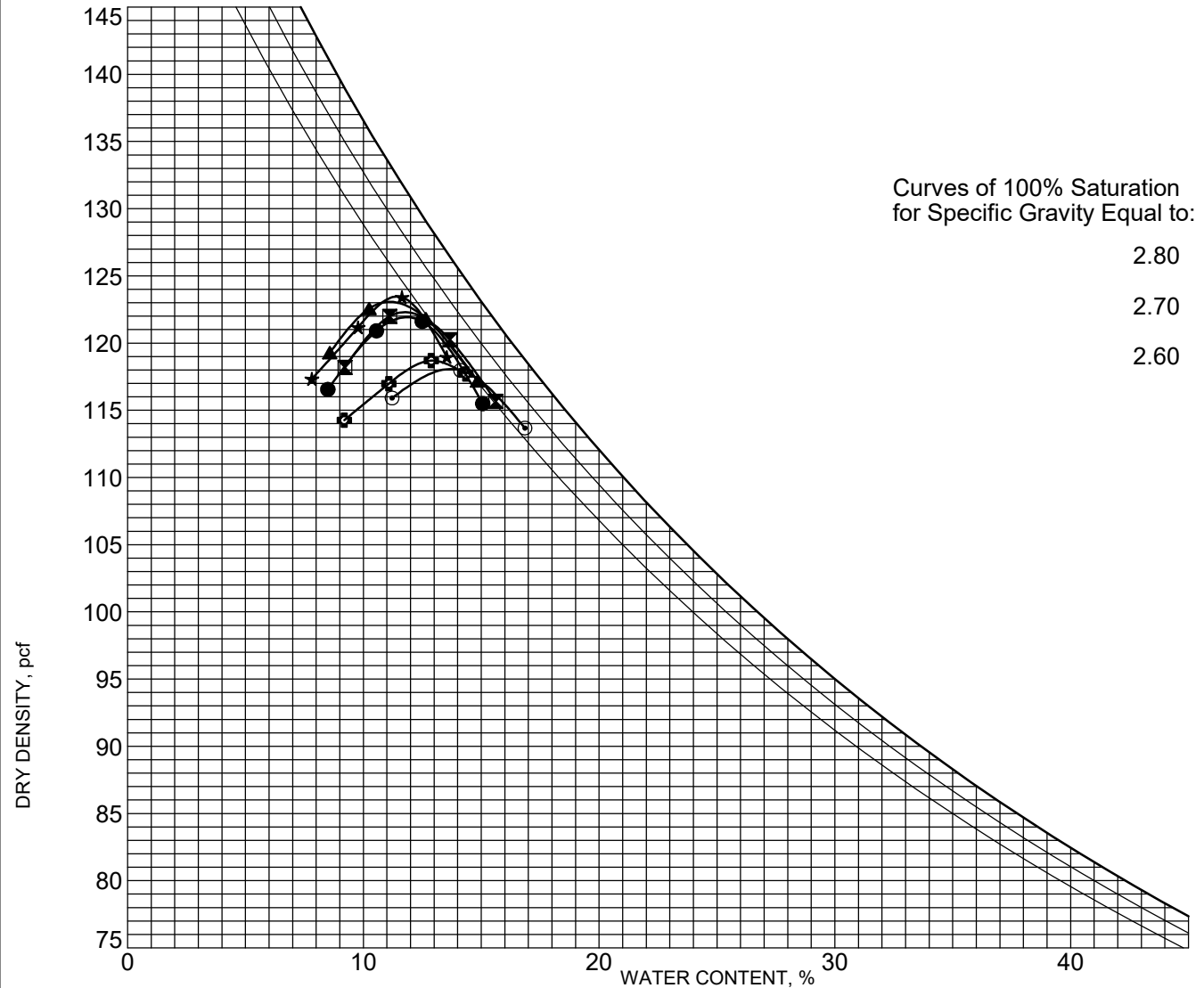
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description        |
|----------|-------|-----------------------|-------------------------|
| ● 7      | 2.0   | A-6 (9)               | SANDY LEAN CLAY(CL)     |
| ⊠ 7      | 7.0   | A-7-6 (31)            | FAT CLAY(CH)            |
| ▲ 8      | 2.0   | A-6 (6)               | SANDY LEAN CLAY(CL)     |
| ★ 9      | 2.0   | A-6 (12)              | LEAN CLAY with SAND(CL) |
| ⊙ 10     | 2.0   | A-6 (5)               | SANDY LEAN CLAY(CL)     |
| ⊕ 11     | 2.0   | A-4 (4)               | SANDY LEAN CLAY(CL)     |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 7      | 2.0   | AASHTO T-180 Method A | 34 | 17 | 17 | 119.4 PCF | 13.1 %     |
| ⊠ 7      | 7.0   | AASHTO T-180 Method A | 51 | 21 | 30 | 118.6 PCF | 13.9 %     |
| ▲ 8      | 2.0   | AASHTO T-180 Method A | 32 | 16 | 16 | 121.8 PCF | 11.6 %     |
| ★ 9      | 2.0   | AASHTO T-180 Method A | 38 | 18 | 20 | 122.1 PCF | 11.9 %     |
| ⊙ 10     | 2.0   | AASHTO T-180 Method A | 30 | 17 | 13 | 123.0 PCF | 11.3 %     |
| ⊕ 11     | 2.0   | AASHTO T-180 Method A | 29 | 19 | 10 | 122.8 PCF | 11.3 %     |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



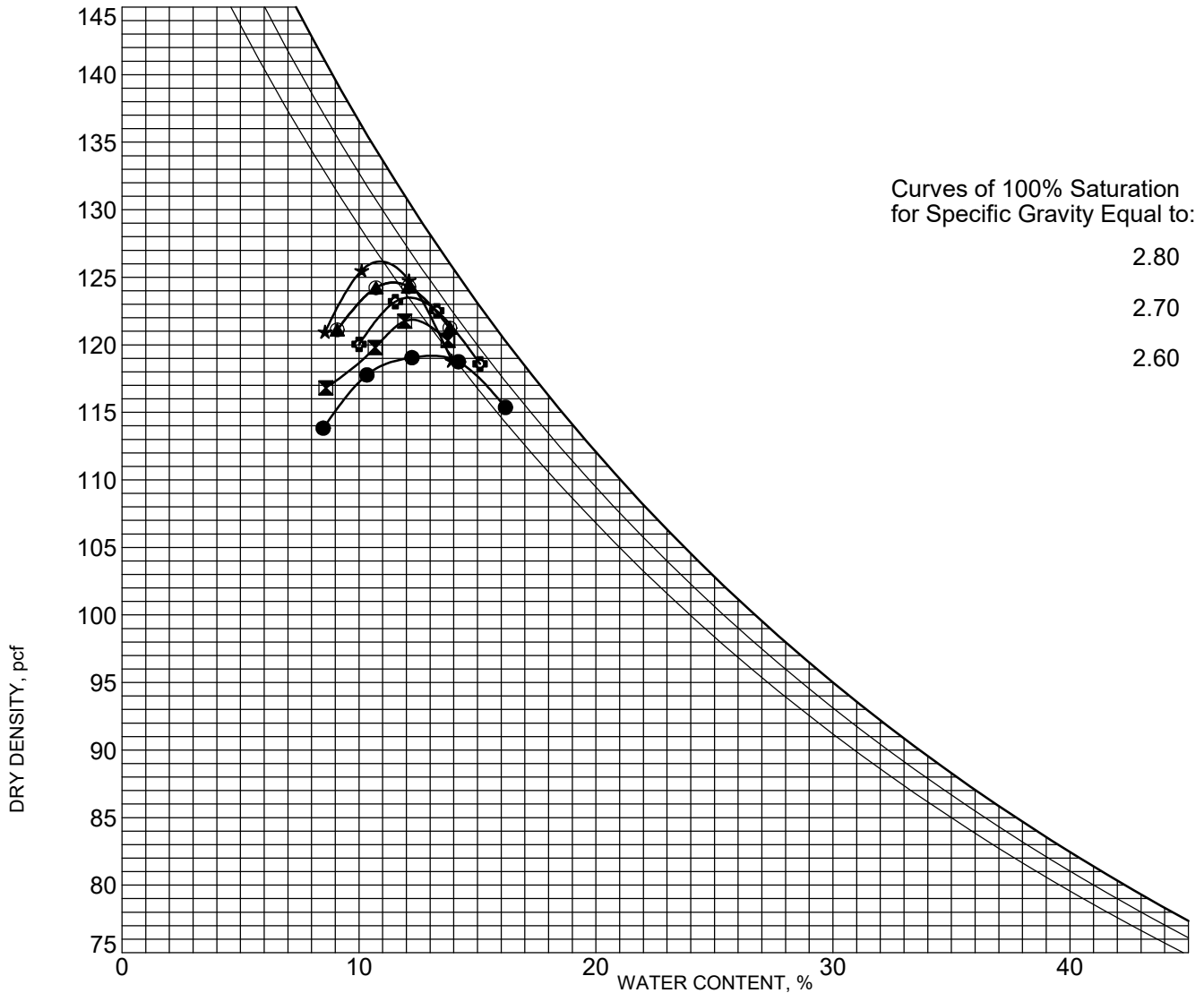
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description        |
|----------|-------|-----------------------|-------------------------|
| ● 12     | 2.1   | A-6 (3)               | SANDY LEAN CLAY(CL)     |
| ▣ 13     | 2.1   | A-6 (9)               | SANDY LEAN CLAY(CL)     |
| ▲ 14     | 2.0   | A-6 (11)              | SANDY LEAN CLAY(CL)     |
| ★ 14     | 7.0   | A-4 (6)               | LEAN CLAY with SAND(CL) |
| ⊙ 15     | 2.0   | A-7-6 (23)            | LEAN CLAY with SAND(CL) |
| ⊕ 16     | 2.0   | A-7-6 (28)            | FAT CLAY(CH)            |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 12     | 2.1   | AASHTO T-180 Method A | 29 | 17 | 12 | 121.9 PCF | 11.9 %     |
| ▣ 13     | 2.1   | AASHTO T-180 Method A | 35 | 19 | 16 | 122.3 PCF | 11.8 %     |
| ▲ 14     | 2.0   | AASHTO T-180 Method A | 36 | 15 | 21 | 123.1 PCF | 11.1 %     |
| ★ 14     | 7.0   | AASHTO T-180 Method A | 31 | 22 | 9  | 123.5 PCF | 11.4 %     |
| ⊙ 15     | 2.0   | AASHTO T-180 Method A | 47 | 19 | 28 | 118.1 PCF | 13.7 %     |
| ⊕ 16     | 2.0   | AASHTO T-180 Method A | 50 | 19 | 31 | 118.7 PCF | 12.9 %     |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



