Geosyntec consultants
Geosyntec Consultants of Michigan

3011 West Grand Boulevard, Suite 301
Detroit, Michigan 48202
PH 313.209.5610
www.geosyntec.com

February 22, 2023

Via Email

Mr. Nicholas M. Reidenbach, P.E.
Civil/Structural Principal Specialist Engineer
DTE Energy
One Energy Plaza
Detroit, MI 48226

Subject: Five-Year Regulatory Compliance Reporting: Safety Factor Assessment - Revised
Monroe Power Plant Fly Ash Basin Facility
Monroe, MI

Dear Mr. Reidenbach:

This letter report presents Geosyntec Consultants of Michigan, Inc.'s (Geosyntec's) revised five-year periodic safety factor assessment for DTE Electric Company's (DTE's) Monroe Power Plant Fly Ash Basin (FAB). The original version of the five-year periodic safety factor assessment for the Monroe Power Plant FAB was placed in the operating record on October 15, 2021. The periodic safety factor assessment is required under the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule (CCR Rule) published on April 17, 2015 (40 CFR Parts 257 and 261) [1]. Under the CCR Rule, the FAB is an "existing surface impoundment" and must meet safety factor requirements per §257.73(e)[1] of the CCR Rule

This letter report presents an executive summary followed by details of the periodic safety factor assessment.

EXECUTIVE SUMMARY

Geosyntec performed the initial safety factor assessment for the FAB and documented it in a letter report dated October 17, 2016 [2], which is also available at DTE's publicly accessible website. As part of the initial assessment, four cross-sections from the north, south, east, and west sides of the FAB that were deemed critical were evaluated for slope stability. The initial assessment concluded that the FAB met the safety factor (SF) requirements per the CCR Rule.

[1] §257.73(e) – Periodic Safety Factor Assessments.

Four critical cross-sections were analyzed in 2016: Station 58+75 for the north embankment, Station 75+50 for the west embankment, Station 133+00 for the south embankment, and Station 164+00 for the east embankment. The 2016 assessment concluded that each cross-section met the SF requirements per the CCR Rule. Since 2016, the embankment has been flattened from two horizontal to one vertical (2H:1V) to 3H:1V at Stations 58+75 (north), 133+00 (south), and 164+00 (east), which will increase the calculated SF for these sections because resisting forces from the slope geometry increase. Although the top of ash within the basin at Station 58+75 (north) had a grade change due to ongoing dry landfilling operations within the Vertical Extension Landfill, the landfill was designed to be over 150 feet from the edge of the embankment crest. For these reasons, the SF assessment did not include new analyses for the north, south, and east embankments because the SF would increase.

There has been no change to the embankment slope at Station 75+50 (the west embankment). The only change in the general area is the grade change for the top of ash within the Vertical Extension Landfill due to ongoing dry landfilling operations. Therefore, slope stability of the west embankment, specifically Station 75+50, was deemed critical and it was re-analyzed.

The re-analysis of the embankment at Station 75+50 indicated the calculated SF is higher than the required minimum values per the CCR Rule. Therefore, the FAB meets the SF requirements per §257.73(e) in this five year periodic assessment based on Geosyntec's assessment.

SAFETY FACTOR ASSESSMENT

Requirements of the CCR Rules

This slope stability assessment has been conducted to assess whether the FAB meets the safety factor (also referred to as "factor of safety") requirements of §257.73(e)(1) of the CCR Rule. §257.73(e)(1) requires that:

- *(i)* *"The calculated static factor of safety under the long-term, maximum storage pool loading condition must equal or exceed 1.50.*
- *(ii)* *The calculated static factor of safety under the maximum surcharge pool loading condition must equal or exceed 1.40.*
- *(iii)* *The calculated seismic factor of safety must equal or exceed 1.00*
- *(iv)* *For embankments constructed of soils that have susceptibility to liquefaction, the calculated liquefaction factor of safety must equal or exceed 1.20."*

Cross Sections for Analyses

Four sections that were deemed critical for the four sides of the FAB embankment were analyzed for the initial safety factor (SF) assessment [2]. The analysis sections included Station 58+75, 75+50, 133+00, and 164+00 for the north, west, south, and east sides of the embankment, respectively. Since 2016, the embankment slopes have been flattened from 2H:1V to 3H:1V with the exception of Station 75+50 on the west side. The flatter slopes are expected to have a higher calculated SF because the resisting forces increase with the flattening of the slopes. The top of ash within the Vertical Extension Landfill near Stations 58+75 and 75+50 had a grade change due to ongoing dry landfilling operations since 2016; however, the landfill was designed to be over 150 feet from the edge of the crest of the embankment to avoid any affect on the SF.

