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GEOTECHNICAL DESIGN MEMORANDUM - FINAL

Date: April 8, 2021

To: Mr. Michael F. McCarthy, P.E. AICP, MS Consultants Inc.

From: Jawdat Siddiqi P.E., NEAS Inc.

RE: **Geotechnical Design Memorandum**
OTIC GES Slope Repair (No. 99-20-04, Task 2)
Wood County, Ohio

INTRODUCTION

This memorandum presents our geotechnical design recommendations for the proposed OTIC GES Slope Repair project (No. 99-20-04, Task 2), located along Ohio turnpike between MM 73.75 and RR Bridge on both sides of the turnpike, Genoa, Ohio. Information provided within this document include slope stability analysis for during construction condition and post-construction condition to aid in design development, and our recommendations for slope stabilization and construction.

NEAS's analyses have been performed in accordance with Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication *LRFD Bridge Design Specifications, 9th Edition* (BDS) (AASHTO, 2020), *ODOT's 2021 LRFD Bridge Design Manual* (BDM) (ODOT, 2021), ODOT's 2020 *Geotechnical Bulletin 2* (GB2) (ODOT, 2020) and ODOT's *Supplemental Specification 863* (SS 863) – *Reinforced Soil Slopes* (ODOT, 2014).

PROPOSED CONSTRUCTION

NEAS understands that MS Consultants Inc. is working with the Ohio Turnpike and Infrastructure Commission (OTIC) to develop construction plans for the proposed OTIC GES Slope Repair project (No. 99-20-04). A summary of the field and laboratory programs, the encountered surficial and subsurface conditions, the geological models for global stability analyses as well as our investigation of the possible cause of embankment slope failure are presented in the Geotechnical Engineering Report (GER) submitted on April 8, 2021 by NEAS.

Based on our engineering experience and global stability analyses, it is NEAS's opinion that the embankment slope is experiencing shallow surface failure instead of deep slip surface failure. Therefore, NEAS recommends stabilizing the existing embankment slope by removal of the failed soil mass in a benched excavation. The benched excavation shall be replaced with well-compacted engineered COHESIVE embankment fills (Item 203 Cohesive Embankment), per Item 203 of the ODOT Construction and Material Specifications (C&MS). Additionally, we recommend that the area, where the culvert is located, be stabilized with geogrid reinforced embankment fills. The begin and end station for the embankment side slope sliver fill removal and backfill and for the geogrid reinforced soil slope (RSS) are presented in Table 1 below.

Table 1: Stabilization Type Limits

Station	Stabilization Type
Eastbound Lanes	
STA. 568+00 to STA. 576+45	Side Slope Sliver Fill Removal and Backfill
STA. 576+45 to STA. 578+55	Reinforced Soil Slope
STA. 578+55 to STA. 583+10	Side Slope Sliver Fill Removal and Backfill
Westbound Lanes	
STA. 574+00 to STA. 577+50	Side Slope Sliver Fill Removal and Backfill
STA. 577+50 to STA. 581+75	Reinforced Soil Slope

SPECIAL BENCHING

Special benching is typically utilized to improve stability in a sidehill fill placed on an existing slope or to remediate an unstable existing slope. At the project site. special benching is recommended to be utilized, to improve the stability of the embankment slope by inhibiting the development of a contiguous shear plane along the interface. After the reconstructed fill is well compacted and built with a stable slope, any potential shear surface will be forced deeper, below the special benched fill, thus improving the resistance against shear failure.

The existing embankment side slope is a 2 Horizontal: 1 Vertical (2H:1V) slope. Based on our global stability analyses presented in the GER report submitted on April 8, 2021, the weak surface layer was modeled to be 10 feet deep, through which shallow slip surface was projected to develop. Figure 1 shows the details of a typical special benching scheme for the side slope silver fill removal and backfill. A 2H:1V line was assumed starting from the edge of paved shoulder to the bottom of slope as a reference for the special bench to be created. The back slope of each bench is cut at a typical 1H:1V slope. In order to minimize the excavation, 4 feet step height is proposed at 1H:1V backslope.

