Minnesota Department of Transportation
Office of Materials & Road Research
1400 Gervais Avenue, Maplewood, MN 55109

Memo

Date: June 10, 2021

To: Nicholas Olson, Project Manager
District Metro

From: Chelsey A. Brummer, Graduate Engineer
Geotechnical Section

Concur: Rich Lamb, Foundations Engineer RAL
Geotechnical Section

Subject: S.P. 0215-76, TH 10 Overhead Signs
TH 10 Overhead Signs OH US10-128 – OH US10-133
TH 10 Sta. 119+00 to 182+50, TH 47/US 169 Sta. 55+22 and Sta 60+29
Foundations Analysis and Design Recommendations

1.0 Project Description

This letter provides a foundation analysis and set of design recommendations for replacing the in-place overhead signs on Trunk Highway 10 in Anoka, MN.

2.0 Field Investigation and Foundation Conditions

Seven Cone Penetration Test (CPT Soundings) were advanced in March of 2021 and one CPT sounding was advanced in June of 2021 at the overhead sign locations by MnDOT staff. A copy of the CPT Sounding results is attached to this report.

The soils encountered at the overhead sign locations generally consists of dense to very dense sandy soils with very hard clay seams. There are four exceptions general soil conditions. CPT sounding c103 has a very hard clay and silt layer from approximately 32 to 38 feet. CPT Sounding c104a has a very hard clay and silt layer from approximately 17 feet to 30 feet. CPT sounding c105 has a very hard clay and silt layer from approximately 37 feet to the bottom of the hole at 49 feet. Finally, CPT sounding c111 has a layer of hard silt and clay from 29 to 38 feet. The CPT Soundings (c100, c103, c104a, c105, c106, c108, and c110) were terminated at approximately 49 feet, with the exception of c106 which was terminated at approximately 33 feet.

3.0 Foundation Analysis

Based on review of preliminary plans, the proposed overhead signs will be replacing existing overhead signs of approximately the same dimensions and in approximately the same location. The exception to this is the sign located at Sta. 182+00 which will be new construction.

The foundation analysis consisted of verifying that the foundation soil properties met the minimum values as required by MnDOT standard plan 5-297.763. The standard assumes the foundations soils have a friction angle of 30°, a unit weight of 125pcf, a maximum coefficient of friction of 0.70 and groundwater elevation at or below the bottom of a spread footing or at least 1.5 ft below finished grade for drilled shafts.

Overhead sign located at Sta. 182+00 is an exception to the above analysis and will be a monotube overhead sign following standard plan 5-297.746. This standard plan assumes foundation soils have a minimum friction angle of 30°, a unit weight of 125pcf, a maximum coefficient of friction of 0.70 and will be supported on a drilled shaft. The water table shall be 1.5' below finished grade.

Based on review of the existing subsurface conditions and assuming that all signs will be supported with the drilled shaft foundation option at the proposed overhead sign footing locations, it has been determined that the soils meet the minimum requirements and that the standard foundations shown in 5-297.763 and 5-297.746 may be used to support the sign structure.

3.1 Settlement

The estimated settlement of the new overhead signs was based on the following assumptions:

A. The roadway profile will not be raised

We estimate the new overhead signs may settle between ½ inch and 1 inch over the life of the sign. Differential settlements are expected to be less than ½ inch.

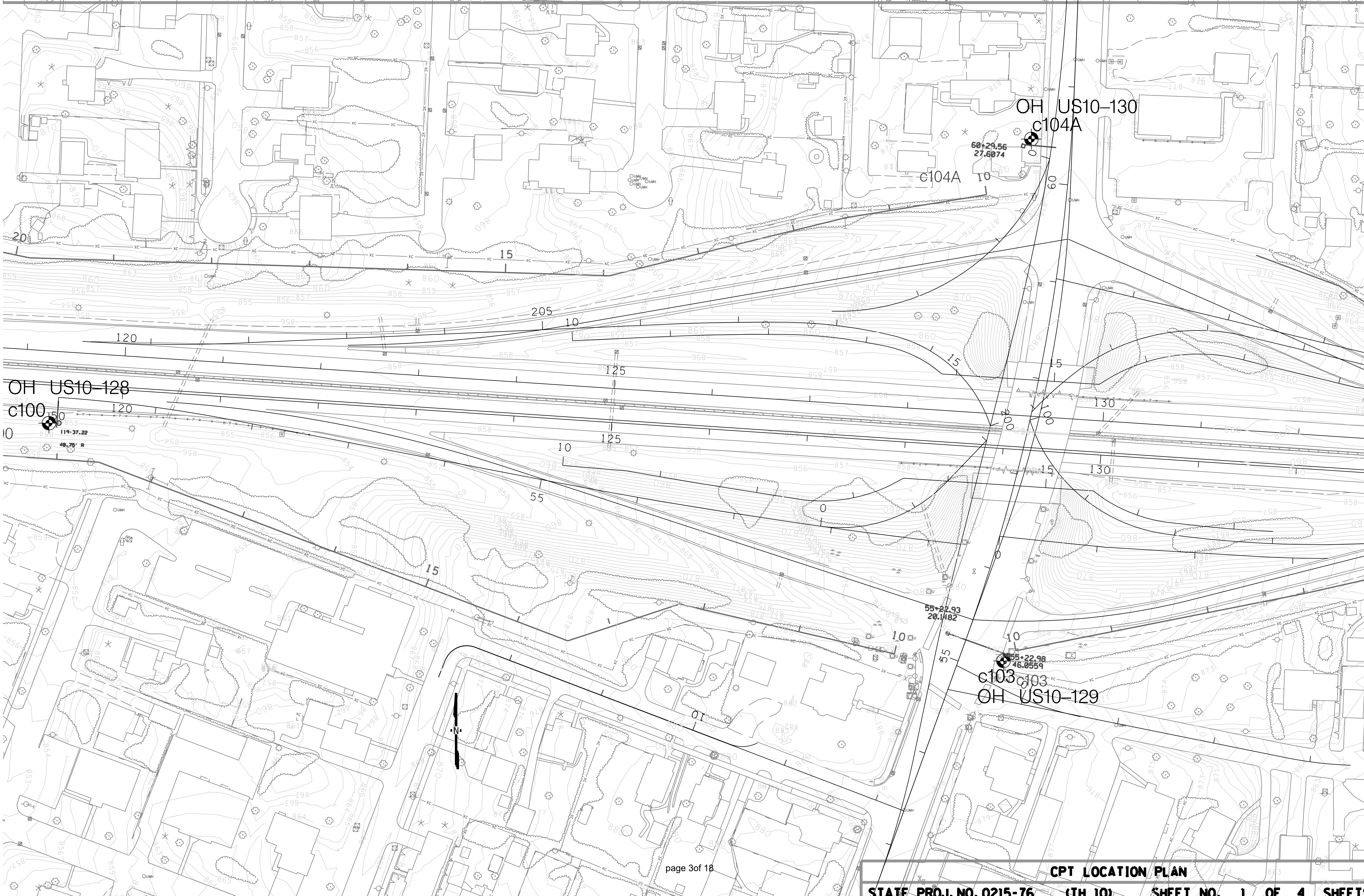
4.0 Foundation Recommendations

Based on the existing conditions along with an analysis of the project soils, we recommend that:

1. The overhead signs be constructed in accordance with MnDOT standard plan 5-297.763 and 5-297.746.
2. This office be contacted for revised foundation recommendations if the foundation soils or groundwater elevations differ from those described in this report.