The section at Station 75+50 (west) was identified as the most critical because the embankment slope remained at 2H:1V. The grade increases of the Vertical Extension Landfill at Station 75+50 are also considered in the slope stability analyses but not expected to affect the calculated SF because the landfill was designed to be located over 150 feet from the edge of the crest of the embankment where the additional weight would not contribute to the driving forces on the embankment slope. A new set of slope stability analyses were conducted for the section at Station 75+50 for the periodic five-year SF assessment of the FAB. No new analyses were conducted for the sections at Stations 58+75 (north), 133+00 (south), and 164+00 (east) because the SF are expected to increase due to the flattening of the slopes (2H:1V to 3H:1V). The results of the new analyses for the section at Station 75+50 (shown on Figure 1) are presented in this letter report.

Engineering Parameters

Shear strength parameters of the embankment and the native soil were evaluated using consolidated-undrained triaxial compression (CU) test results (ASTM D4767). Twenty-three CU tests were performed on soil samples obtained from the embankment and eight CU tests were performed on native soil samples.

As presented in the 2016 safety factor assessment, Geosyntec selected effective friction angles and effective cohesions (i.e., drained shear strength properties) from the slope and intercept of the best fit linear relationship of the test results. The embankment was modeled with an effective friction angle of 34° and effective cohesion of 165 pounds per square foot (psf). The native soil was modeled with an effective friction angle of 37° and effective cohesion of 90 psf.

The undrained shear strength (S_u) of the embankment and native soil were evaluated based on the results of the triaxial tests. Figure 2 presents the change in undrained shear strength with respect to the effective confining stress (σ_c') for the laboratory test results. The interpreted undrained shear strength envelope is a constant value of 1,000 psf up to an effective confining stress of 1,500 psf, then increases at a ratio of 0.8 as effective confining stress increases.

Total unit weights of 133 and 137 pounds per cubic foot (pcf) were selected for the embankment and native soil, respectively, based on samples collected as part of various field investigations since 2009.

The drained shear strength properties for the embankment and native soil were considered for the static loading conditions with the storage and surcharge pools [§257.73(e)(1)(i) and §257.73(e)(1)(ii)]. For the seismic loading conditions [§257.73(e)(1)(iii)], undrained shear strength properties were used for the embankment and native soil because these materials are not expected to freely-drain excess pore pressures that develop during the relatively short period of seismic shaking due to the clayey nature of these materials. The ash and gravel drains are expected to be freely-draining and thus, use effective friction angles and cohesions for the seismic loading conditions.

Seismic Coefficient for Analysis

An updated peak horizontal acceleration was selected based on the seismic hazard maps published by the United States Geological Survey [3]. A peak horizontal acceleration at the hard rock (with a 2% probability of exceedance in 50 years) of 0.06g (where g is the gravitational constant) was selected. The peak horizontal acceleration at the hard rock was amplified by a factor of 1.6 to account for amplification of the bedrock motions through the site soils (i.e., stiff clays) consistent with the ASCE [4] recommendations resulting in a design ground acceleration of 0.10g. For the slope stability analysis with seismic loading conditions, a horizontal seismic coefficient of 0.10 was used. The use of a horizontal seismic coefficient for slope stability analysis based on the amplified peak horizontal acceleration (without any reduction) is conservative (i.e., yields a lower calculated FS).

Summary of Methods and Analyses

Analyses for Section 75+50 were conducted to calculate SF for loading conditions described in §257.73(e)(1)(i) through §257.73(e)(1)(iii) of the Rule. Analysis for liquefaction SF was not conducted per §257.73(e)(1)(iv) of the Rule because the embankment is not considered to be susceptible to liquefaction because of its stiff clayey nature. Evaluation of the liquefaction potential for the Monroe FAB embankment is documented in the initial safety factor assessment [2].

The SF values were calculated with limit equilibrium methods using the computer software program Slide2 (by Rocscience), a two-dimensional slope stability computer program. The SF for potential slip surfaces were evaluated using Spencer's method [5].

Analysis Results and Conclusion

The analysis results for the section at Station 75+50 and the loading conditions considered are summarized in Table 1 and provided in Figures 3 through 6.

Table 1. Analysis Summary for Station 75+50 (West Embankment).

Station #	**Maximum Storage Pool Loading Condition Per §257.73(e)(1)(i) SF ≥ 1.50**		**Maximum Surcharge Pool Loading Condition Per §257.73(e)(1)(ii) SF ≥ 1.40**		**Seismic Loading Condition Per §257.73(e)(1)(iii) SF ≥ 1.00**	
	SF	Figure #	SF	Figure #	SF	Figure #
75+50	1.87, 1.83 (note1)	3, 4	1.87	5	1.73	6

[1] Additional analysis that considers the toe ditch (Navarre Drain) empty/drained.

Based on the results of the updated slope stability analyses for Station 75+50, and the expected increases in the SF for the remaining sections of the FAB embankment, the FAB meets the SF assessment required per §257.73(e) of the CCR Rule.