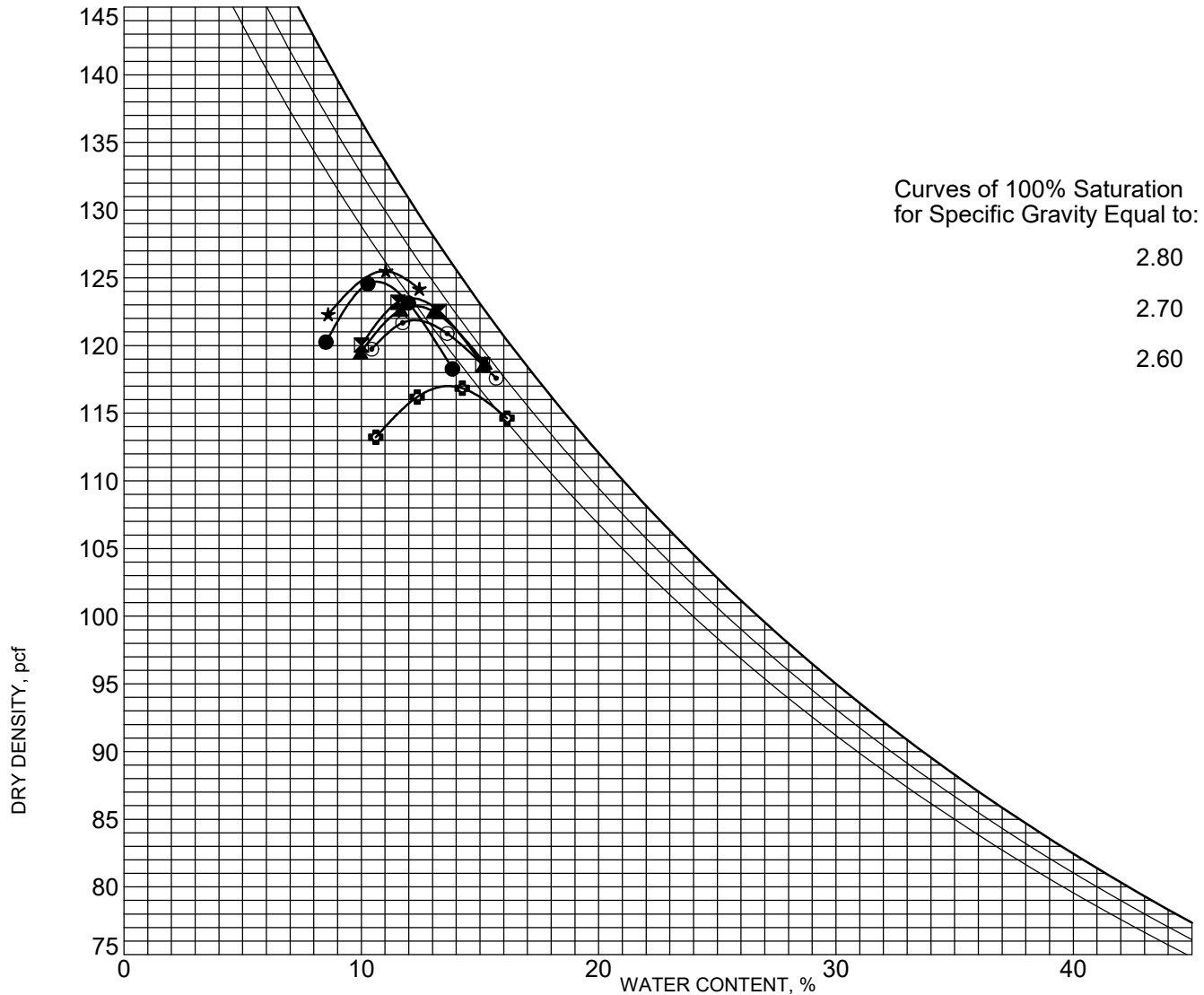
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description        |
|----------|-------|-----------------------|-------------------------|
| ● 17     | 2.0   | A-7-6 (28)            | FAT CLAY(CH)            |
| ⊠ 18     | 2.0   | A-7-6 (18)            | LEAN CLAY with SAND(CL) |
| ▲ 19     | 2.0   | A-6 (13)              | SANDY LEAN CLAY(CL)     |
| ★ 19     | 7.0   | A-4 (2)               | SANDY LEAN CLAY(CL)     |
| ⊙ 19     | 9.0   | A-6 (13)              | SANDY LEAN CLAY(CL)     |
| ⊕ 20     | 2.0   | A-7-6 (18)            | LEAN CLAY with SAND(CL) |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 17     | 2.0   | AASHTO T-180 Method A | 50 | 19 | 31 | 119.2 PCF | 13.1 %     |
| ⊠ 18     | 2.0   | AASHTO T-180 Method A | 46 | 19 | 27 | 121.9 PCF | 12.2 %     |
| ▲ 19     | 2.0   | AASHTO T-180 Method A | 39 | 17 | 22 | 124.6 PCF | 11.4 %     |
| ★ 19     | 7.0   | AASHTO T-180 Method A | 26 | 17 | 9  | 126.2 PCF | 11.0 %     |
| ⊙ 19     | 9.0   | AASHTO T-180 Method A | 39 | 17 | 22 | 124.6 PCF | 11.4 %     |
| ⊕ 20     | 2.0   | AASHTO T-180 Method A | 41 | 17 | 24 | 123.5 PCF | 12.1 %     |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



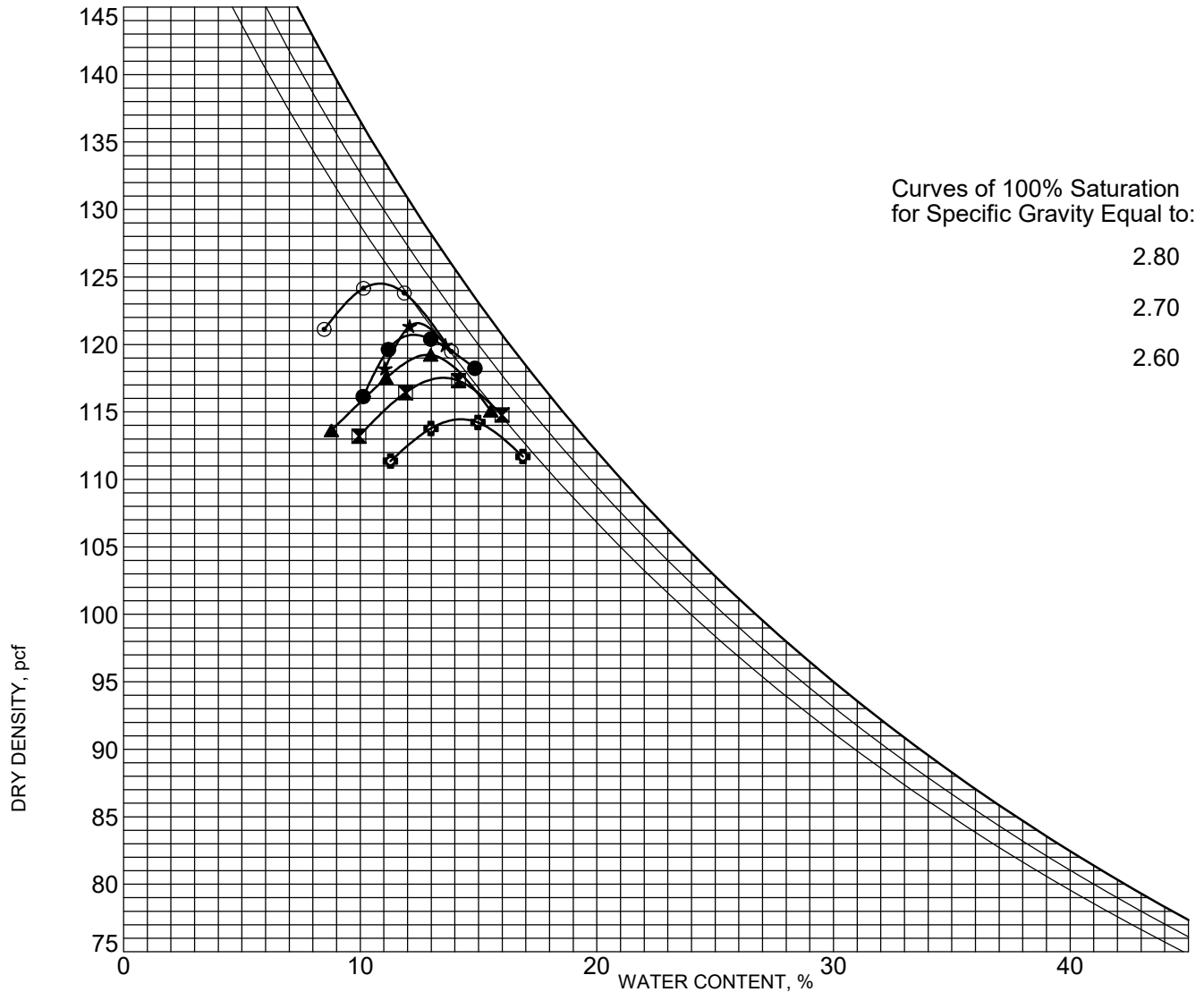
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description        |
|----------|-------|-----------------------|-------------------------|
| ● 20     | 7.0   | A-4 (2)               | SANDY LEAN CLAY(CL)     |
| ⊠ 20     | 8.0   | A-7-6 (18)            | LEAN CLAY with SAND(CL) |
| ▲ 21     | 2.0   | A-7-6 (19)            | LEAN CLAY with SAND(CL) |
| ★ 21     | 7.0   | A-6 (7)               | SANDY LEAN CLAY(CL)     |
| ⊙ 22     | 2.0   | A-7-6 (17)            | LEAN CLAY with SAND(CL) |
| ⊕ 23     | 2.0   | A-7-6 (25)            | LEAN CLAY with SAND(CL) |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 20     | 7.0   | AASHTO T-180 Method A | 26 | 16 | 10 | 124.7 PCF | 10.6 %     |
| ⊠ 20     | 8.0   | AASHTO T-180 Method A | 41 | 17 | 24 | 123.5 PCF | 12.1 %     |
| ▲ 21     | 2.0   | AASHTO T-180 Method A | 42 | 16 | 26 | 122.9 PCF | 12.2 %     |
| ★ 21     | 7.0   | AASHTO T-180 Method A | 31 | 16 | 15 | 125.5 PCF | 11.0 %     |
| ⊙ 22     | 2.0   | AASHTO T-180 Method A | 41 | 18 | 23 | 121.9 PCF | 12.2 %     |
| ⊕ 23     | 2.0   | AASHTO T-180 Method A | 48 | 19 | 29 | 117.0 PCF | 13.7 %     |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



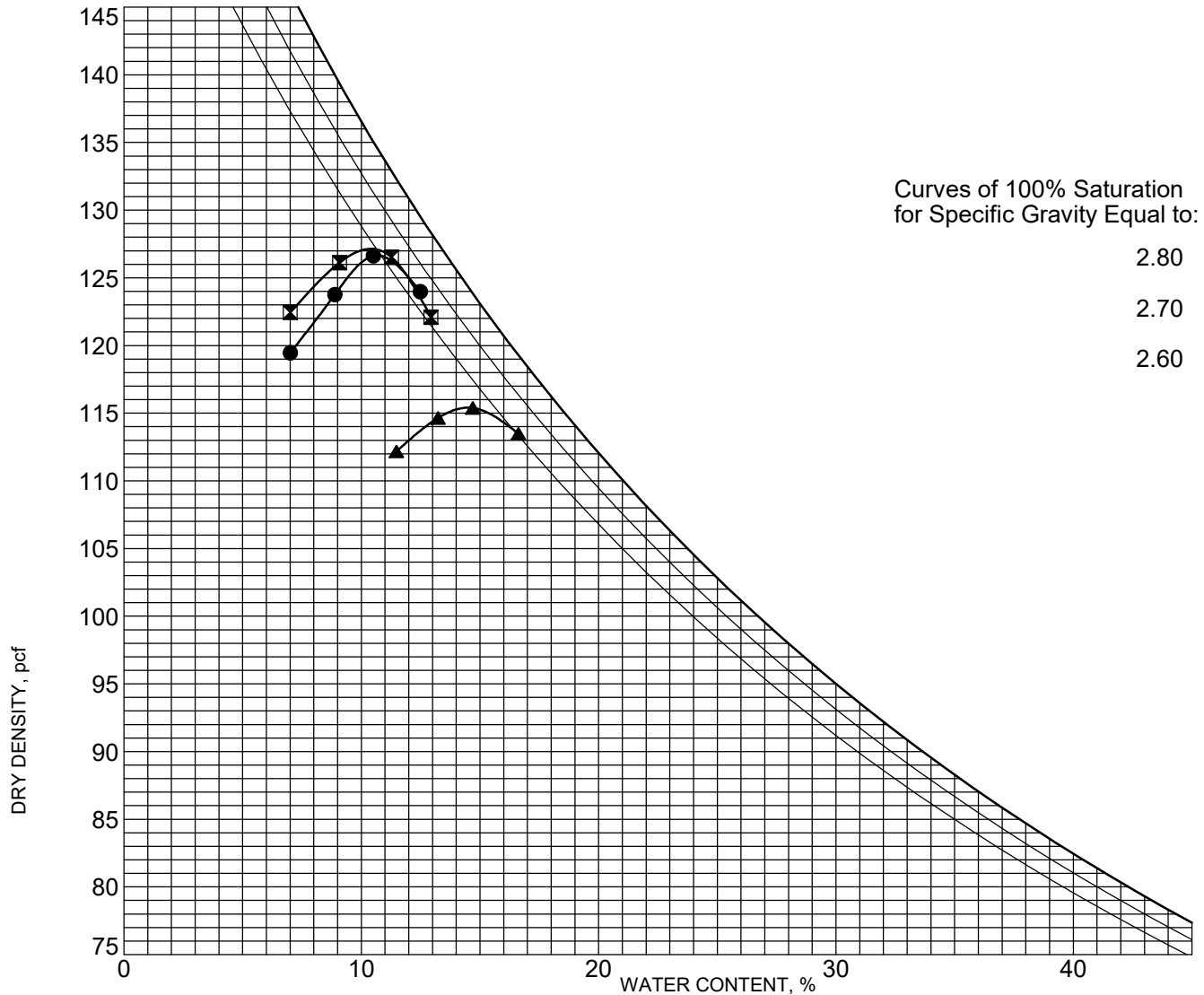
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description        |
|----------|-------|-----------------------|-------------------------|
| ● 24     | 2.0   | A-7-6 (23)            | LEAN CLAY with SAND(CL) |
| ⊠ 25     | 2.0   | A-7-6 (19)            | LEAN CLAY with SAND(CL) |
| ▲ 26     | 2.0   | A-6 (7)               | SANDY LEAN CLAY(CL)     |
| ★ 27     | 2.0   | A-6 (13)              | LEAN CLAY with SAND(CL) |
| ⊙ 28     | 2.0   | A-6 (10)              | SANDY LEAN CLAY(CL)     |
| ⊕ 29     | 2.0   | A-7-6 (23)            | FAT CLAY with SAND(CH)  |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 24     | 2.0   | AASHTO T-180 Method A | 46 | 17 | 29 | 120.7 PCF | 12.2 %     |
| ⊠ 25     | 2.0   | AASHTO T-180 Method A | 43 | 21 | 22 | 117.5 PCF | 13.6 %     |
| ▲ 26     | 2.0   | AASHTO T-180 Method A | 36 | 21 | 15 | 119.2 PCF | 12.9 %     |
| ★ 27     | 2.0   | AASHTO T-180 Method A | 38 | 21 | 17 | 121.6 PCF | 12.4 %     |
| ⊙ 28     | 2.0   | AASHTO T-180 Method A | 36 | 17 | 19 | 124.5 PCF | 10.9 %     |
| ⊕ 29     | 2.0   | AASHTO T-180 Method A | 50 | 22 | 28 | 114.5 PCF | 14.2 %     |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