Attachments: CPT Location Plan
CPT Index
CPT Sounding Logs

cc: Dave VanDeusen (Metro District Materials Engineer)
Brad Skow (Geotechnical Section Manager)
Joseph Bruer (Metro Signing)



CPT LOCATION PLAN

STATE PROJ. NO. 0215-76 (TH 10) SHEET NO. 1 OF 4 SHEETS

141+32.51
45.2719
c106
c106
OH US10-132
OH US10-131
c105
139+69.74
46.750
c105
OH US10-133
149+94.43
46.750
c108
TH 10 / TH 47
4TH AVE.
55'
50'
150
145
140
N

CPT LOCATION PLAN

STATE PROJ. NO. 0215-76 (TH 10) SHEET NO. 2 OF 4 SHEETS

OH US10–130
c111

7TH AVE.

TH 10 / TH 47

TH 10 / TH 47

NC–62

NC–64

NC–66

NC–67

PI , 22+94.10

CPT LOCATION PLAN

STATE PROJ. NO. 0215-76 (TH 10) SHEET NO. 3 OF 4 SHEETS

9th Ln

11th Ave NW

North St.

C110

TH WB

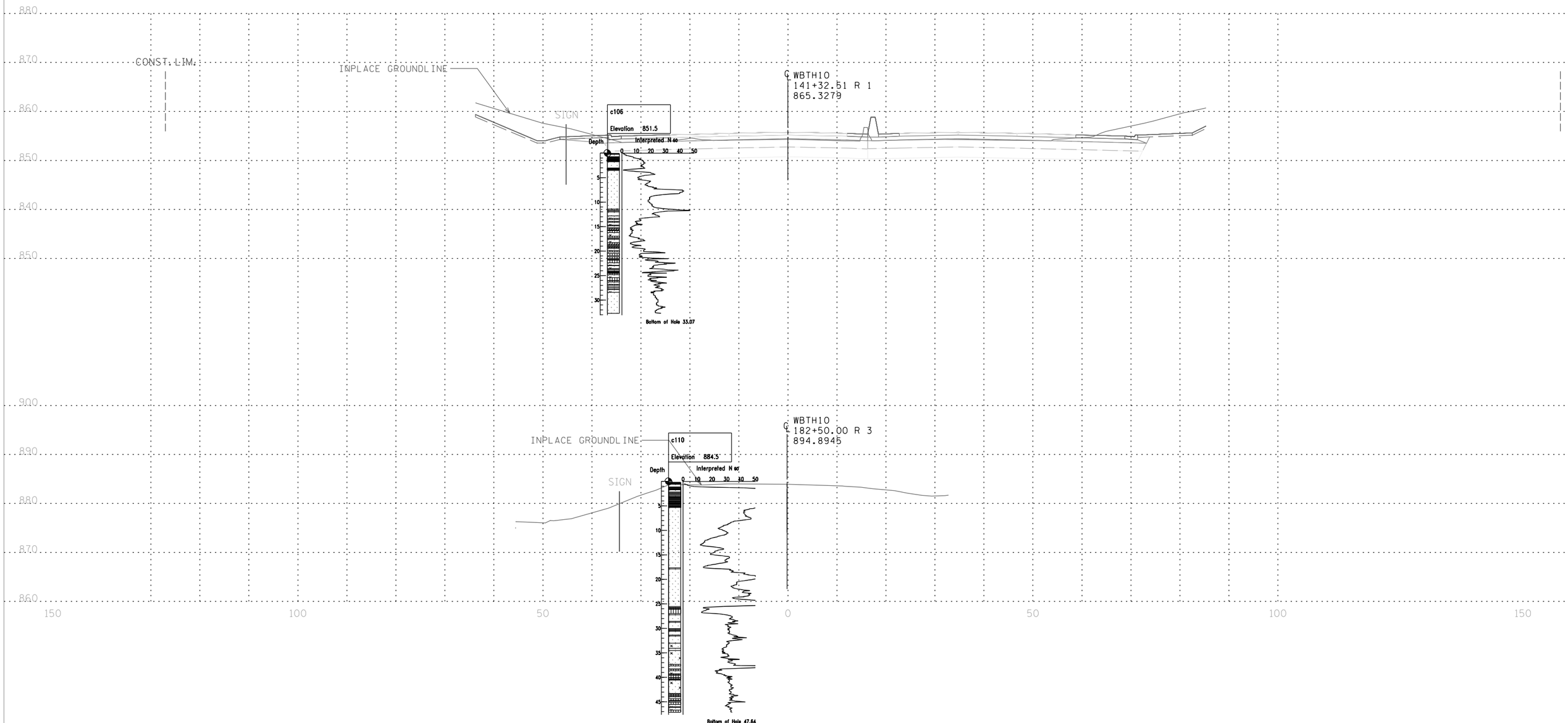
TH EB

N

CPT LOCATION PLAN

STATE PROJ. NO. 0215-76 (TH 10) SHEET NO. 4 OF 4 SHEETS

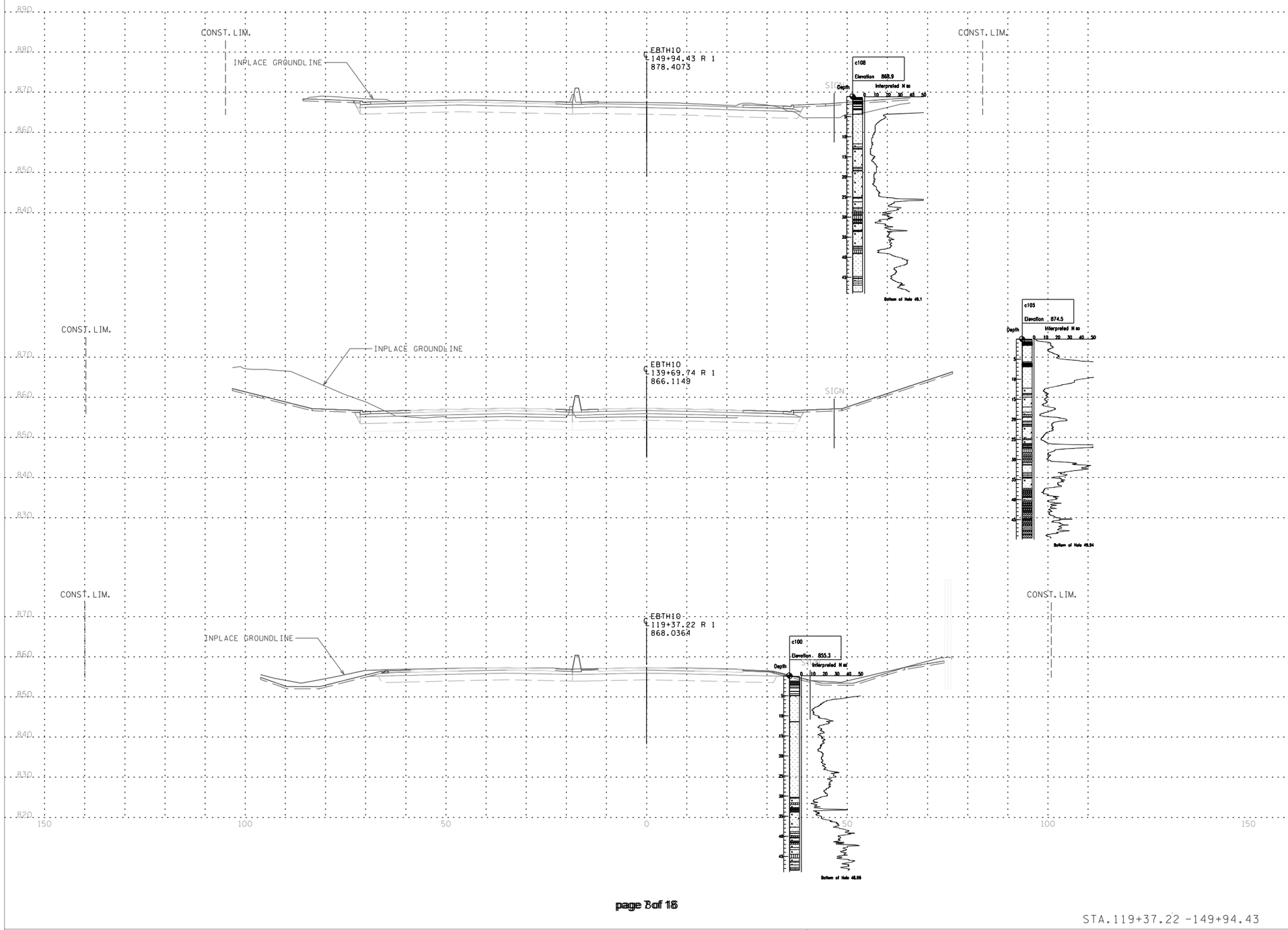
EXCAVATION CU.YD. EMBANKMENT CU.YD.