QUALIFICATIONS OF LICENSED PROFESSIONAL ENGINEER

John Seymour is a qualified licensed professional engineer with over 40 years of experience in civil and geotechnical engineering associated with earthen structures and dams.

CERTIFICATION

I, John Seymour, am a qualified licensed professional engineer in Michigan, have evaluated the FAB, and hereby certify that the FAB meets the criteria of 40 CFR 257.73(e).

Mr. Nicholas M. Reidenbach
February 22, 2023
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Certified by:

STATE OF MICHIGAN
JOHN P.
SEYMOUR
ENGINEER
No.
33056
LICENSED PROFESSIONAL ENGINEER

____________________ Date February 22, 2023

John Seymour, P.E.
Michigan License Number 620103356
Senior Principal

Attachments: Figures 1 through 6

Copies to: Mark Green (DTE)
Chris Scieszka (DTE)
Gerald Chilson (DTE)

REFERENCES

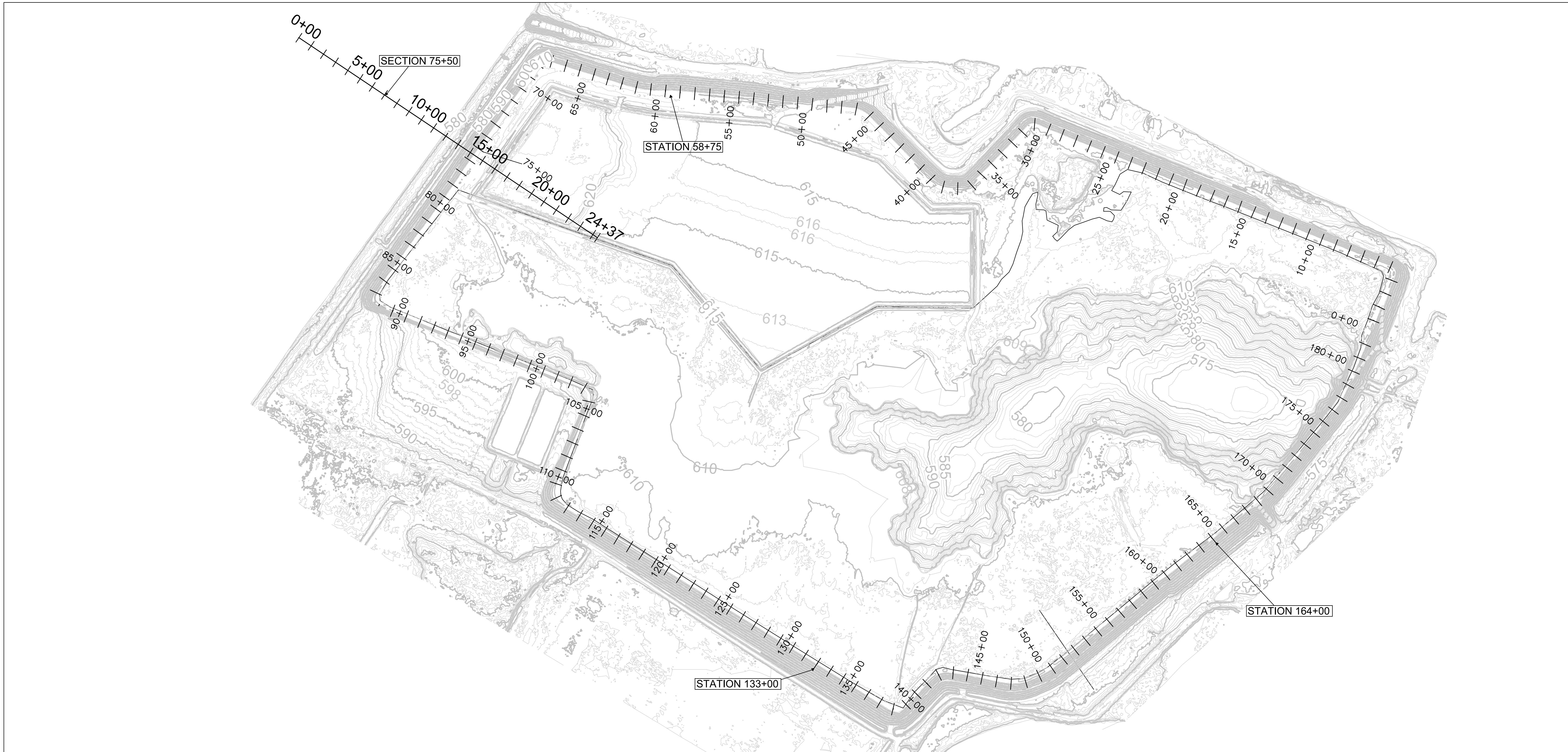
[1] United States Environmental Protection Agency, "Coal Combustion Residual Rule, 40 Code of Federal Regulations Part 257," 2015.