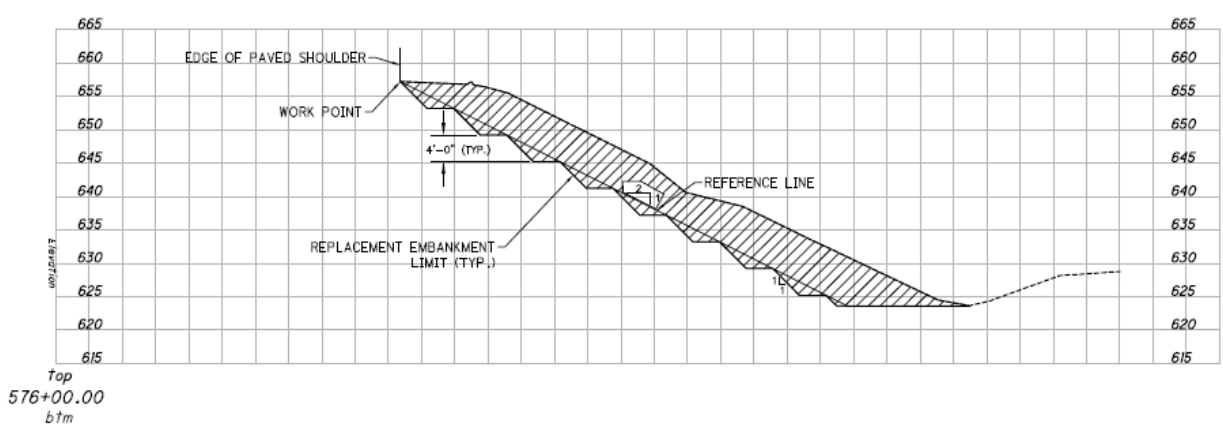

Figure 1: Typical Special Bench

For purposes of evaluating the stability of 1H:1V slope with 4 feet high special benches for the short time period between excavation and placement of new fill material, global stability analysis of a cross section at STA. 576+00 along the eastbound was performed. As can be seen in Figure 2, the minimum

Factor of Safety (FOS) for the short time period is 3.74 (0.27 resistance factor), which exceeds the target FOS of 1.3.