STA. 141+32.51 -182+53.09

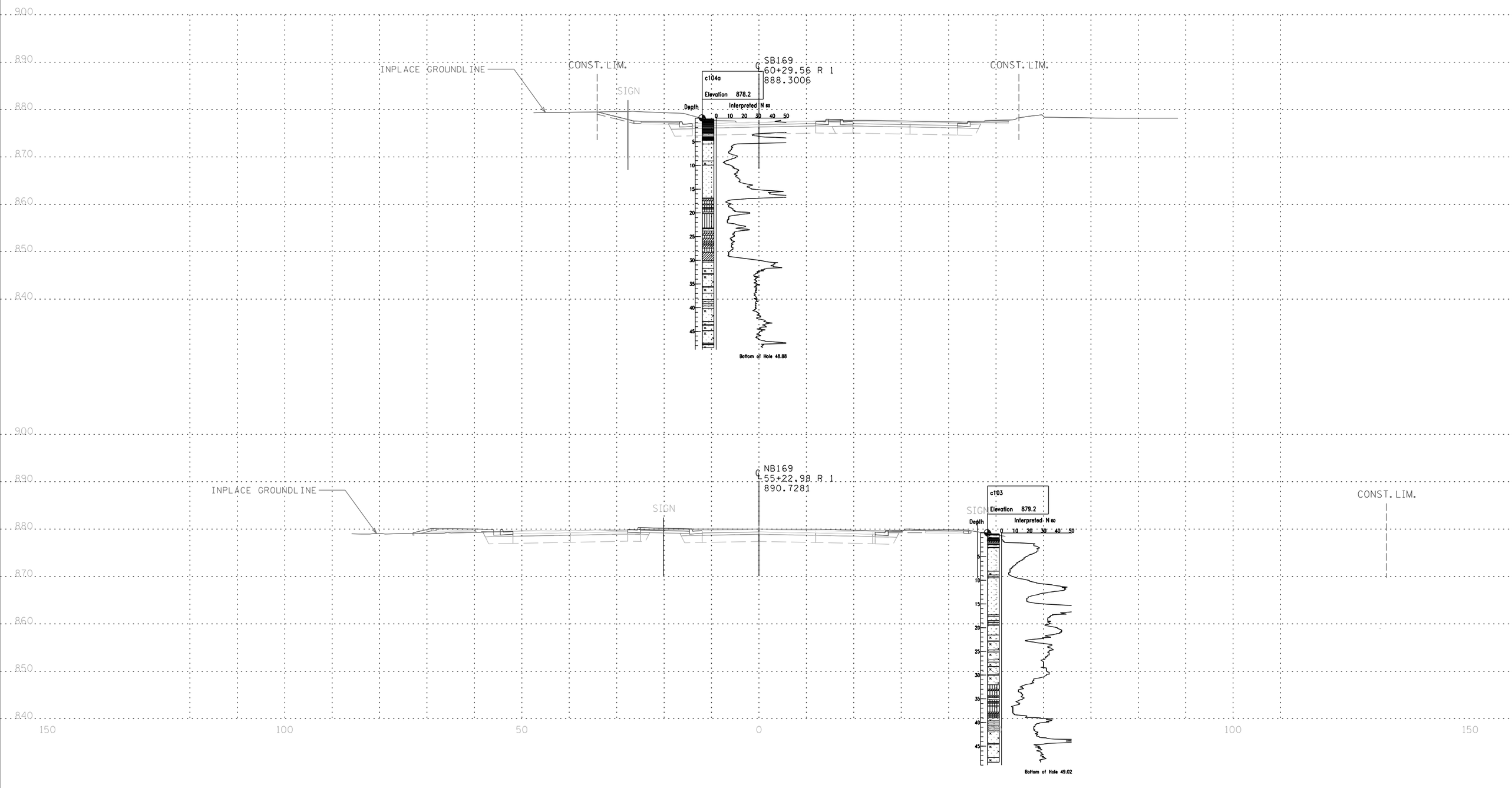
STATE PROJ. NO. 0215-76 (TH 10) SHEET NO. 1 OF 3 SHEETS

EXCAVATION CU.YD. | EMBANKMENT CU.YD.



STA.119+37.22 -149+94.43

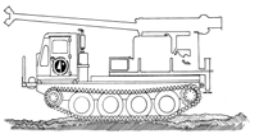
EXCAVATION CU.YD. EMBANKMENT CU.YD.



STA.60+29.56 -60+29.56
STA.55+22.98 -55+22.98

STATE PROJ. NO. 0215-76 (TH 10) SHEET NO. 3 OF 3 SHEETS

Minnesota Department of Transportation
Geotechnical Section
Cone Penetration Test Index Sheet 1.0 (CPT 1.0)



USER NOTES, ABBREVIATIONS AND DEFINITIONS

This Index sheet accompanies Cone Penetration Test Data. Please refer to the Boring Log Descriptive Terminology Sheet for information relevant to conventional boring logs.

This Cone Penetration Test (CPT) Sounding follows ASTM D 5778 and was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this sounding was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this sounding.

Since subsurface conditions outside each CPT Sounding are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this sounding will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water pressure measurements and subsequent interpreted water levels shown on this log should be used with discretion since they represent dynamic conditions. Dynamic Pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils. In cohesive soils, water pressures often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

CPT Terminology

CPT ..... Cone Penetration Test
CPTU..... Cone Penetration Test with Pore Pressure measurements
SCPTU..... Cone Penetration Test with Pore Pressure and Seismic measurements
Piezocone...Common name for CPTU test

(Note: This test is not related to the Dynamic Cone Penetrometer DCP)

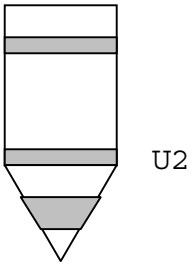
q_T TIP RESISTANCE
The resistance at the cone corrected for water pressure. Data is from cone with 60 degree apex angle and a 10 cm^2 end area.

f_s SLEEVE FRICTION RESISTANCE
The resistance along the sleeve of the penetrometer.

FR Friction Ratio
Ratio of sleeve friction over corrected tip resistance.
FR = fs/qt

V_s Shear Wave Velocity
A measure of the speed at which a siesmic wave travels through soil/rock.