[2] Geosyntec Consultants, "Safety Factor Assessment, Monroe Power Plant Ash Basin Facility, Monroe, MI," Chicago , 2016.

[3] United States Geological Survey, "Unified Hazard Tool," Dynamic: Conterminous U.S. 2014 v4.2.0. [Online]. Available: https://earthquake.usgs.gov/hazards/interactive/.

[4] American Society of Civil Engineers, "ASCE/SEI 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures," American Society of Civil Engineers, Reston, VA, 2017.

[5] E. Spencer, "A Method of Analysis of Embankments Assuming Parallel Interslice Forces," *Geotechnique,* vol. 17, no. 1, pp. 11-26, 1967.



LEGEND

610	GROUND SURFACE (MAJOR CONTOUR 5-FT INTERVAL)
608	GROUND SURFACE (MINOR CONTOUR 1-FT INTERVAL)

NOTE: THE EXISTING GRADES ARE BASED ON AERIAL SURVEY PERFORMED BY KUCERA INTERNATIONAL INC. ON JULY 3, 2021 AND BATHYMETRY SURVEY CONDUCTED BY DTE IN MAY 2021.

N

0 500 1000 Feet

REV	DATE	DESCRIPTION	DRN	APP

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DTE ENERGY
ONE ENERGY PLAZA
DETROIT, MI 48226 USA