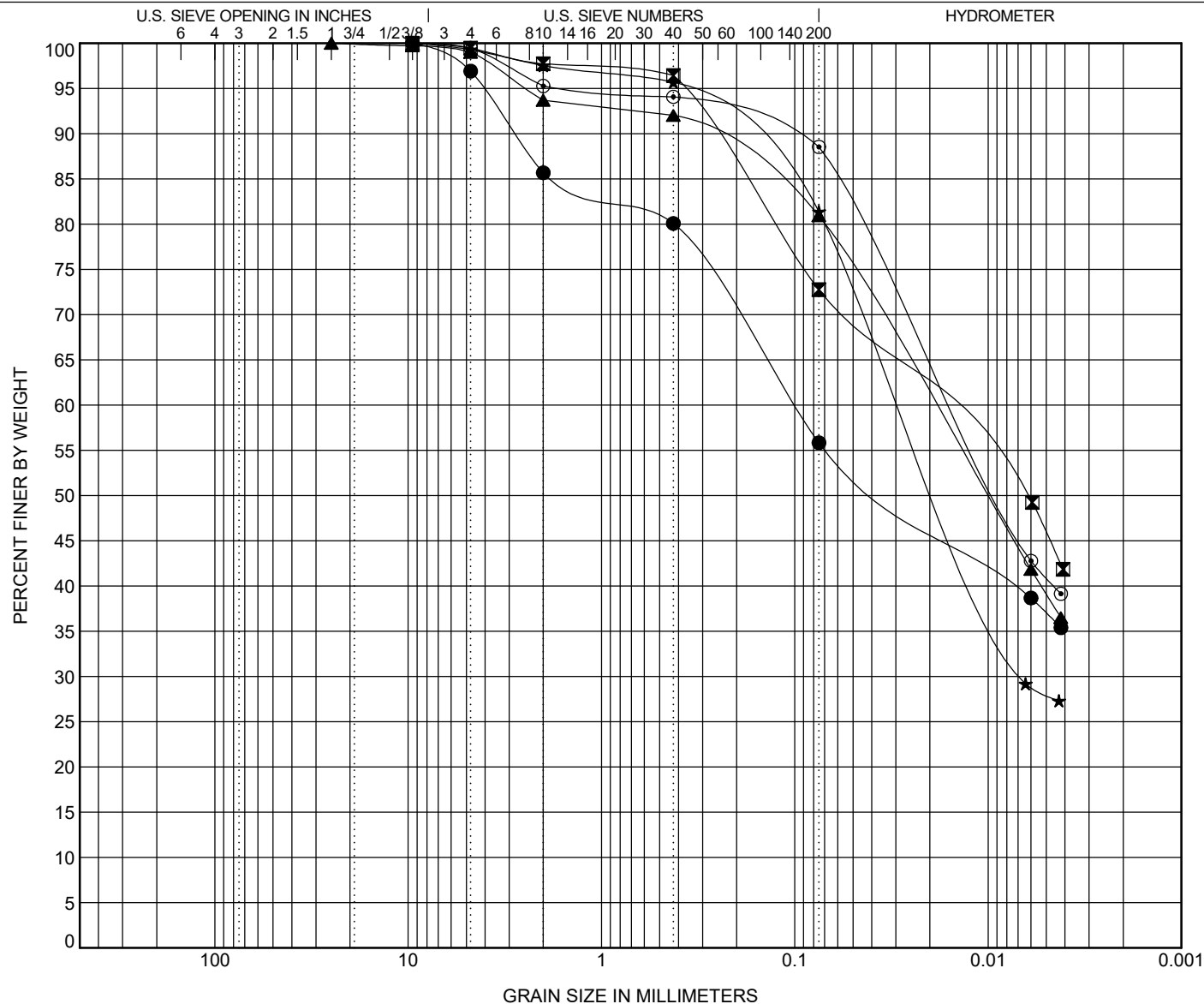
| BOREHOLE | DEPTH | AASHTO Classification | USCS Description          |
|----------|-------|-----------------------|---------------------------|
| ● 30     | 2.0   | A-4 (0)               | SILTY, CLAYEY SAND(SC-SM) |
| ⊠ 31     | 2.0   | A-6 (2)               | CLAYEY SAND(SC)           |
| ▲ 32     | 2.0   | A-7-6 (13)            | SANDY LEAN CLAY(CL)       |
|          |       |                       |                           |
|          |       |                       |                           |
|          |       |                       |                           |

| BOREHOLE | DEPTH | Test Method           | LL | PL | PI | Max DD    | Optimum WC |
|----------|-------|-----------------------|----|----|----|-----------|------------|
| ● 30     | 2.0   | AASHTO T-180 Method A | 26 | 19 | 7  | 126.7 PCF | 10.6 %     |
| ⊠ 31     | 2.0   | AASHTO T-180 Method A | 31 | 16 | 15 | 127.1 PCF | 10.4 %     |
| ▲ 32     | 2.0   | AASHTO T-180 Method A | 43 | 20 | 23 | 115.4 PCF | 14.5 %     |
|          |       |                       |    |    |    |           |            |
|          |       |                       |    |    |    |           |            |
|          |       |                       |    |    |    |           |            |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