PORE WATER MEASUREMENTS
Pore water measurements reported on CPT Log are representative of water pressures measured at the U2 location, just behind the cone tip, prior to the sleeve, as shown in the figure below. These measurements are considered to be dynamic water pressures due to the local disturbance caused by the cone tip. Dynamic water pressure decay and Static water pressure measurements are reported on a Pore Water Pressure Dissipation Graph.



SBT SOIL BEHAVIOR TYPE
Soil Classification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these classification charts are meant to provide a guide to Soil Behavior Type and should not be used to infer a soil classification based on grain size distribution.

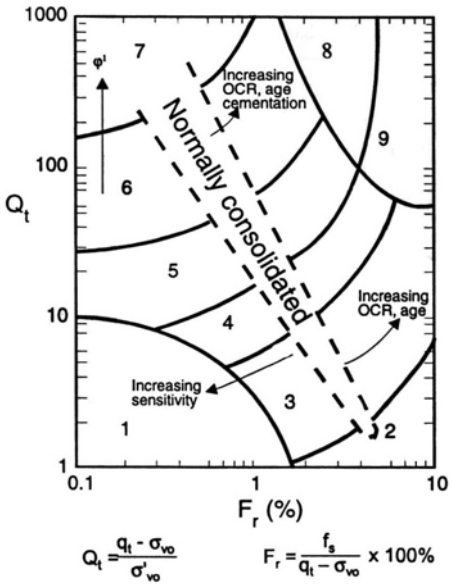
The numbers corresponding to different regions on the charts represent the following soil behavior types:

1. Sensitive, Fine Grained
2. Organic Soils - Peats
3. Clays - Clay to Silty Clay
4. Silt Mixtures - Clayey Silt to Silty Clay
5. Sand Mixtures - Silty Sand to Sandy Silt
6. Sands - Clean Sand to Silty Sand
7. Gravelly Sand to Sand
8. Very Stiff Sand to Clayey Sand
9. Very Stiff, Fine Grained

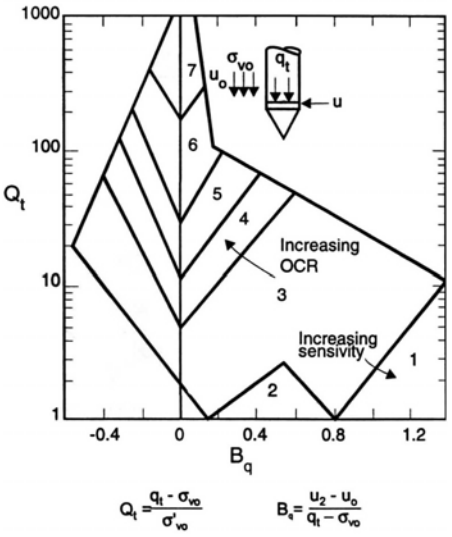
Note that engineering judgment, and comparison with conventional borings is especially important in the proper interpretation of CPT data in certain geo-materials.

The following charts are used to provide a Soil Behavior Type for the CPT Data.

Robertson CPT 1990
Soil Behavior type based on friction ratio



Robertson CPTU 1990
Soil Behavior type based on pore pressure



where ...
Q_T ..... normalized cone resistance
B_q ..... pore pressure ratio
F_r ..... Normalized friction ratio
σ_{vo} ..... overburden pressure
σ'_{vo} ..... effective over burden pressure
u_2 ..... measured pore pressure
u_0 ..... equilibrium pore pressure

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DEPARTMENT OF TRANSPORTATION

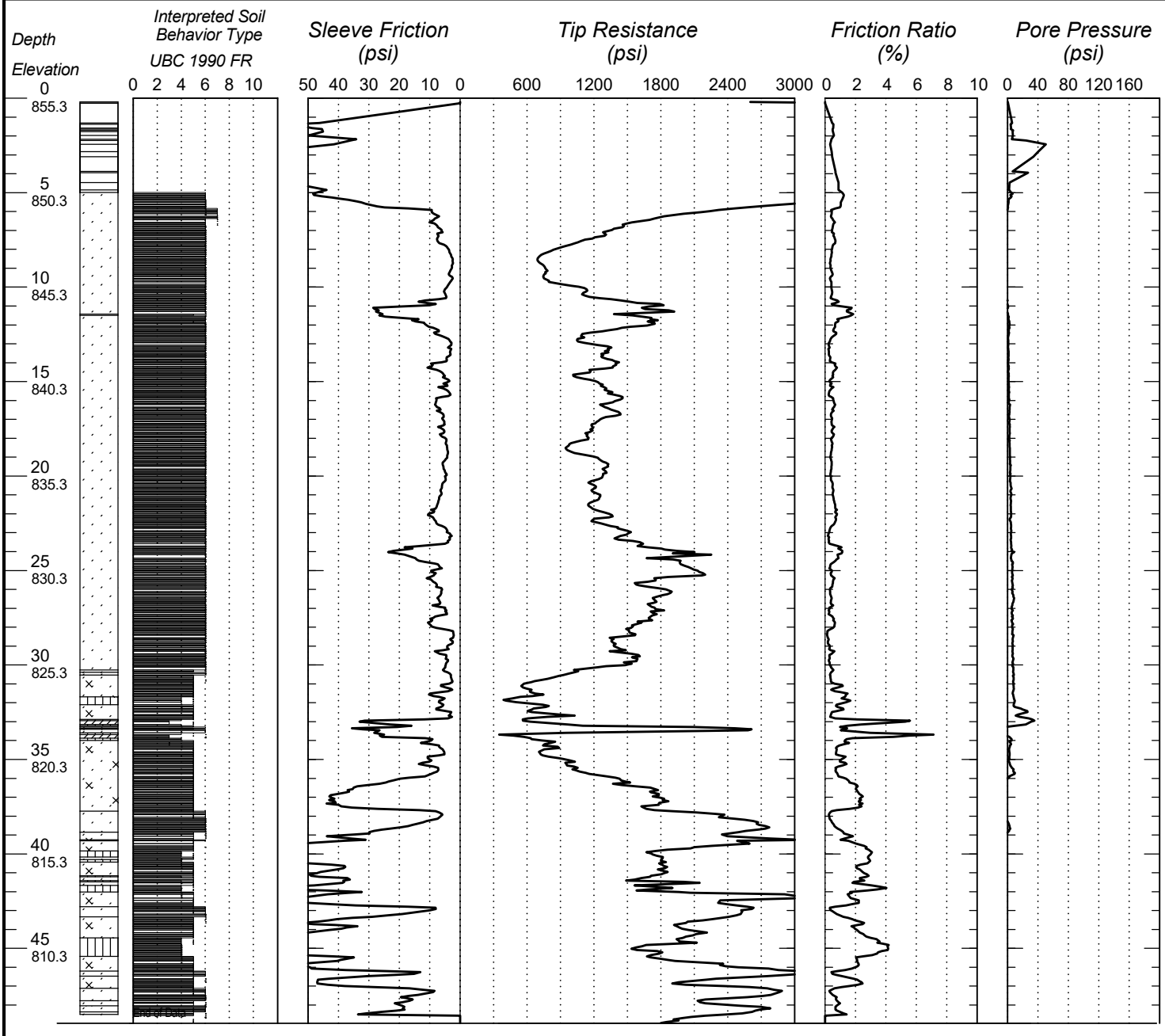
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85814

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**NOISE WALL**	**US Highway TH 10**	**c100**	**855.3** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**205146 CPT Truck (H)**	
X=467265 Y=161894	CPT Operator **ODonnel**	Date Completed
Latitude (North)=45°12'17.83" Longitude (West)=93°23'37.18"	Hole Type **CPT-STD**	**3/2/21**