TITLE: ANALYSIS SECTION 75+50 LOCATION

PROJECT: 5-YEAR SAFETY FACTOR ASSESSMENT

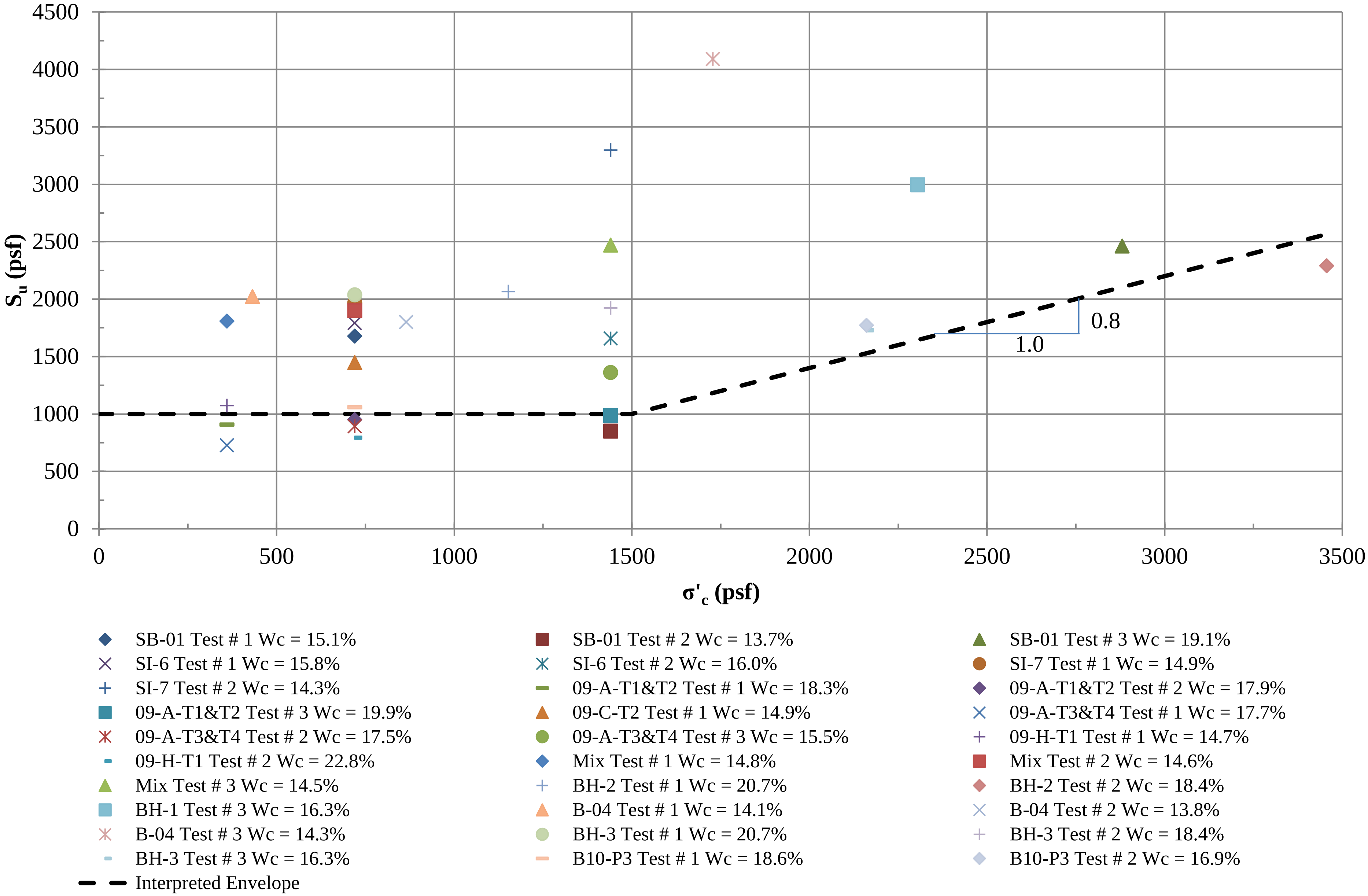
SITE: MONROE POWER PLANT, MONROE, MI

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:		DATE:	OCTOBER 2021
DRAWN BY:		PROJECT NO.:	CHE8242
CHECKED BY:		FILE:	
REVIEWED BY:		FIGURE 1	
APPROVED BY:			



Undrained Shear Strength Parameters of Embankment and Subgrade

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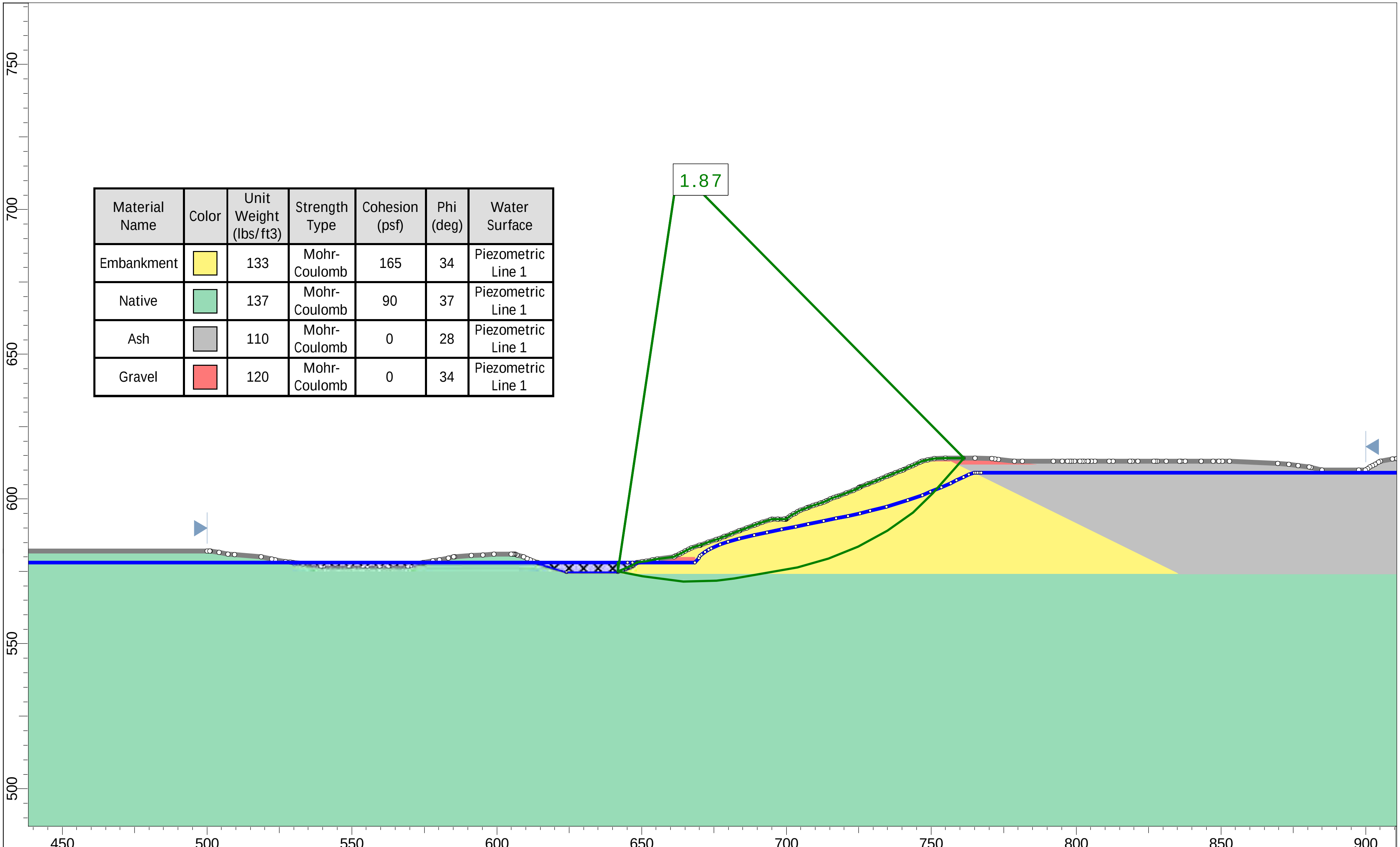
Figure