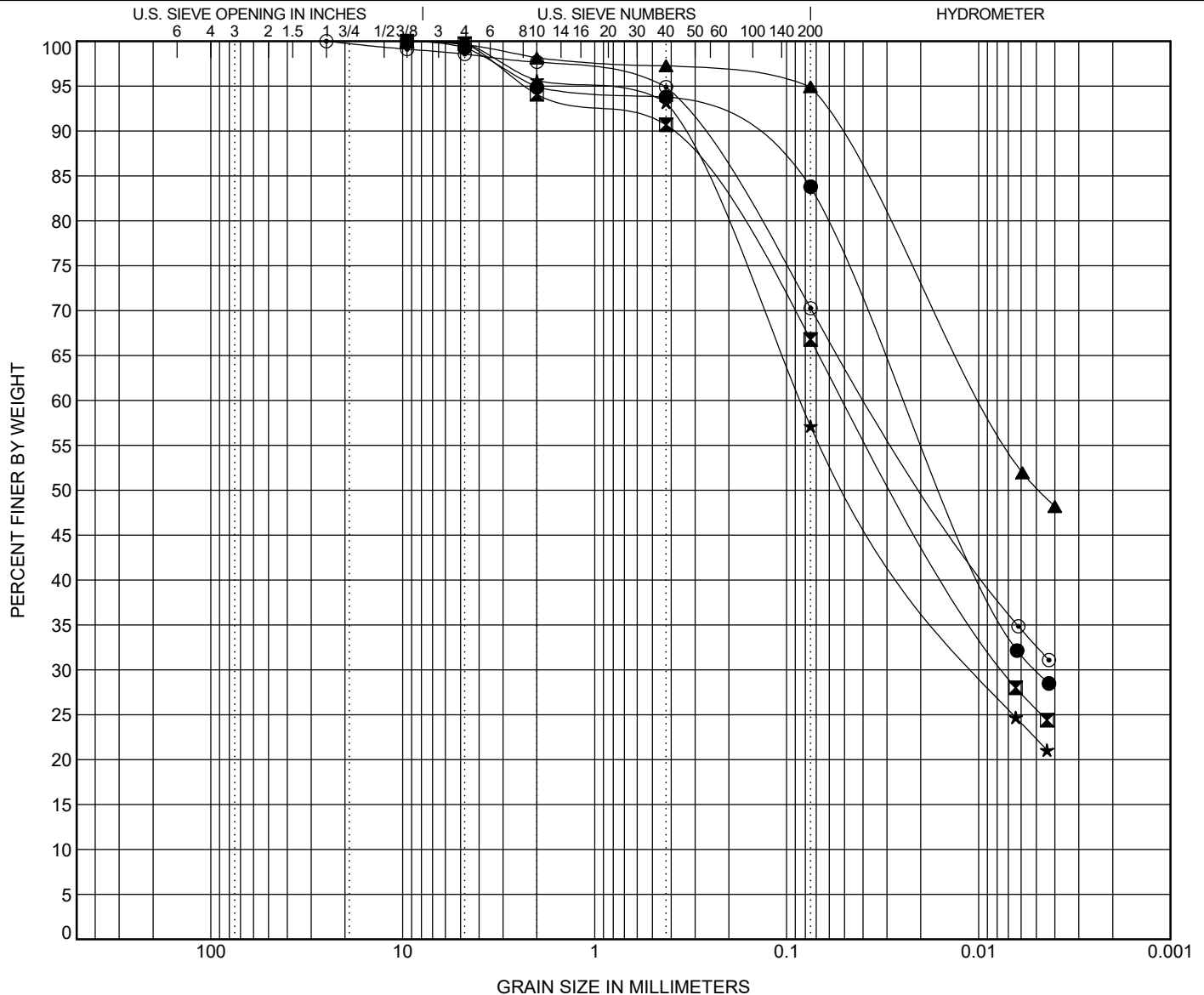
PCN 23324



PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

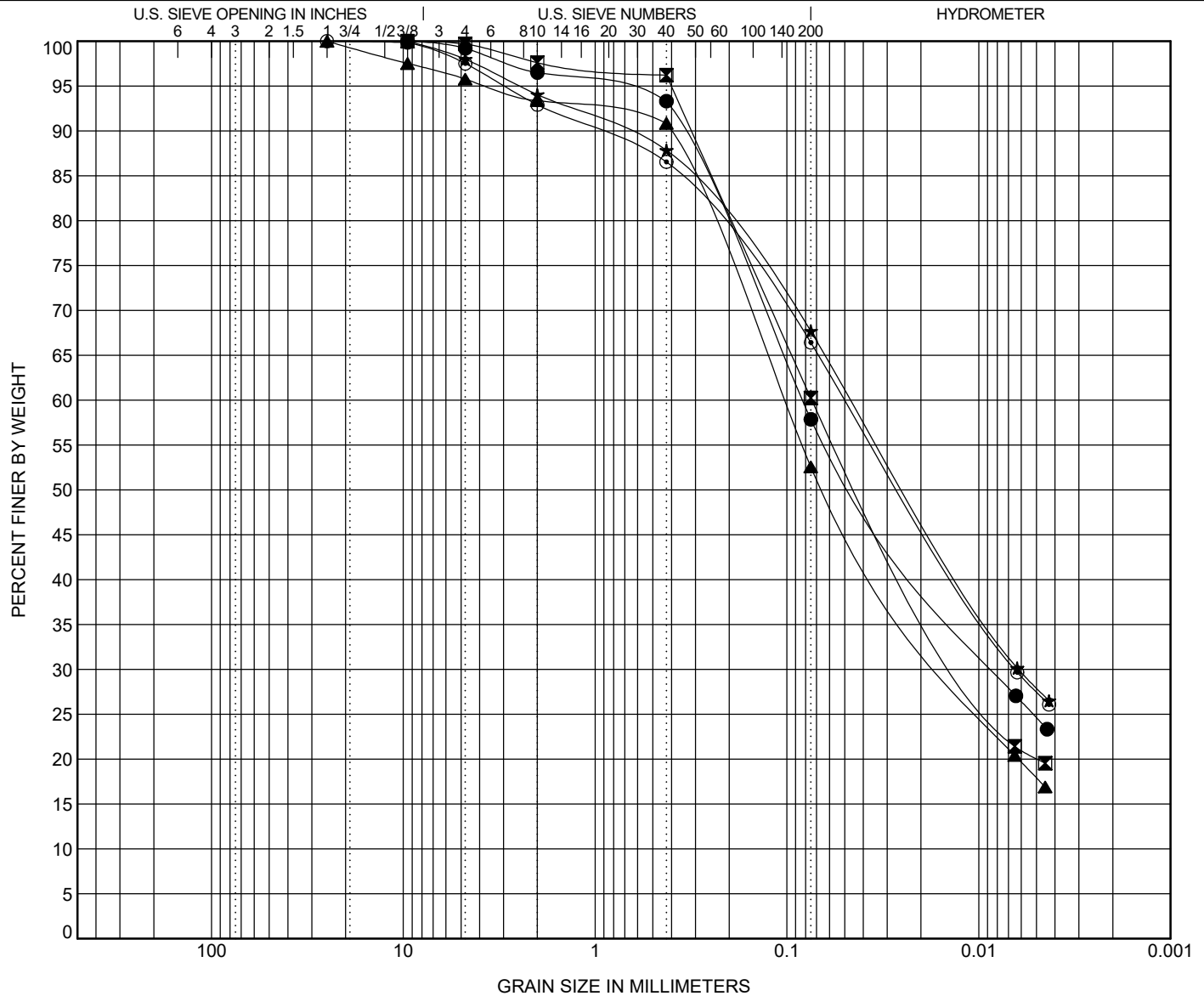
PCN 23324



PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

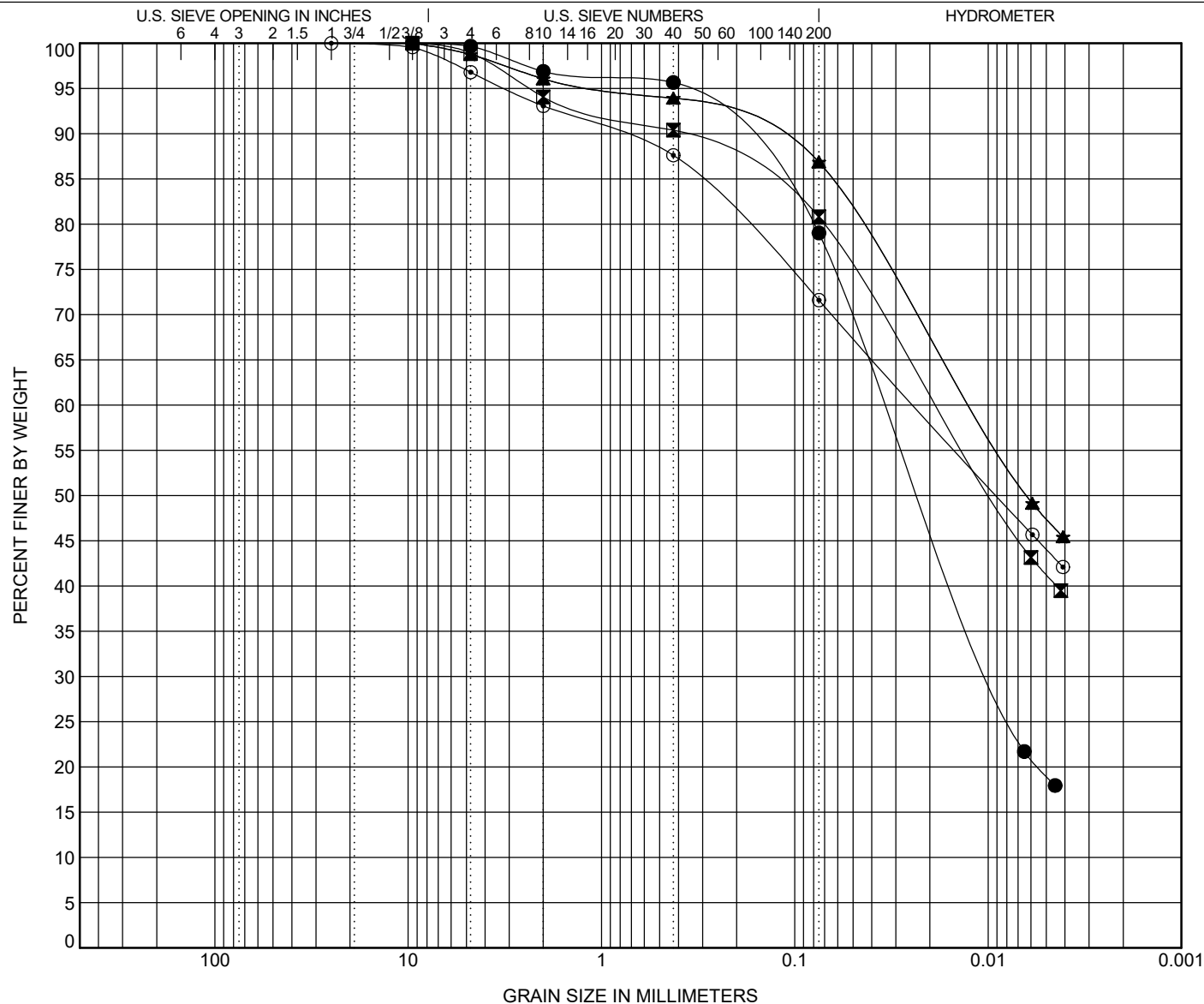
PCN 23324



PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



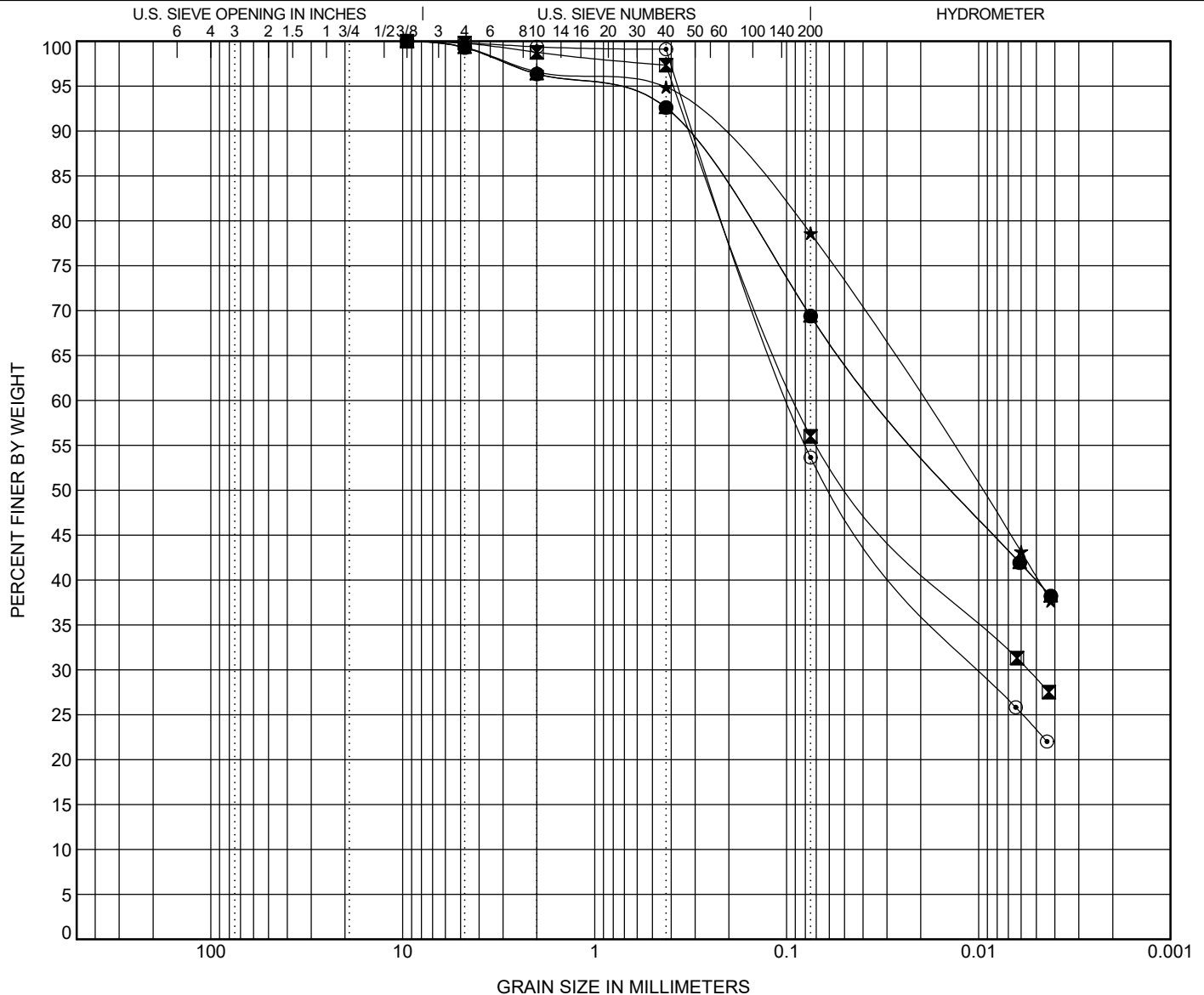
| COBBLES | GRAVEL |      | SAND   |        |      | SILT OR CLAY |
|---------|--------|------|--------|--------|------|--------------|
|         | coarse | fine | coarse | medium | fine |              |

| BOREHOLE |    | DEPTH | AASHTO Classification |       |       | USCS Classification |         |       | LL    | PL | PI    | Cc | Cu |
|----------|----|-------|-----------------------|-------|-------|---------------------|---------|-------|-------|----|-------|----|----|
| ●        | 14 | 7.0   | A-4 (6)               |       |       | CL                  |         |       | 31    | 22 | 9     |    |    |
| ▣        | 15 | 2.0   | A-7-6 (23)            |       |       | CL                  |         |       | 47    | 19 | 28    |    |    |
| ▲        | 16 | 2.0   | A-7-6 (28)            |       |       | CH                  |         |       | 50    | 19 | 31    |    |    |
| ★        | 17 | 2.0   | A-7-6 (28)            |       |       | CH                  |         |       | 50    | 19 | 31    |    |    |
| ⊙        | 18 | 2.0   | A-7-6 (18)            |       |       | CL                  |         |       | 46    | 19 | 27    |    |    |
| BOREHOLE |    | DEPTH | D100                  | D50   | D30   | D15                 | %Gravel | %Sand | %Silt |    | %Clay |    |    |
| ●        | 14 | 7.0   | 9.5                   | 0.022 | 0.009 |                     | 0.3     | 20.6  | 79.0  |    |       |    |    |
| ▣        | 15 | 2.0   | 9.5                   | 0.009 |       |                     | 1.1     | 18.1  | 80.8  |    |       |    |    |
| ▲        | 16 | 2.0   | 9.5                   | 0.006 |       |                     | 1.3     | 11.9  | 86.9  |    |       |    |    |
| ★        | 17 | 2.0   | 9.5                   | 0.006 |       |                     | 1.3     | 11.9  | 86.9  |    |       |    |    |
| ⊙        | 18 | 2.0   | 25                    | 0.009 |       |                     | 3.2     | 25.2  | 71.6  |    |       |    |    |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