Bottom of Hole 48.96

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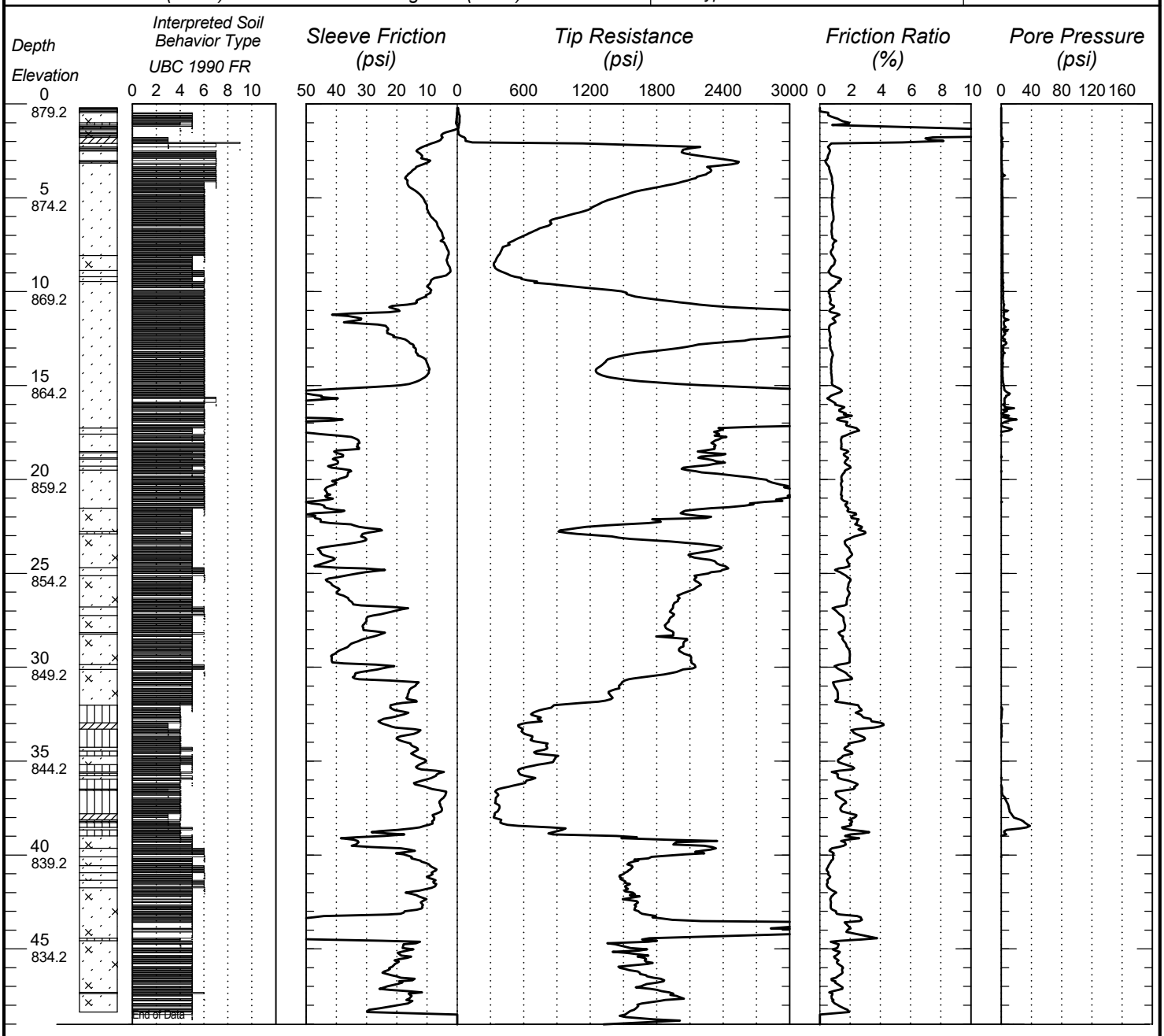
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85817

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**NOISE WALL**	**US Highway TH 10**	**c103**	**879.2** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**205146 CPT Truck (H)**	
X=468242 Y=161671	CPT Operator **ODonnel**	Date Completed
Latitude (North)=45°12'15.64" Longitude (West)=93°23'23.52"	Hole Type **CPT-STD**	**3/3/21**



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DEPARTMENT OF TRANSPORTATION

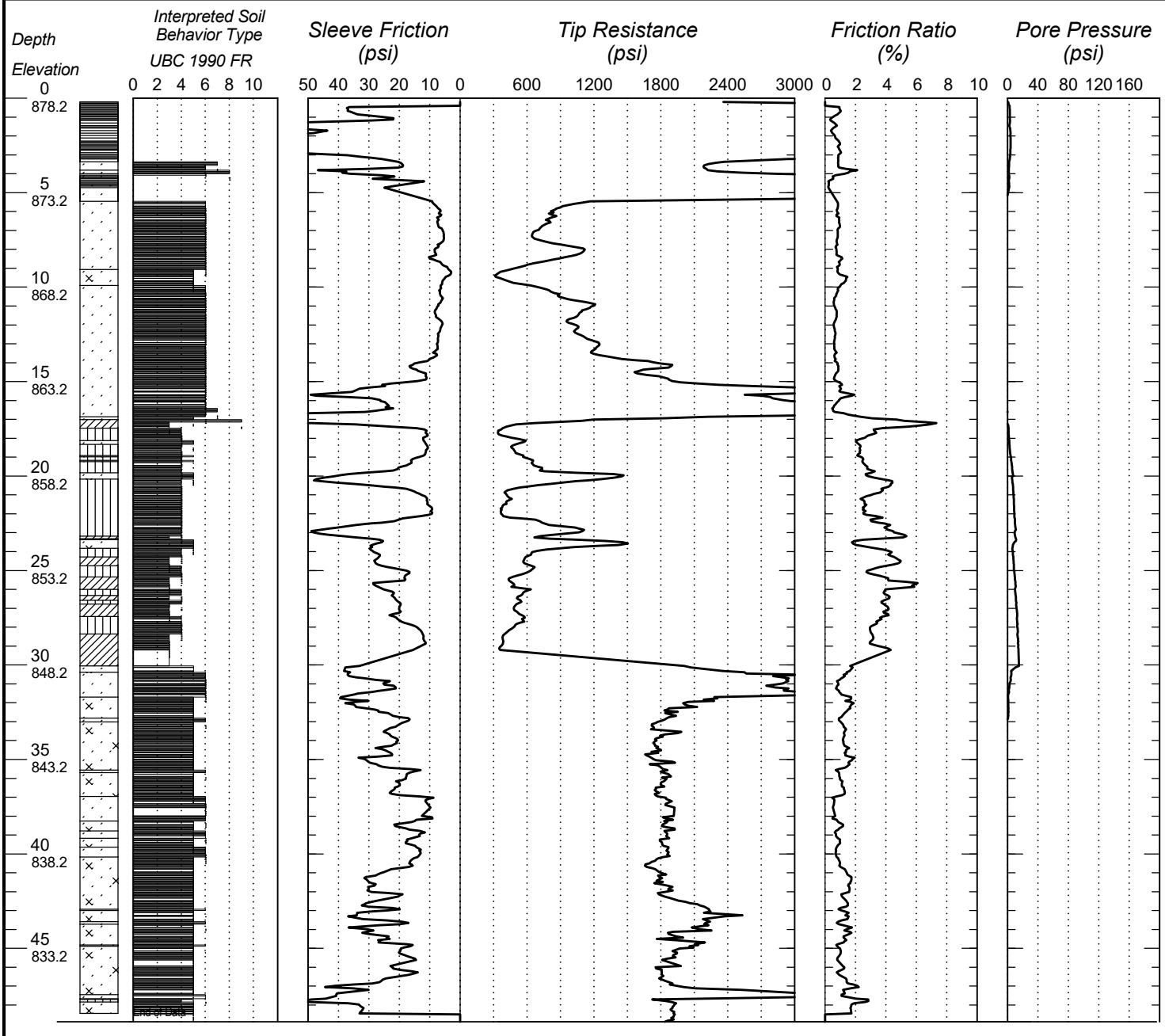
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85818