2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment		133	Mohr-Coulomb	165	34	Piezometric Line 1
Native		137	Mohr-Coulomb	90	37	Piezometric Line 1
Ash		110	Mohr-Coulomb	0	28	Piezometric Line 1
Gravel		120	Mohr-Coulomb	0	34	Piezometric Line 1

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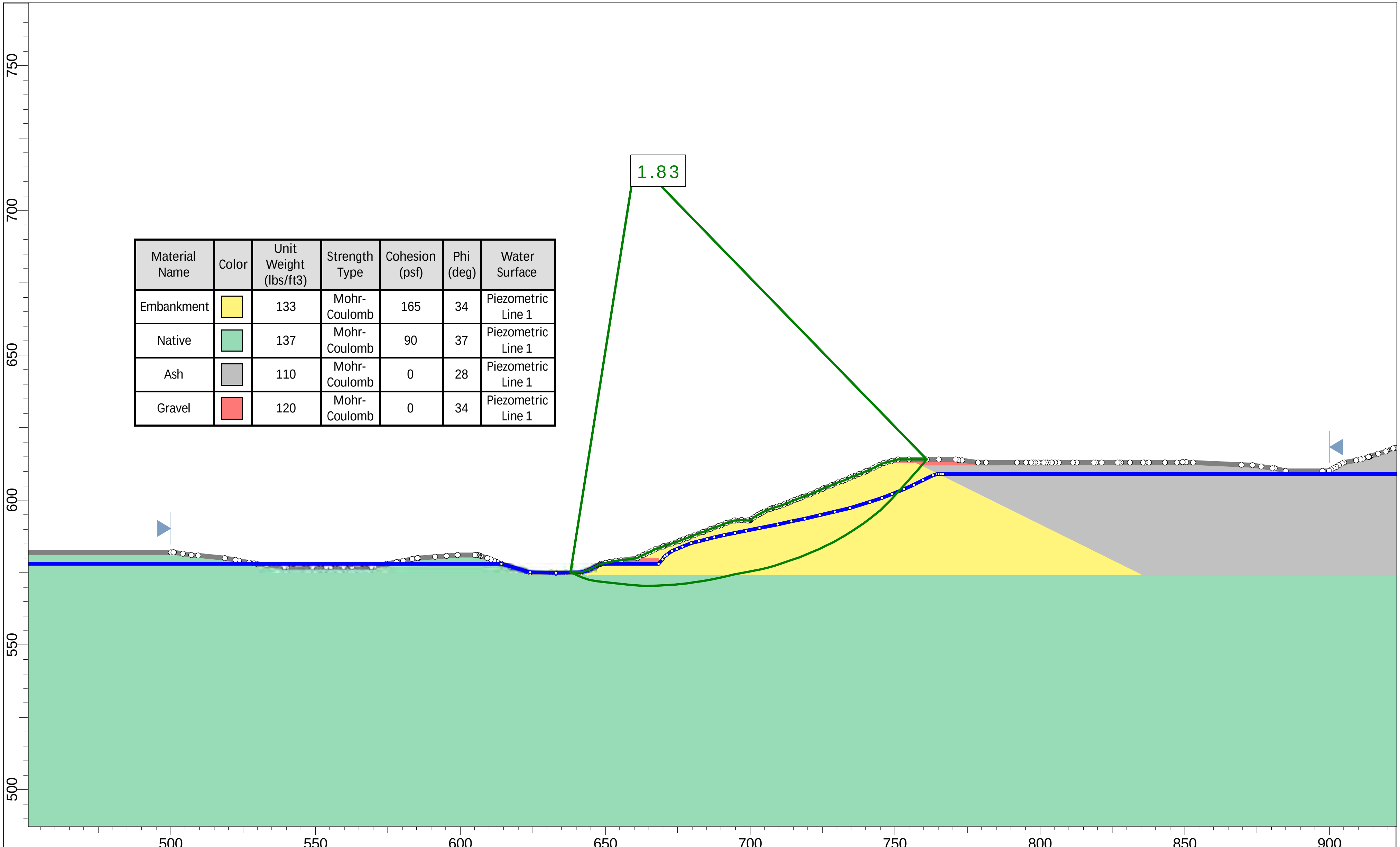
SLIDEINTERPRET 9.012

Project	5-Year Periodic Safety Factor Assessment		
Group	Long Term Maximum Storage Pool Loading	*Scenario*	Station 75+50
Drawn By	IJV	*Company*	DTE
Date	January 17, 2023	*Figure*	Figure 3