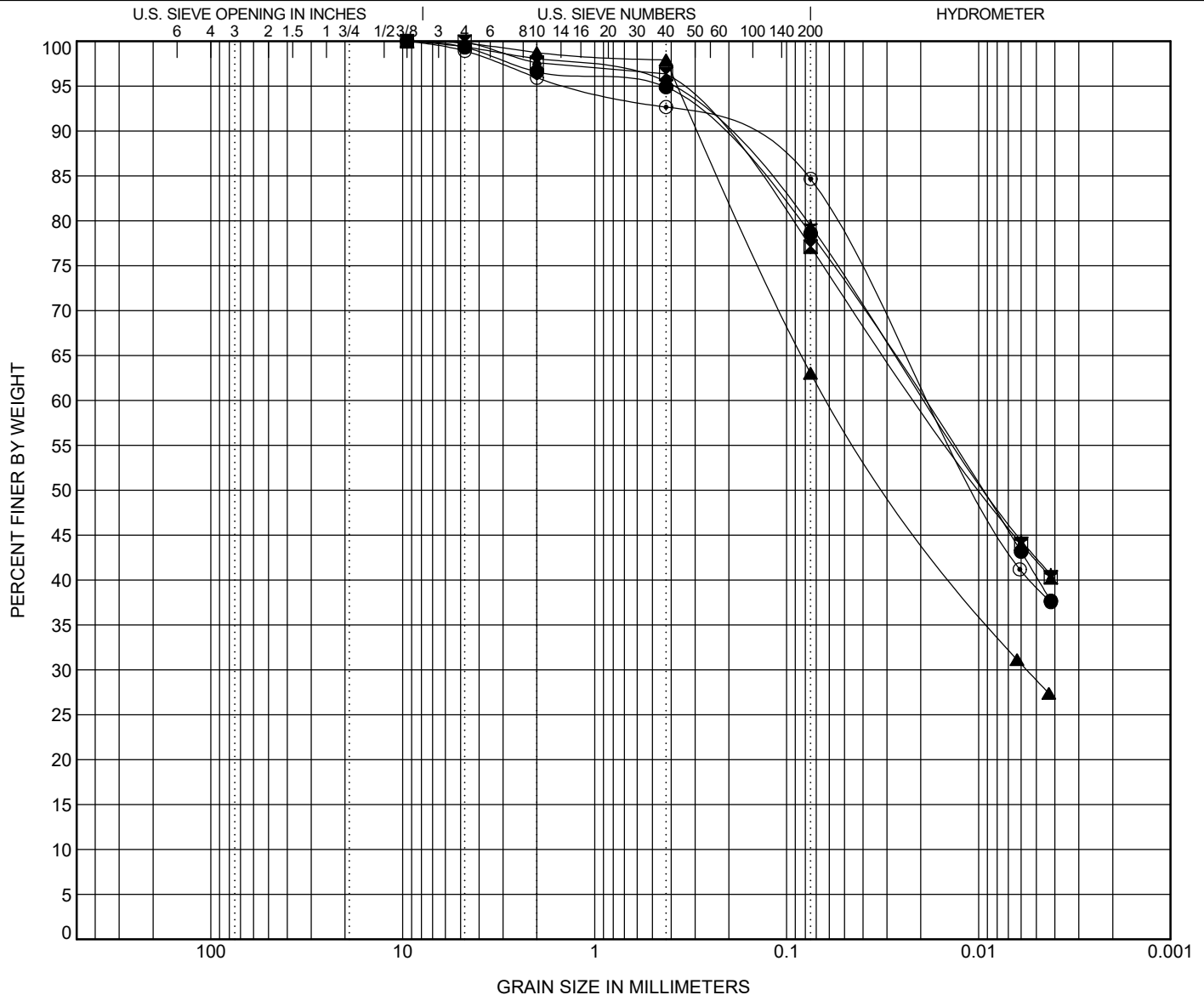
| COBBLES | GRAVEL |      | SAND   |        |      | SILT OR CLAY |
|---------|--------|------|--------|--------|------|--------------|
|         | coarse | fine | coarse | medium | fine |              |

| BOREHOLE | DEPTH | AASHTO Classification |       | USCS Classification |     | LL      | PL    | PI    | Cc    | Cu |
|----------|-------|-----------------------|-------|---------------------|-----|---------|-------|-------|-------|----|
| ● 19     | 2.0   | A-6 (13)              |       | CL                  |     | 39      | 17    | 22    |       |    |
| ■ 19     | 7.0   | A-4 (2)               |       | CL                  |     | 26      | 17    | 9     |       |    |
| ▲ 19     | 9.0   | A-6 (13)              |       | CL                  |     | 39      | 17    | 22    |       |    |
| ★ 20     | 2.0   | A-7-6 (18)            |       | CL                  |     | 41      | 17    | 24    |       |    |
| ⊙ 20     | 7.0   | A-4 (2)               |       | CL                  |     | 26      | 16    | 10    |       |    |
| BOREHOLE | DEPTH | D100                  | D50   | D30                 | D15 | %Gravel | %Sand | %Silt | %Clay |    |
| ● 19     | 2.0   | 9.5                   | 0.013 |                     |     | 0.7     | 29.9  | 69.4  |       |    |
| ■ 19     | 7.0   | 9.5                   | 0.041 | 0.006               |     | 0.2     | 43.8  | 56.0  |       |    |
| ▲ 19     | 9.0   | 9.5                   | 0.013 |                     |     | 0.7     | 29.9  | 69.4  |       |    |
| ★ 20     | 2.0   | 9.5                   | 0.01  |                     |     | 0.7     | 20.7  | 78.6  |       |    |
| ⊙ 20     | 7.0   | 9.5                   | 0.054 | 0.009               |     | 0.2     | 46.2  | 53.7  |       |    |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



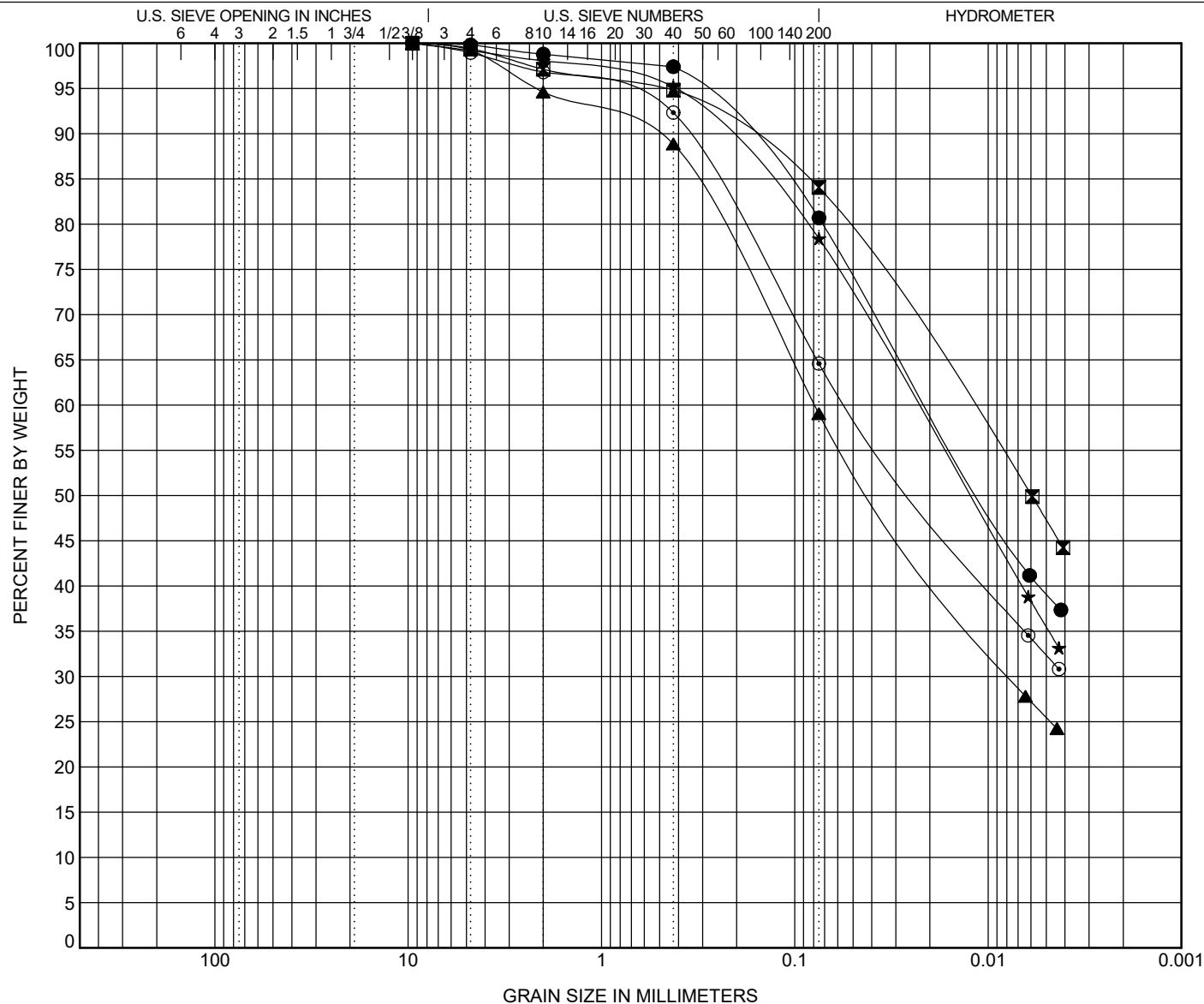
| COBBLES | GRAVEL |      | SAND   |        |      | SILT OR CLAY |
|---------|--------|------|--------|--------|------|--------------|
|         | coarse | fine | coarse | medium | fine |              |

| BOREHOLE | DEPTH | AASHTO Classification |       | USCS Classification |     | LL      | PL    | PI    | Cc    | Cu |
|----------|-------|-----------------------|-------|---------------------|-----|---------|-------|-------|-------|----|
| ● 20     | 8.0   | A-7-6 (18)            |       | CL                  |     | 41      | 17    | 24    |       |    |
| ■ 21     | 2.0   | A-7-6 (19)            |       | CL                  |     | 42      | 16    | 26    |       |    |
| ▲ 21     | 7.0   | A-6 (7)               |       | CL                  |     | 31      | 16    | 15    |       |    |
| ★ 22     | 2.0   | A-7-6 (17)            |       | CL                  |     | 41      | 18    | 23    |       |    |
| ⊙ 23     | 2.0   | A-7-6 (25)            |       | CL                  |     | 48      | 19    | 29    |       |    |
| BOREHOLE | DEPTH | D100                  | D50   | D30                 | D15 | %Gravel | %Sand | %Silt | %Clay |    |
| ● 20     | 8.0   | 9.5                   | 0.01  |                     |     | 0.7     | 20.7  | 78.6  |       |    |
| ■ 21     | 2.0   | 9.5                   | 0.009 |                     |     | 0.1     | 22.8  | 77.1  |       |    |
| ▲ 21     | 7.0   | 9.5                   | 0.027 | 0.006               |     | 0.2     | 36.7  | 63.0  |       |    |
| ★ 22     | 2.0   | 9.5                   | 0.009 |                     |     | 0.6     | 19.9  | 79.5  |       |    |
| ⊙ 23     | 2.0   | 9.5                   | 0.01  |                     |     | 1.1     | 14.2  | 84.7  |       |    |

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



| COBBLES | GRAVEL |      | SAND   |        |      | SILT OR CLAY |
|---------|--------|------|--------|--------|------|--------------|
|         | coarse | fine | coarse | medium | fine |              |

| BOREHOLE | DEPTH | AASHTO Classification |       | USCS Classification |     | LL      | PL    | PI    | Cc    | Cu |
|----------|-------|-----------------------|-------|---------------------|-----|---------|-------|-------|-------|----|
| ● 24     | 2.0   | A-7-6 (23)            |       | CL                  |     | 46      | 17    | 29    |       |    |
| ■ 25     | 2.0   | A-7-6 (19)            |       | CL                  |     | 43      | 21    | 22    |       |    |
| ▲ 26     | 2.0   | A-6 (7)               |       | CL                  |     | 36      | 21    | 15    |       |    |
| ★ 27     | 2.0   | A-6 (13)              |       | CL                  |     | 38      | 21    | 17    |       |    |
| ⊙ 28     | 2.0   | A-6 (10)              |       | CL                  |     | 36      | 17    | 19    |       |    |
| BOREHOLE | DEPTH | D100                  | D50   | D30                 | D15 | %Gravel | %Sand | %Silt | %Clay |    |
| ● 24     | 2.0   | 9.5                   | 0.011 |                     |     | 0.2     | 19.1  | 80.7  |       |    |
| ■ 25     | 2.0   | 9.5                   | 0.006 |                     |     | 0.6     | 15.4  | 84.1  |       |    |
| ▲ 26     | 2.0   | 9.5                   | 0.037 | 0.008               |     | 0.7     | 40.2  | 59.0  |       |    |
| ★ 27     | 2.0   | 9.5                   | 0.013 |                     |     | 0.8     | 20.8  | 78.4  |       |    |
| ⊙ 28     | 2.0   | 9.5                   | 0.022 |                     |     | 1.1     | 34.4  | 64.6  |       |    |