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**NOISE WALL**	**US Highway TH 10**	**c104a**	**878.2** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**205146 CPT Truck (H)**	
X=468233 Y=162142	CPT Operator **ODonnel**	Date Completed
Latitude (North)=45°12'20.29" Longitude (West)=93°23'23.66"	Hole Type **CPT-STD**	**3/2/21**



Bottom of Hole 48.88

DEPARTMENT OF TRANSPORTATION

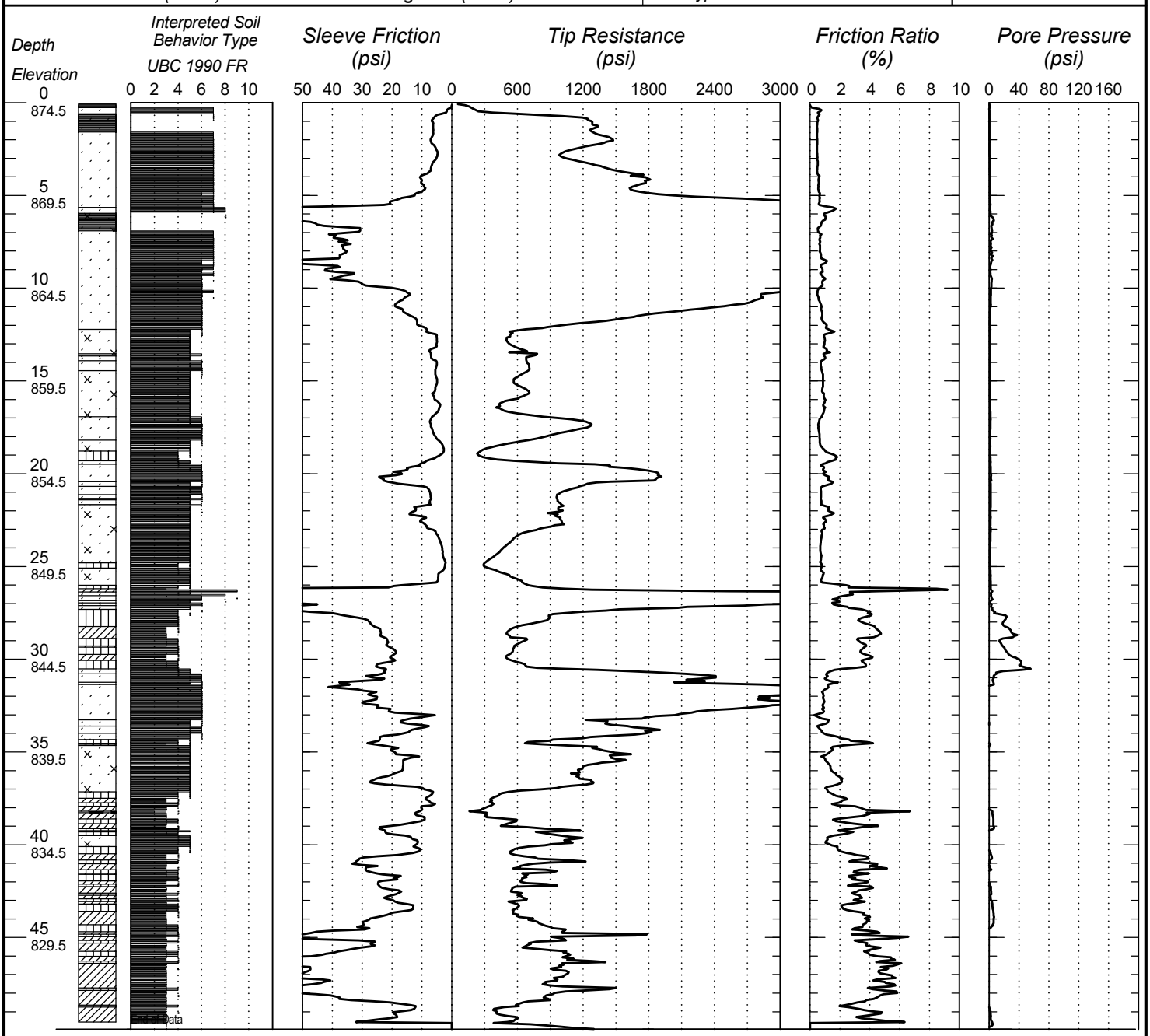
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85835

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**NOISE WALL**	**US Highway TH 10**	**c105**	**874.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**211328 CPT Marooka Track**	
X=469310 Y=161768	CPT Operator **Walcynski**	Date Completed
Latitude (North)=45°12'16.62" Longitude (West)=93°23'08.61"	Hole Type **CPT-STD**	**3/8/21**



Bottom of Hole 49.94

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DEPARTMENT OF TRANSPORTATION

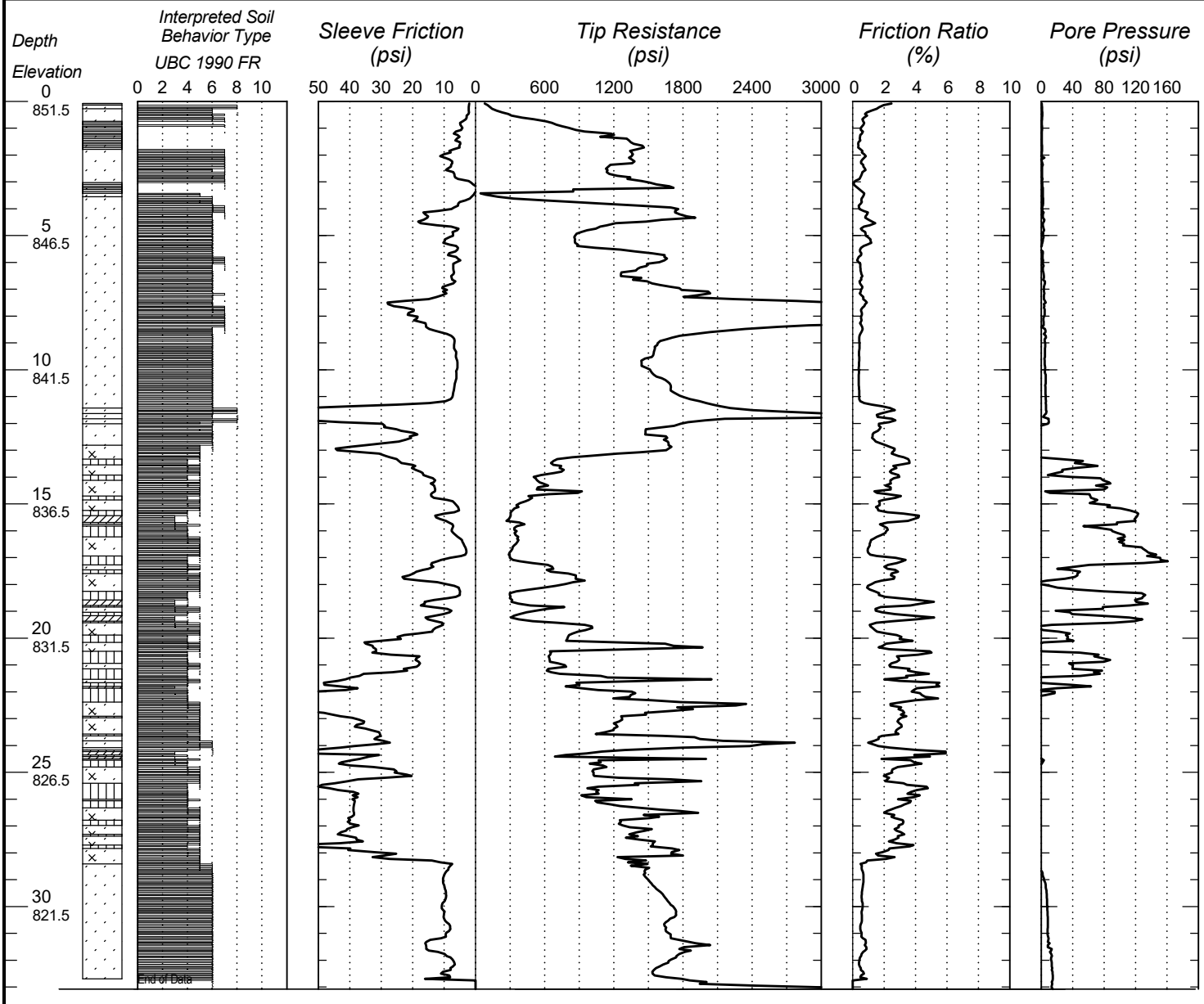
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85836