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment		133	Mohr-Coulomb	165	34	Piezometric Line 1
Native		137	Mohr-Coulomb	90	37	Piezometric Line 1
Ash		110	Mohr-Coulomb	0	28	Piezometric Line 1
Gravel		120	Mohr-Coulomb	0	34	Piezometric Line 1

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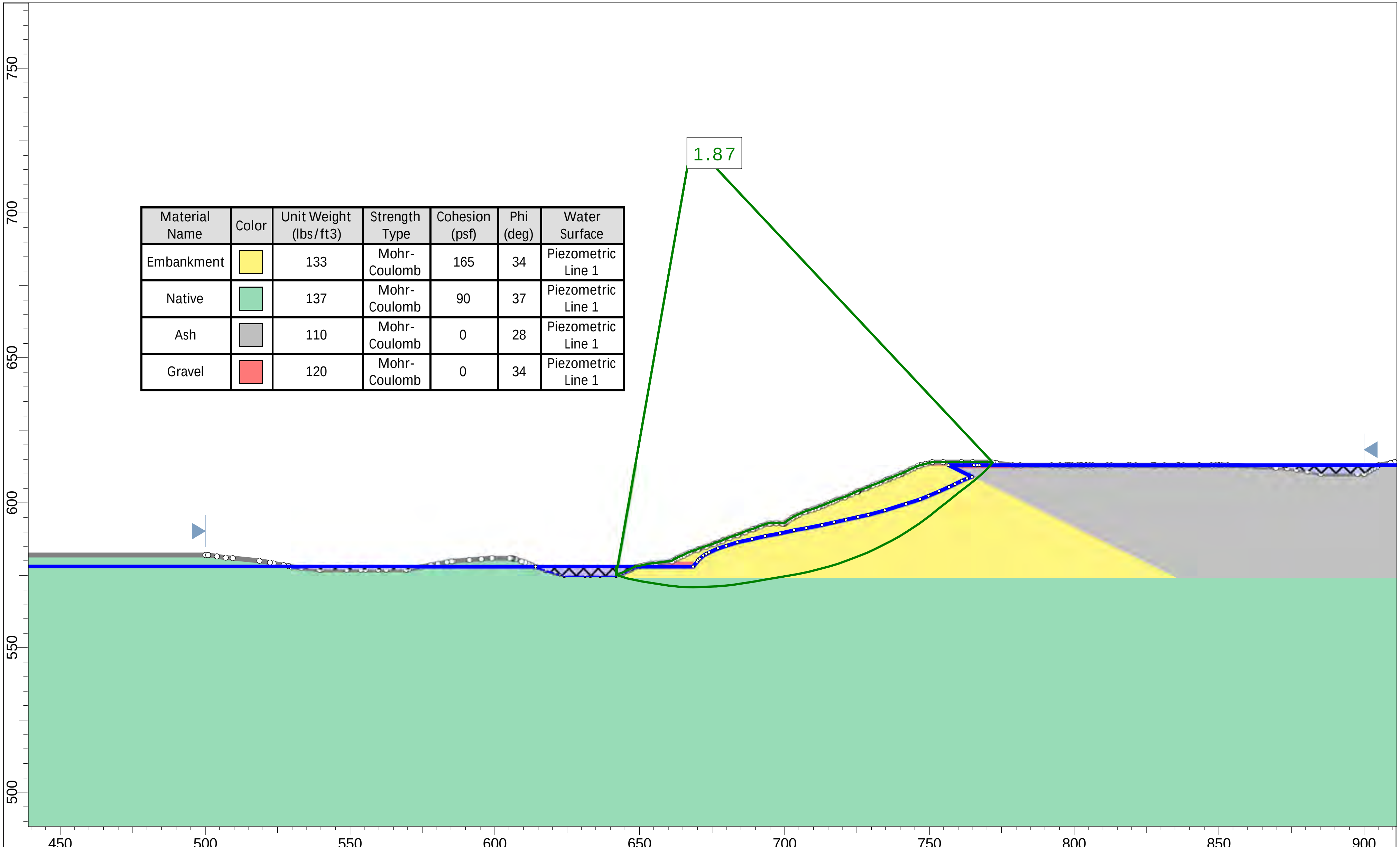
Project	5-Year Periodic Safety Factor Assessment		
Group	Long Term Maximum Storage Pool Loading (Empty Navarre Drain)	*Scenario*	Station 75+50
Drawn By	IJV	*Company*	DTE
Date	January 17, 2023	*Figure*	Figure 4



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Embankment	Yellow	133	Mohr-Coulomb	165	34	Piezometric Line 1
Native	Green	137	Mohr-Coulomb	90	37	Piezometric Line 1
Ash	Grey	110	Mohr-Coulomb	0	28	Piezometric Line 1
Gravel	Red	120	Mohr-Coulomb	0	34	Piezometric Line 1