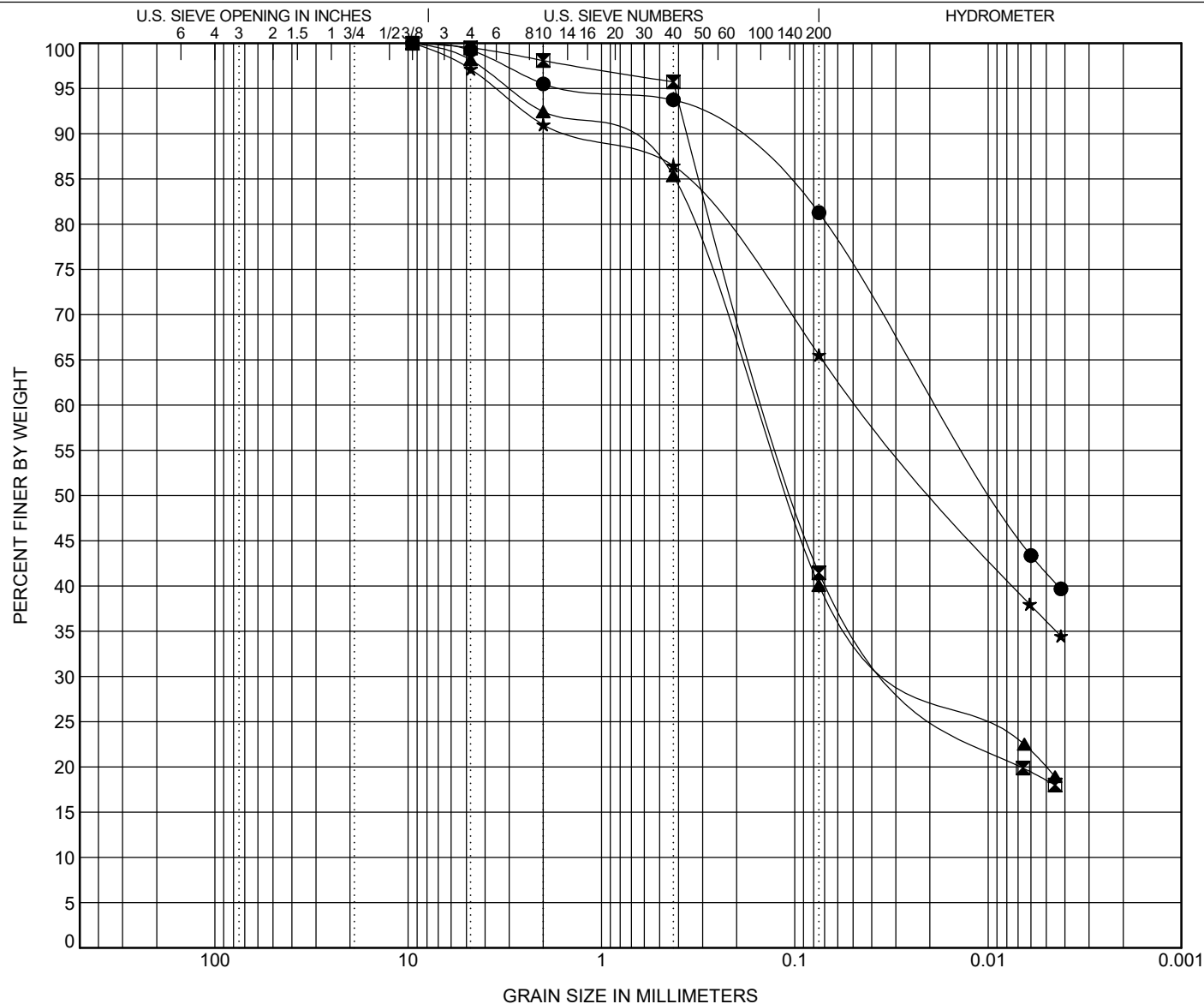
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION  
300 AIRPORT ROAD  
BISMARCK, ND 58504

# GRAIN SIZE DISTRIBUTION

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324



| COBBLES | GRAVEL |      | SAND   |        |      | SILT OR CLAY |
|---------|--------|------|--------|--------|------|--------------|
|         | coarse | fine | coarse | medium | fine |              |

| BOREHOLE | DEPTH | AASHTO Classification |       | USCS Classification |     | LL      | PL    | PI    | Cc    | Cu |
|----------|-------|-----------------------|-------|---------------------|-----|---------|-------|-------|-------|----|
| ● 29     | 2.0   | A-7-6 (23)            |       | CH                  |     | 50      | 22    | 28    |       |    |
| ■ 30     | 2.0   | A-4 (0)               |       | SC-SM               |     | 26      | 19    | 7     |       |    |
| ▲ 31     | 2.0   | A-6 (2)               |       | SC                  |     | 31      | 16    | 15    |       |    |
| ★ 32     | 2.0   | A-7-6 (13)            |       | CL                  |     | 43      | 20    | 23    |       |    |
| BOREHOLE | DEPTH | D100                  | D50   | D30                 | D15 | %Gravel | %Sand | %Silt | %Clay |    |
| ● 29     | 2.0   | 9.5                   | 0.009 |                     |     | 0.8     | 18.0  | 81.3  |       |    |
| ■ 30     | 2.0   | 9.5                   | 0.099 | 0.021               |     | 0.5     | 58.1  | 41.4  |       |    |
| ▲ 31     | 2.0   | 9.5                   | 0.11  | 0.018               |     | 1.8     | 58.1  | 40.1  |       |    |
| ★ 32     | 2.0   | 9.5                   | 0.018 |                     |     | 2.9     | 31.6  | 65.5  |       |    |

GRAIN SIZE D ADJUSTED - 20171219.GDT - 4/11/23 15:20 - F:\LAB\PROJECTS\GINT1-031(021)078.GPJ

**PROJECT NUMBER** SS-1-031(021)078

**LOCATION** Morton & Oliver County

**PCN** 23324

| 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 |
|----------|-------|--------------|---------------|------------------|-------------------|--------------|-----------------------|---------------------|-------------------|------------------------|-------------------|----------------|------------|
| 1        | 2.0   | 42           | 19            | 23               | 9.5               | 56           | A-7-6 (10)            | CL                  | 22.1              | 23.1                   |                   |                |            |
| 1        | 3.0   |              |               |                  |                   |              |                       |                     | 25.3              | 23.1                   |                   |                |            |
| 1        | 4.0   |              |               |                  |                   |              |                       |                     | 22.4              | 23.1                   |                   |                |            |
| 1        | 5.0   |              |               |                  |                   |              |                       |                     | 22.6              | 23.1                   |                   |                |            |
| 2        | 2.0   | 42           | 16            | 26               | 9.5               | 73           | A-7-6 (17)            | CL                  | 16.9              | 26.2                   |                   |                |            |
| 2        | 3.0   |              |               |                  |                   |              |                       |                     | 26.8              | 26.2                   |                   |                |            |
| 2        | 4.0   |              |               |                  |                   |              |                       |                     | 26.2              | 26.2                   |                   |                |            |
| 2        | 5.0   |              |               |                  |                   |              |                       |                     | 35.1              | 26.2                   |                   |                |            |
| 3        | 2.0   | 47           | 19            | 28               | 25                | 81           | A-7-6 (23)            | CL                  | 17.0              | 22.5                   |                   |                |            |
| 3        | 3.0   |              |               |                  |                   |              |                       |                     | 24.0              | 22.5                   |                   |                |            |
| 3        | 4.0   |              |               |                  |                   |              |                       |                     | 26.2              | 22.5                   |                   |                |            |
| 3        | 5.0   |              |               |                  |                   |              |                       |                     | 22.9              | 22.5                   |                   |                |            |
| 4        | 2.0   | 41           | 18            | 23               | 9.5               | 81           | A-7-6 (18)            | CL                  | 12.8              | 22.3                   |                   |                |            |
| 4        | 3.0   |              |               |                  |                   |              |                       |                     | 24.0              | 22.3                   |                   |                |            |
| 4        | 4.0   |              |               |                  |                   |              |                       |                     | 27.5              | 22.3                   |                   |                |            |
| 4        | 5.0   |              |               |                  |                   |              |                       |                     | 24.9              | 22.3                   |                   |                |            |
| 5        | 2.0   | 45           | 20            | 25               | 9.5               | 89           | A-7-6 (23)            | CL                  | 20.4              | 25.1                   |                   |                |            |
| 5        | 3.0   |              |               |                  |                   |              |                       |                     | 24.9              | 25.1                   |                   |                |            |
| 5        | 4.0   |              |               |                  |                   |              |                       |                     | 28.9              | 25.1                   |                   |                |            |
| 5        | 5.0   |              |               |                  |                   |              |                       |                     | 28.9              | 25.1                   |                   |                |            |
| 5        | 6.0   |              |               |                  |                   |              |                       |                     | 24.6              | 25.1                   |                   |                |            |
| 5        | 7.0   |              |               |                  |                   |              |                       |                     | 26.8              | 25.1                   |                   |                |            |
| 5        | 8.0   |              |               |                  |                   |              |                       |                     | 23.2              | 25.1                   |                   |                |            |
| 5        | 9.0   |              |               |                  |                   |              |                       |                     | 23.9              | 25.1                   |                   |                |            |
| 5        | 10.0  |              |               |                  |                   |              |                       |                     | 24.5              | 25.1                   |                   |                |            |
| 6        | 2.1   | 40           | 19            | 21               | 9.5               | 84           | A-6 (17)              | CL                  | 15.6              | 20.8                   |                   |                |            |
| 6        | 3.0   |              |               |                  |                   |              |                       |                     | 22.0              | 20.8                   |                   |                |            |
| 6        | 4.0   |              |               |                  |                   |              |                       |                     | 24.5              | 20.8                   |                   |                |            |
| 6        | 5.0   |              |               |                  |                   |              |                       |                     | 23.9              | 20.8                   |                   |                |            |
| 6        | 6.0   |              |               |                  |                   |              |                       |                     | 14.2              | 20.8                   |                   |                |            |
| 6        | 7.0   |              |               |                  |                   |              |                       |                     | 19.5              | 20.8                   |                   |                |            |
| 6        | 8.0   |              |               |                  |                   |              |                       |                     | 21.1              | 20.8                   |                   |                |            |
| 6        | 9.0   |              |               |                  |                   |              |                       |                     | 21.7              | 20.8                   |                   |                |            |
| 6        | 10.0  |              |               |                  |                   |              |                       |                     | 24.6              | 20.8                   |                   |                |            |
| 7        | 2.0   | 34           | 17            | 17               | 9.5               | 67           | A-6 (9)               | CL                  | 18.0              | 23.2                   |                   |                |            |
| 7        | 3.0   |              |               |                  |                   |              |                       |                     | 18.1              | 23.2                   |                   |                |            |
| 7        | 4.0   |              |               |                  |                   |              |                       |                     | 30.5              | 23.2                   |                   |                |            |
| 7        | 5.0   |              |               |                  |                   |              |                       |                     | 23.8              | 23.2                   |                   |                |            |
| 7        | 6.0   |              |               |                  |                   |              |                       |                     | 25.4              | 23.2                   |                   |                |            |
| 7        | 7.0   | 51           | 21            | 30               | 9.5               | 95           | A-7-6 (31)            | CH                  | 18.9              | 21.5                   |                   |                |            |
| 7        | 8.0   |              |               |                  |                   |              |                       |                     | 20.7              | 21.5                   |                   |                |            |
| 7        | 9.0   |              |               |                  |                   |              |                       |                     | 22.6              | 21.5                   |                   |                |            |
| 7        | 10.0  |              |               |                  |                   |              |                       |                     | 23.8              | 21.5                   |                   |                |            |