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**NOISE WALL**	**US Highway TH 10**	**c106**	**851.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**211328 CPT Marooka Track**	
X=469498 Y=161927	*CPT Operator* **Walcynski**	*Date Completed*
Latitude (North)=45°12'18.19" Longitude (West)=93°23'05.99"	*Hole Type* **CPT-STD**	**3/8/21**



Bottom of Hole 33.07

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DEPARTMENT OF TRANSPORTATION

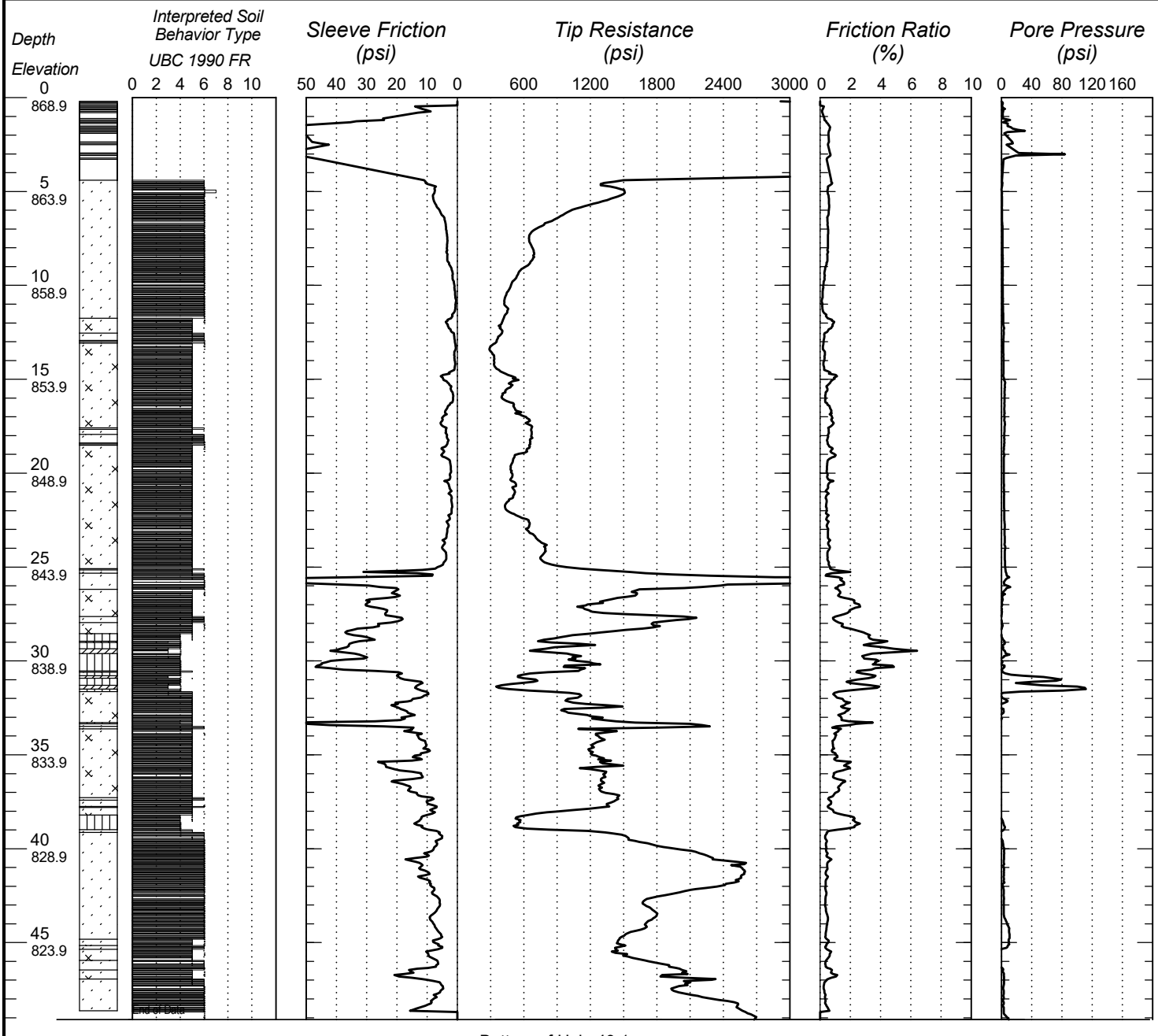
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85820

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**NOISE WALL**	**US Highway TH 10**	**c108**	**868.9** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**205146 CPT Truck (H)**	
X=470522 Y=161765	CPT Operator **ODonnel**	Date Completed
Latitude (North)=45°12'16.60" Longitude (West)=93°22'51.69"	Hole Type **CPT-STD**	**3/3/21**



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DEPARTMENT OF TRANSPORTATION