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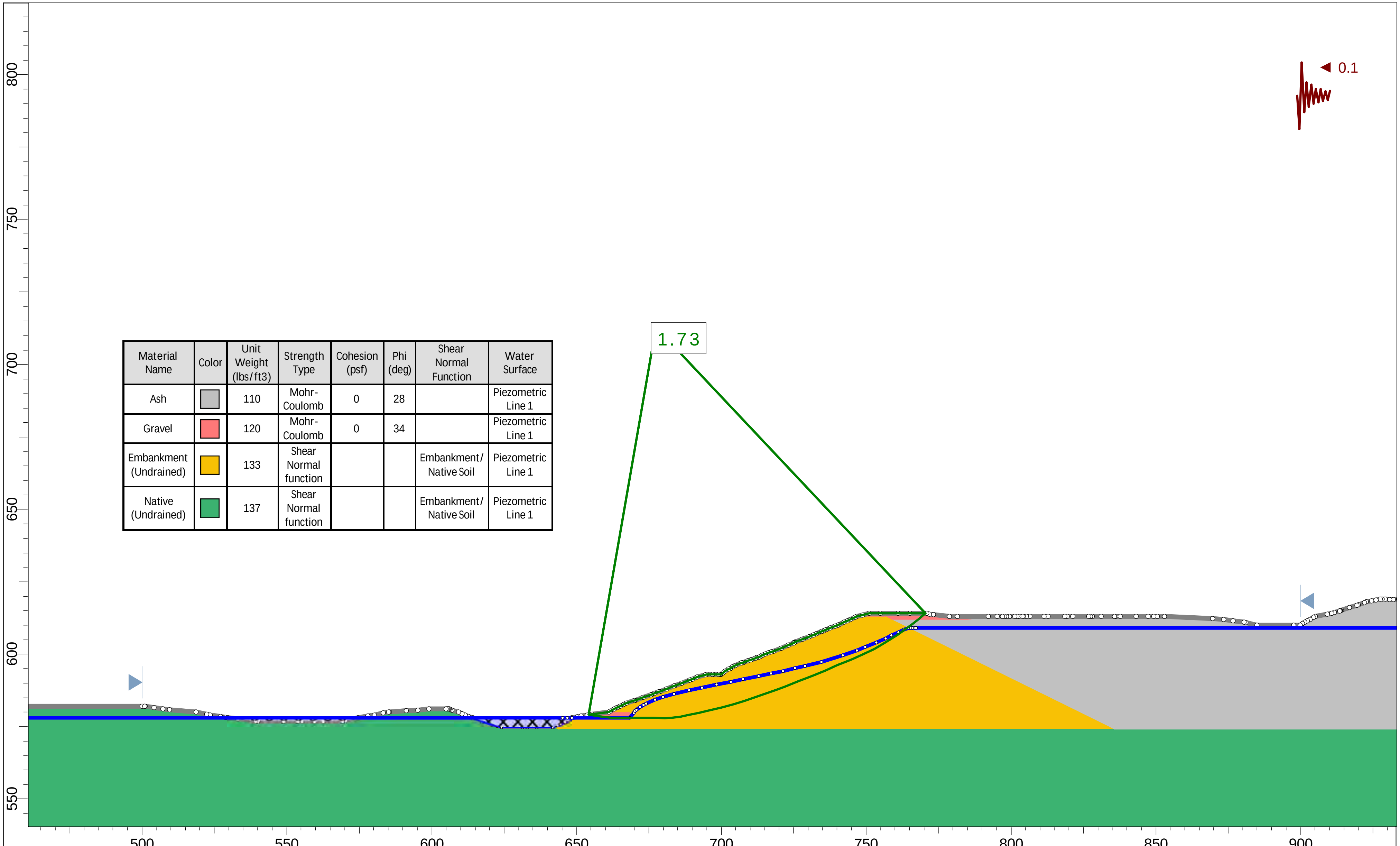
Project	5-Year Periodic Safety Factor Assessment		
Group	Maximum Surcharge Pool Loading	*Scenario*	Station 75+50
Drawn By	IJV	*Company*	DTE
Date	January 17, 2023	*Figure*	Figure 5



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Shear Normal Function	Water Surface
Ash		110	Mohr-Coulomb	0	28		Piezometric Line 1
Gravel		120	Mohr-Coulomb	0	34		Piezometric Line 1
Embankment (Undrained)		133	Shear Normal function			Embankment/ Native Soil	Piezometric Line 1
Native (Undrained)		137	Shear Normal function			Embankment/ Native Soil	Piezometric Line 1

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Project	5-Year Periodic Safety Factor Assessment		
Group	Seismic Loading	*Scenario*	Station 75+50
Drawn By	IJV	*Company*	DTE
Date	January 17, 2023	*Figure*	Figure 6