**PROJECT NUMBER** SS-1-031(021)078

**LOCATION** Morton & Oliver County

**PCN** 23324

| 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 |
|----------|-------|--------------|---------------|------------------|-------------------|--------------|-----------------------|---------------------|-------------------|------------------------|-------------------|----------------|------------|
| 8        | 2.0   | 32           | 16            | 16               | 9.5               | 57           | A-6 (6)               | CL                  | 19.9              | 21.9                   |                   |                |            |
| 8        | 3.0   |              |               |                  |                   |              |                       |                     | 19.8              | 21.9                   |                   |                |            |
| 8        | 4.0   |              |               |                  |                   |              |                       |                     | 16.4              | 21.9                   |                   |                |            |
| 8        | 5.0   |              |               |                  |                   |              |                       |                     | 21.4              | 21.9                   |                   |                |            |
| 8        | 6.0   |              |               |                  |                   |              |                       |                     | 11.9              | 21.9                   |                   |                |            |
| 8        | 7.0   |              |               |                  |                   |              |                       |                     | 24.2              | 21.9                   |                   |                |            |
| 8        | 8.0   |              |               |                  |                   |              |                       |                     | 34.8              | 21.9                   |                   |                |            |
| 8        | 9.0   |              |               |                  |                   |              |                       |                     | 24.7              | 21.9                   |                   |                |            |
| 8        | 10.0  |              |               |                  |                   |              |                       |                     | 24.4              | 21.9                   |                   |                |            |
| 9        | 2.0   | 38           | 18            | 20               | 25                | 70           | A-6 (12)              | CL                  | 16.2              | 22.5                   |                   |                |            |
| 9        | 3.0   |              |               |                  |                   |              |                       |                     | 23.8              | 22.5                   |                   |                |            |
| 9        | 4.0   |              |               |                  |                   |              |                       |                     | 23.9              | 22.5                   |                   |                |            |
| 9        | 5.0   |              |               |                  |                   |              |                       |                     | 17.4              | 22.5                   |                   |                |            |
| 9        | 6.0   |              |               |                  |                   |              |                       |                     | 17.4              | 22.5                   |                   |                |            |
| 9        | 7.0   |              |               |                  |                   |              |                       |                     | 20.3              | 22.5                   |                   |                |            |
| 9        | 8.0   |              |               |                  |                   |              |                       |                     | 27.3              | 22.5                   |                   |                |            |
| 9        | 9.0   |              |               |                  |                   |              |                       |                     | 32.9              | 22.5                   |                   |                |            |
| 9        | 10.0  |              |               |                  |                   |              |                       |                     | 22.9              | 22.5                   |                   |                |            |
| 10       | 2.0   | 30           | 17            | 13               | 9.5               | 58           | A-6 (5)               | CL                  | 13.4              | 19.0                   |                   |                |            |
| 10       | 3.0   |              |               |                  |                   |              |                       |                     | 16.2              | 19.0                   |                   |                |            |
| 10       | 4.0   |              |               |                  |                   |              |                       |                     | 17.1              | 19.0                   |                   |                |            |
| 10       | 5.0   |              |               |                  |                   |              |                       |                     | 16.1              | 19.0                   |                   |                |            |
| 10       | 6.0   |              |               |                  |                   |              |                       |                     | 18.0              | 19.0                   |                   |                |            |
| 10       | 7.0   |              |               |                  |                   |              |                       |                     | 16.0              | 19.0                   |                   |                |            |
| 10       | 8.0   |              |               |                  |                   |              |                       |                     | 22.1              | 19.0                   |                   |                |            |
| 10       | 9.0   |              |               |                  |                   |              |                       |                     | 23.2              | 19.0                   |                   |                |            |
| 10       | 10.0  |              |               |                  |                   |              |                       |                     | 28.4              | 19.0                   |                   |                |            |
| 11       | 2.0   | 29           | 19            | 10               | 9.5               | 60           | A-4 (4)               | CL                  | 12.9              | 21.3                   |                   |                |            |
| 11       | 3.0   |              |               |                  |                   |              |                       |                     | 15.5              | 21.3                   |                   |                |            |
| 11       | 4.0   |              |               |                  |                   |              |                       |                     | 27.3              | 21.3                   |                   |                |            |
| 11       | 5.0   |              |               |                  |                   |              |                       |                     | 25.4              | 21.3                   |                   |                |            |
| 11       | 6.0   |              |               |                  |                   |              |                       |                     | 16.7              | 21.3                   |                   |                |            |
| 11       | 7.0   |              |               |                  |                   |              |                       |                     | 19.8              | 21.3                   |                   |                |            |
| 11       | 8.0   |              |               |                  |                   |              |                       |                     | 22.3              | 21.3                   |                   |                |            |
| 11       | 9.0   |              |               |                  |                   |              |                       |                     | 24.1              | 21.3                   |                   |                |            |
| 11       | 10.0  |              |               |                  |                   |              |                       |                     | 27.4              | 21.3                   |                   |                |            |
| 12       | 2.1   | 29           | 17            | 12               | 25                | 53           | A-6 (3)               | CL                  | 7.7               | 18.4                   |                   |                |            |
| 12       | 3.0   |              |               |                  |                   |              |                       |                     | 21.1              | 18.4                   |                   |                |            |
| 12       | 4.0   |              |               |                  |                   |              |                       |                     | 19.3              | 18.4                   |                   |                |            |
| 12       | 5.0   |              |               |                  |                   |              |                       |                     | 18.6              | 18.4                   |                   |                |            |
| 12       | 6.0   |              |               |                  |                   |              |                       |                     | 13.8              | 18.4                   |                   |                |            |
| 12       | 7.0   |              |               |                  |                   |              |                       |                     | 20.3              | 18.4                   |                   |                |            |
| 12       | 8.0   |              |               |                  |                   |              |                       |                     | 22.3              | 18.4                   |                   |                |            |

# SUMMARY OF LABORATORY RESULTS

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324

| 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 |
|----------|-------|--------------|---------------|------------------|-------------------|--------------|-----------------------|---------------------|-------------------|------------------------|-------------------|----------------|------------|
| 12       | 9.0   |              |               |                  |                   |              |                       |                     | 21.9              | 18.4                   |                   |                |            |
| 12       | 10.0  |              |               |                  |                   |              |                       |                     | 20.4              | 18.4                   |                   |                |            |
| 13       | 2.1   | 35           | 19            | 16               | 9.5               | 68           | A-6 (9)               | CL                  | 4.0               | 20.2                   |                   |                |            |
| 13       | 3.0   |              |               |                  |                   |              |                       |                     | 18.9              | 20.2                   |                   |                |            |
| 13       | 4.0   |              |               |                  |                   |              |                       |                     | 15.6              | 20.2                   |                   |                |            |
| 13       | 5.0   |              |               |                  |                   |              |                       |                     | 17.0              | 20.2                   |                   |                |            |
| 13       | 6.0   |              |               |                  |                   |              |                       |                     | 15.5              | 20.2                   |                   |                |            |
| 13       | 7.0   |              |               |                  |                   |              |                       |                     | 17.2              | 20.2                   |                   |                |            |
| 13       | 8.0   |              |               |                  |                   |              |                       |                     | 27.7              | 20.2                   |                   |                |            |
| 13       | 9.0   |              |               |                  |                   |              |                       |                     | 31.8              | 20.2                   |                   |                |            |
| 13       | 10.0  |              |               |                  |                   |              |                       |                     | 33.8              | 20.2                   |                   |                |            |
| 14       | 2.0   | 36           | 15            | 21               | 25                | 66           | A-6 (11)              | CL                  | 9.8               | 18.3                   |                   |                |            |
| 14       | 3.0   |              |               |                  |                   |              |                       |                     | 21.9              | 18.3                   |                   |                |            |
| 14       | 4.0   |              |               |                  |                   |              |                       |                     | 22.4              | 18.3                   |                   |                |            |
| 14       | 5.0   |              |               |                  |                   |              |                       |                     | 20.2              | 18.3                   |                   |                |            |
| 14       | 6.0   |              |               |                  |                   |              |                       |                     | 17.5              | 18.3                   |                   |                |            |
| 14       | 7.0   | 31           | 22            | 9                | 9.5               | 79           | A-4 (6)               | CL                  | 15.7              | 13.0                   |                   |                |            |
| 14       | 8.0   |              |               |                  |                   |              |                       |                     | 11.5              | 13.0                   |                   |                |            |
| 14       | 9.0   |              |               |                  |                   |              |                       |                     | 10.8              | 13.0                   |                   |                |            |
| 14       | 10.0  |              |               |                  |                   |              |                       |                     | 14.1              | 13.0                   |                   |                |            |
| 15       | 2.0   | 47           | 19            | 28               | 9.5               | 81           | A-7-6 (23)            | CL                  | 11.1              | 26.2                   |                   |                |            |
| 15       | 3.0   |              |               |                  |                   |              |                       |                     | 28.2              | 26.2                   |                   |                |            |
| 15       | 4.0   |              |               |                  |                   |              |                       |                     | 32.4              | 26.2                   |                   |                |            |
| 15       | 5.0   |              |               |                  |                   |              |                       |                     | 28.8              | 26.2                   |                   |                |            |
| 15       | 6.0   |              |               |                  |                   |              |                       |                     | 24.8              | 26.2                   |                   |                |            |
| 15       | 7.0   |              |               |                  |                   |              |                       |                     | 23.4              | 26.2                   |                   |                |            |
| 15       | 8.0   |              |               |                  |                   |              |                       |                     | 30.5              | 26.2                   |                   |                |            |
| 15       | 9.0   |              |               |                  |                   |              |                       |                     | 28.6              | 26.2                   |                   |                |            |
| 15       | 10.0  |              |               |                  |                   |              |                       |                     | 27.7              | 26.2                   |                   |                |            |
| 16       | 2.0   | 50           | 19            | 31               | 9.5               | 87           | A-7-6 (28)            | CH                  | 8.7               | 22.5                   |                   |                |            |
| 16       | 3.0   |              |               |                  |                   |              |                       |                     | 23.3              | 22.5                   |                   |                |            |
| 16       | 4.0   |              |               |                  |                   |              |                       |                     | 26.2              | 22.5                   |                   |                |            |
| 16       | 5.0   |              |               |                  |                   |              |                       |                     | 24.0              | 22.5                   |                   |                |            |
| 16       | 6.0   |              |               |                  |                   |              |                       |                     | 21.8              | 22.5                   |                   |                |            |
| 16       | 7.0   |              |               |                  |                   |              |                       |                     | 29.5              | 22.5                   |                   |                |            |
| 16       | 8.0   |              |               |                  |                   |              |                       |                     | 22.9              | 22.5                   |                   |                |            |
| 16       | 9.0   |              |               |                  |                   |              |                       |                     | 22.6              | 22.5                   |                   |                |            |
| 16       | 10.0  |              |               |                  |                   |              |                       |                     | 23.6              | 22.5                   |                   |                |            |
| 17       | 2.0   | 50           | 19            | 31               | 9.5               | 87           | A-7-6 (28)            | CH                  | 9.2               | 20.8                   |                   |                |            |
| 17       | 3.0   |              |               |                  |                   |              |                       |                     | 22.9              | 20.8                   |                   |                |            |
| 17       | 4.0   |              |               |                  |                   |              |                       |                     | 22.8              | 20.8                   |                   |                |            |
| 17       | 5.0   |              |               |                  |                   |              |                       |                     | 23.0              | 20.8                   |                   |                |            |
| 17       | 6.0   |              |               |                  |                   |              |                       |                     | 19.7              | 20.8                   |                   |                |            |