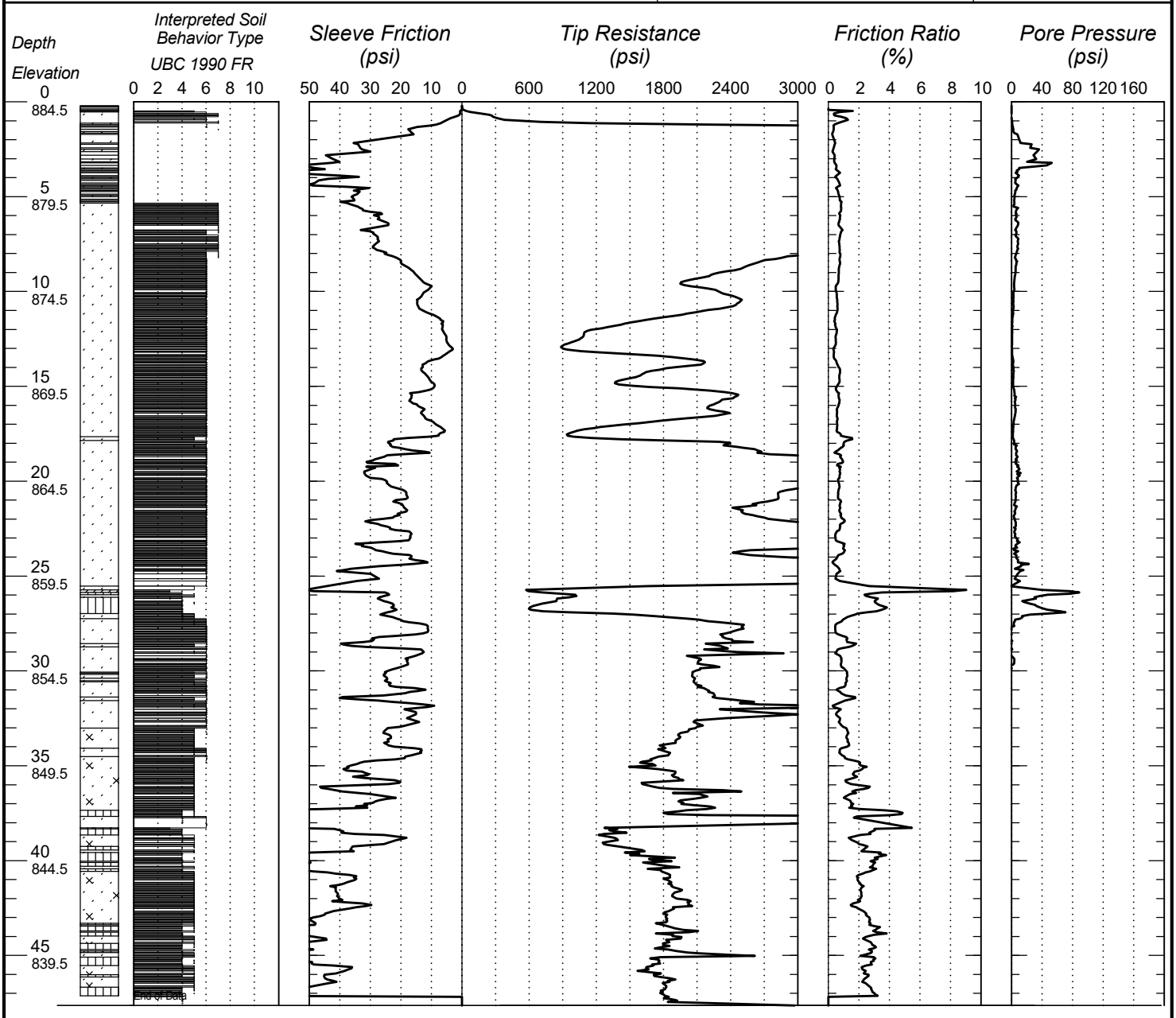
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85821

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**Over Head Sign**	**US Highway TH 10**	**c110**	**884.5** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**205146 CPT Truck (H)**	
X=473521 Y=161787	CPT Operator **ODonnel**	Date Completed
Latitude (North)=45°12'16.86" Longitude (West)=93°22'09.81"	Hole Type **CPT-STD**	**3/2/21**



Bottom of Hole 47.64

DEPARTMENT OF TRANSPORTATION

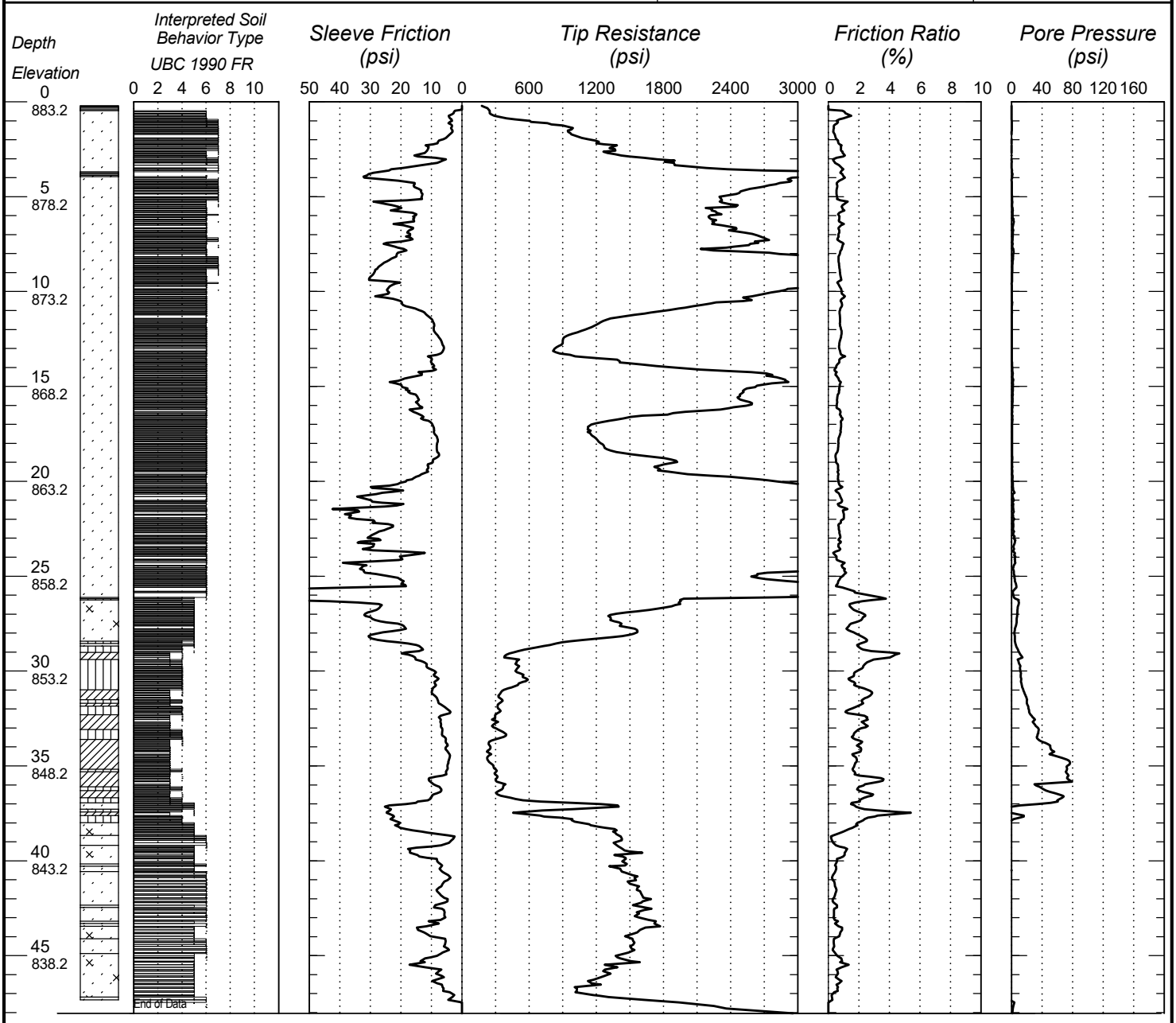
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 85998

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0215-76	**SIGN BASE**	**US Highway TH 10**	**c111**	**883.2** *(DTM)*

Location	CPT Machine	SHEET 1 of 1
Anoka County Coordinate System	**205146 CPT Truck (H)**	
X=471098 Y=161786	CPT Operator **ODonnel**	Date Completed
Latitude (North)=45°12'16.82" Longitude (West)=93°22'43.64"	Hole Type **CPT-STD**	**6/1/21**



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