**PROJECT NUMBER** SS-1-031(021)078

**LOCATION** Morton & Oliver County

**PCN** 23324

| 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 |
|----------|-------|--------------|---------------|------------------|-------------------|--------------|-----------------------|---------------------|-------------------|------------------------|-------------------|----------------|------------|
| 17       | 7.0   |              |               |                  |                   |              |                       |                     | 25.2              | 20.8                   |                   |                |            |
| 17       | 8.0   |              |               |                  |                   |              |                       |                     | 20.8              | 20.8                   |                   |                |            |
| 17       | 9.0   |              |               |                  |                   |              |                       |                     | 24.6              | 20.8                   |                   |                |            |
| 17       | 10.0  |              |               |                  |                   |              |                       |                     | 18.8              | 20.8                   |                   |                |            |
| 18       | 2.0   | 46           | 19            | 27               | 25                | 72           | A-7-6 (18)            | CL                  | 18.9              | 18.7                   |                   |                |            |
| 18       | 3.0   |              |               |                  |                   |              |                       |                     | 14.0              | 18.7                   |                   |                |            |
| 18       | 4.0   |              |               |                  |                   |              |                       |                     | 23.1              | 18.7                   |                   |                |            |
| 18       | 5.0   |              |               |                  |                   |              |                       |                     | 18.6              | 18.7                   |                   |                |            |
| 19       | 2.0   | 39           | 17            | 22               | 9.5               | 69           | A-6 (13)              | CL                  | 19.8              | 19.2                   |                   |                |            |
| 19       | 3.0   |              |               |                  |                   |              |                       |                     | 14.1              | 19.2                   |                   |                |            |
| 19       | 4.0   |              |               |                  |                   |              |                       |                     | 20.0              | 19.2                   |                   |                |            |
| 19       | 5.0   |              |               |                  |                   |              |                       |                     | 17.0              | 19.2                   |                   |                |            |
| 19       | 6.0   |              |               |                  |                   |              |                       |                     | 13.6              | 19.2                   |                   |                |            |
| 19       | 7.0   | 26           | 17            | 9                | 9.5               | 56           | A-4 (2)               | CL                  | 18.3              | 24.0                   |                   |                |            |
| 19       | 8.0   |              |               |                  |                   |              |                       |                     | 29.7              | 24.0                   |                   |                |            |
| 19       | 9.0   | 39           | 17            | 22               | 9.5               | 69           | A-6 (13)              | CL                  | 23.1              | 19.2                   |                   |                |            |
| 19       | 10.0  |              |               |                  |                   |              |                       |                     | 26.8              | 19.2                   |                   |                |            |
| 20       | 2.0   | 41           | 17            | 24               | 9.5               | 79           | A-7-6 (18)            | CL                  | 14.6              | 21.9                   |                   |                |            |
| 20       | 3.0   |              |               |                  |                   |              |                       |                     | 20.2              | 21.9                   |                   |                |            |
| 20       | 4.0   |              |               |                  |                   |              |                       |                     | 25.1              | 21.9                   |                   |                |            |
| 20       | 5.0   |              |               |                  |                   |              |                       |                     | 24.0              | 21.9                   |                   |                |            |
| 20       | 6.0   |              |               |                  |                   |              |                       |                     | 22.2              | 21.9                   |                   |                |            |
| 20       | 7.0   | 26           | 16            | 10               | 9.5               | 54           | A-4 (2)               | CL                  | 11.7              | 11.7                   |                   |                |            |
| 20       | 8.0   | 41           | 17            | 24               | 9.5               | 79           | A-7-6 (18)            | CL                  | 18.0              | 21.9                   |                   |                |            |
| 20       | 9.0   |              |               |                  |                   |              |                       |                     | 21.9              | 21.9                   |                   |                |            |
| 20       | 10.0  |              |               |                  |                   |              |                       |                     | 29.4              | 21.9                   |                   |                |            |
| 21       | 2.0   | 42           | 16            | 26               | 9.5               | 77           | A-7-6 (19)            | CL                  | 18.6              | 23.1                   |                   |                |            |
| 21       | 3.0   |              |               |                  |                   |              |                       |                     | 16.6              | 23.1                   |                   |                |            |
| 21       | 4.0   |              |               |                  |                   |              |                       |                     | 23.8              | 23.1                   |                   |                |            |
| 21       | 5.0   |              |               |                  |                   |              |                       |                     | 29.3              | 23.1                   |                   |                |            |
| 21       | 6.0   |              |               |                  |                   |              |                       |                     | 27.2              | 23.1                   |                   |                |            |
| 21       | 7.0   | 31           | 16            | 15               | 9.5               | 63           | A-6 (7)               | CL                  | 11.8              | 16.8                   |                   |                |            |
| 21       | 8.0   |              |               |                  |                   |              |                       |                     | 18.1              | 16.8                   |                   |                |            |
| 21       | 9.0   |              |               |                  |                   |              |                       |                     | 20.3              | 16.8                   |                   |                |            |
| 21       | 10.0  |              |               |                  |                   |              |                       |                     | 17.2              | 16.8                   |                   |                |            |
| 22       | 2.0   | 41           | 18            | 23               | 9.5               | 79           | A-7-6 (17)            | CL                  | 20.9              | 19.7                   |                   |                |            |
| 22       | 3.0   |              |               |                  |                   |              |                       |                     | 21.1              | 19.7                   |                   |                |            |
| 22       | 4.0   |              |               |                  |                   |              |                       |                     | 18.1              | 19.7                   |                   |                |            |
| 22       | 5.0   |              |               |                  |                   |              |                       |                     | 18.9              | 19.7                   |                   |                |            |
| 23       | 2.0   | 48           | 19            | 29               | 9.5               | 85           | A-7-6 (25)            | CL                  | 24.9              | 29.5                   |                   |                |            |
| 23       | 3.0   |              |               |                  |                   |              |                       |                     | 37.3              | 29.5                   |                   |                |            |
| 23       | 4.0   |              |               |                  |                   |              |                       |                     | 27.2              | 29.5                   |                   |                |            |
| 23       | 5.0   |              |               |                  |                   |              |                       |                     | 28.7              | 29.5                   |                   |                |            |

**PROJECT NUMBER** SS-1-031(021)078

**LOCATION** Morton & Oliver County

**PCN** 23324

| 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 |
|----------|-------|--------------|---------------|------------------|-------------------|--------------|-----------------------|---------------------|-------------------|------------------------|-------------------|----------------|------------|
| 24       | 2.0   | 46           | 17            | 29               | 9.5               | 81           | A-7-6 (23)            | CL                  | 25.8              | 24.7                   |                   |                |            |
| 24       | 3.0   |              |               |                  |                   |              |                       |                     | 26.1              | 24.7                   |                   |                |            |
| 24       | 4.0   |              |               |                  |                   |              |                       |                     | 23.3              | 24.7                   |                   |                |            |
| 24       | 5.0   |              |               |                  |                   |              |                       |                     | 23.5              | 24.7                   |                   |                |            |
| 25       | 2.0   | 43           | 21            | 22               | 9.5               | 84           | A-7-6 (19)            | CL                  | 23.0              | 27.1                   |                   |                |            |
| 25       | 3.0   |              |               |                  |                   |              |                       |                     | 28.5              | 27.1                   |                   |                |            |
| 25       | 4.0   |              |               |                  |                   |              |                       |                     | 29.4              | 27.1                   |                   |                |            |
| 25       | 5.0   |              |               |                  |                   |              |                       |                     | 27.9              | 27.1                   |                   |                |            |
| 25       | 6.0   |              |               |                  |                   |              |                       |                     | 30.1              | 27.1                   |                   |                |            |
| 25       | 7.0   |              |               |                  |                   |              |                       |                     | 25.5              | 27.1                   |                   |                |            |
| 25       | 8.0   |              |               |                  |                   |              |                       |                     | 27.5              | 27.1                   |                   |                |            |
| 25       | 9.0   |              |               |                  |                   |              |                       |                     | 26.0              | 27.1                   |                   |                |            |
| 25       | 10.0  |              |               |                  |                   |              |                       |                     | 25.7              | 27.1                   |                   |                |            |
| 26       | 2.0   | 36           | 21            | 15               | 9.5               | 59           | A-6 (7)               | CL                  | 11.5              | 24.6                   |                   |                |            |
| 26       | 3.0   |              |               |                  |                   |              |                       |                     | 25.0              | 24.6                   |                   |                |            |
| 26       | 4.0   |              |               |                  |                   |              |                       |                     | 27.0              | 24.6                   |                   |                |            |
| 26       | 5.0   |              |               |                  |                   |              |                       |                     | 27.7              | 24.6                   |                   |                |            |
| 26       | 6.0   |              |               |                  |                   |              |                       |                     | 21.2              | 24.6                   |                   |                |            |
| 26       | 7.0   |              |               |                  |                   |              |                       |                     | 27.5              | 24.6                   |                   |                |            |
| 26       | 8.0   |              |               |                  |                   |              |                       |                     | 26.7              | 24.6                   |                   |                |            |
| 26       | 9.0   |              |               |                  |                   |              |                       |                     | 30.1              | 24.6                   |                   |                |            |
| 26       | 10.0  |              |               |                  |                   |              |                       |                     | 24.8              | 24.6                   |                   |                |            |
| 27       | 2.0   | 38           | 21            | 17               | 9.5               | 78           | A-6 (13)              | CL                  | 24.1              | 26.0                   |                   |                |            |
| 27       | 3.0   |              |               |                  |                   |              |                       |                     | 23.1              | 26.0                   |                   |                |            |
| 27       | 4.0   |              |               |                  |                   |              |                       |                     | 23.7              | 26.0                   |                   |                |            |
| 27       | 5.0   |              |               |                  |                   |              |                       |                     | 22.3              | 26.0                   |                   |                |            |
| 27       | 6.0   |              |               |                  |                   |              |                       |                     | 22.8              | 26.0                   |                   |                |            |
| 27       | 7.0   |              |               |                  |                   |              |                       |                     | 31.3              | 26.0                   |                   |                |            |
| 27       | 8.0   |              |               |                  |                   |              |                       |                     | 33.7              | 26.0                   |                   |                |            |
| 27       | 9.0   |              |               |                  |                   |              |                       |                     | 27.0              | 26.0                   |                   |                |            |
| 27       | 10.0  |              |               |                  |                   |              |                       |                     | 26.1              | 26.0                   |                   |                |            |
| 28       | 2.0   | 36           | 17            | 19               | 9.5               | 65           | A-6 (10)              | CL                  | 15.5              | 16.3                   |                   |                |            |
| 28       | 3.0   |              |               |                  |                   |              |                       |                     | 18.1              | 16.3                   |                   |                |            |
| 28       | 4.0   |              |               |                  |                   |              |                       |                     | 15.5              | 16.3                   |                   |                |            |
| 28       | 5.0   |              |               |                  |                   |              |                       |                     | 16.3              | 16.3                   |                   |                |            |
| 29       | 2.0   | 50           | 22            | 28               | 9.5               | 81           | A-7-6 (23)            | CH                  | 26.8              | 29.3                   |                   |                |            |
| 29       | 3.0   |              |               |                  |                   |              |                       |                     | 27.3              | 29.3                   |                   |                |            |
| 29       | 4.0   |              |               |                  |                   |              |                       |                     | 37.6              | 29.3                   |                   |                |            |
| 29       | 5.0   |              |               |                  |                   |              |                       |                     | 25.7              | 29.3                   |                   |                |            |
| 30       | 2.0   | 26           | 19            | 7                | 9.5               | 41           | A-4 (0)               | SC-SM               | 11.2              | 12.6                   |                   |                |            |
| 30       | 3.0   |              |               |                  |                   |              |                       |                     | 12.8              | 12.6                   |                   |                |            |
| 30       | 4.0   |              |               |                  |                   |              |                       |                     | 12.0              | 12.6                   |                   |                |            |
| 30       | 5.0   |              |               |                  |                   |              |                       |                     | 14.5              | 12.6                   |                   |                |            |



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

## SUMMARY OF LABORATORY RESULTS

PAGE 6 OF 6

PROJECT NUMBER SS-1-031(021)078

LOCATION Morton & Oliver County

PCN 23324

| 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 |
|----------|-------|--------------|---------------|------------------|-------------------|--------------|-----------------------|---------------------|-------------------|------------------------|-------------------|----------------|------------|
| 31       | 2.0   | 31           | 16            | 15               | 9.5               | 40           | A-6 (2)               | SC                  | 12.1              | 15.5                   |                   |                |            |
| 31       | 3.0   |              |               |                  |                   |              |                       |                     | 14.9              | 15.5                   |                   |                |            |
| 31       | 4.0   |              |               |                  |                   |              |                       |                     | 12.4              | 15.5                   |                   |                |            |
| 31       | 5.0   |              |               |                  |                   |              |                       |                     | 22.5              | 15.5                   |                   |                |            |
| 32       | 2.0   | 43           | 20            | 23               | 9.5               | 66           | A-7-6 (13)            | CL                  | 23.3              | 24.7                   |                   |                |            |
| 32       | 3.0   |              |               |                  |                   |              |                       |                     | 31.2              | 24.7                   |                   |                |            |
| 32       | 4.0   |              |               |                  |                   |              |                       |                     | 21.4              | 24.7                   |                   |                |            |
| 32       | 5.0   |              |               |                  |                   |              |                       |                     | 22.8              | 24.7                   |                   |                |            |