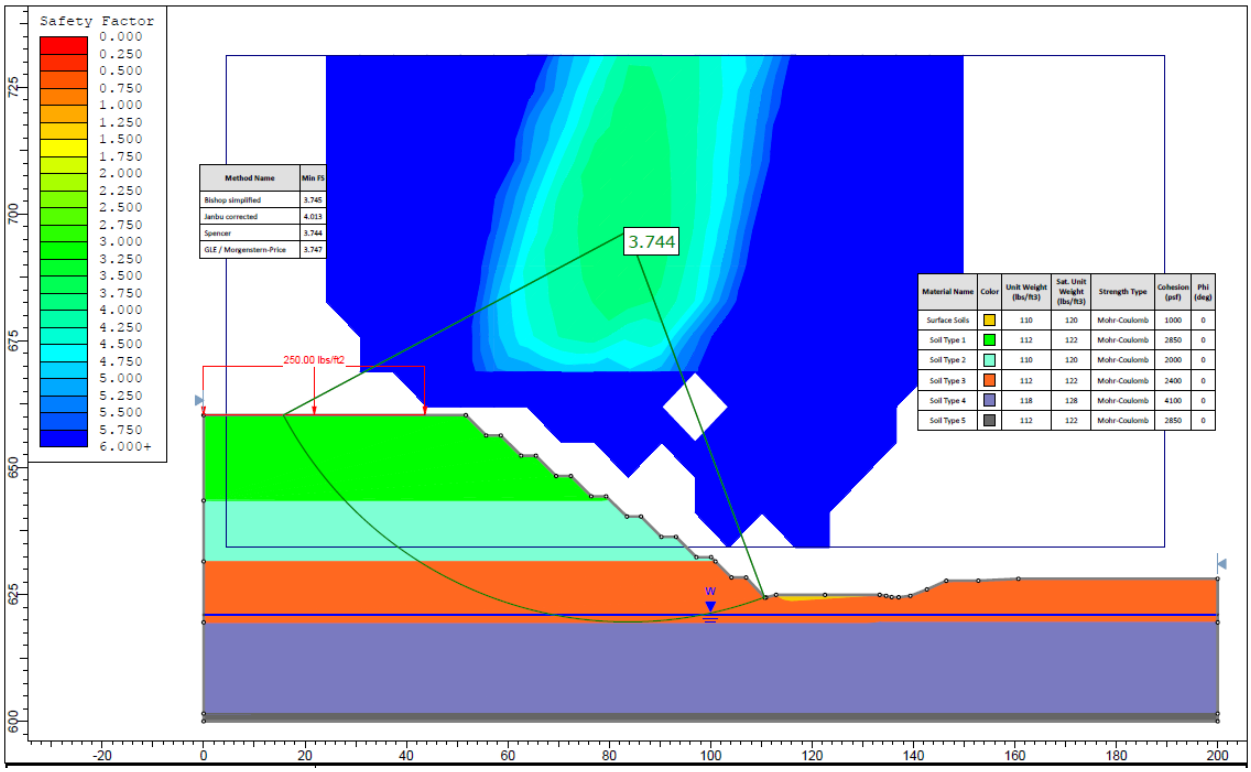

Figure 2: Short Term Global Stability During Construction

Backfill Materials: The uniform or benched excavation shall be replaced with well-compacted engineered COHESIVE embankment fills (Item 203 Cohesive Embankment), per Item 203 of the ODOT C&MS. However, the cohesive soils Clay (A-7-6) are not recommended to be used as backfills at the project site because they tend to have high water content and high plasticity. Also, Item 203 Granular Embankment fills are not recommended, since it is a 2H:1V slope and they will not stabilize the embankment slope. Place and compact embankment material according to C&MS 203 Embankment. Proper lift thicknesses and material density are to be maintained in the fills, per Item 203.06. ODOT's GB2 dictate analysis parameters and design minimums/constraints to be used in the analysis and design process. The referenced soil parameters and design minimums/constraints that are significant to our analyses are listed in Table 2 below:

Table 2: Minimum Design Soil Parameters for Backfill Materials

Fill Zone	Type of Soil	Soil Unit Weight (pcf)	Undrained Shear Strength (psf)	Cohesion (psf)	Friction Angle (°)
Side Slope Backfill	Item 203 Cohesive Embankment (A-6a and A-6b)	120	2500	250	28

Drainage: Since the pavement edge drain is planned to be installed per the OTIC requirements, NEAS does not see the need to install slope drains as the pavement edge drain should be sufficient to capture any water infiltration into the embankment slope. However, NEAS does recommend that roadway surface drainage captured at the catch basins should be installed within the slope and daylighted at the drainage ditch at the toe of slope.

REINFORCED SOIL SLOPE

Reinforced soil slope is recommended to stabilize the embankment slope where the culvert is located, more specifically, from STA. 576+45 to STA. 578+55 along the eastbound and from STA. 577+50 to STA. 581+75 along the westbound. The geosynthetic material geogrid will be used as the reinforcement. It is recommended the primary geogrid Type P1 and secondary geogrid Type S1 be used in accordance with Table 863.02-1 of ODOT's SS 863, as reproduced in Table 3 below.

Table 3: Design Geogrid Properties

Geogrid Type	Ultimate Tensile Strength (lb/ft)	Long-Term Design Tensile Strength (lb/ft)
P1	-	1300
S1	1400	-
Notes: *1 Table reproduced from Table 863.02-1 of the ODOT SS 863.*		

For the purpose of designing the reinforced soil slope, NEAS developed a typical cross-section by using the software entitled ReSSA by Amada Engineering, Inc. Specifically, the factor of safety (FOS) of RSS for rotational, sliding and three-part wedge type failures were checked. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.3 which approximately equates to an AASHTO resistance factor less than 0.75 (per AASHTO's LRFD BDS, the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs).

NEAS recommends a minimum length of 10 feet (measured horizontally from the proposed face of slope) primary geogrid Type P1 spaced at 2'-8" vertically and 5 feet long secondary Type S1 spaced at 1'-4" vertically between primary geogrid layers. The first primary reinforcement is recommended to be placed at the toe of the embankment slope; while at the culvert location, place at least 8 inches of embankment materials on the top of culvert before placing the first primary reinforcement. No wrap-around facing system is needed for the primary and secondary geogrid reinforcement. Based on our analyses, the min FOS for the rotational, sliding and three-part wedge type failures is 1.41, 2.77, 1.59, respectively. The graphical outputs of the RSS stability (cross-sectional model, generalized soil profile, calculated factor of safety, and slip surface) are presented in Appendix A.

Excavation and Embankment: The excavation benching details for the reinforced soil slope match the aformentioned Special Benching for the project, i.e., 4 feet step height at 1H:1V backslope. The backfill materials and their strengths should meet the requirements presented in the section Special Benching of this memo. The embankment material should also meet the requirements in the Table 4 below.

Table 4: Additional Requirements for Reinforced Embankment

Property	Test Method	Required Value
Organic Content	AASHTO T 267	≤ 4.0%
Plasticity Index	AASHTO T 90	≤ 20
Notes: *1. Table reproduced from Table 863.02-3 of the ODOT SS863.*		

Drainage: It is recommended that adequate drainage is maintained/controlled during and after construction of the RSS, and that roadway/ditch drainage is carefully controlled around the slope location in order to prevent ponding, erosion of reinforced or embankment soil, loss of shear strength of foundation soils due to saturation, and other drainage related issues.

Construction: Before placing the first layer of geogrid at the toe of the embankment slope, remove any deleterious materials, sharp objects, weak, plastic or otherwise unsuitable soils and prepare the embankment foundation according to C&MS 203.05. With respect to placement of geogrid reinforcement, it is recommended that geogrid be placed in accordance with SS 863 Section 863.03.C "Geogrid Placement". With respect to placement of embankment materials, place and compact embankment materials according to C&MS 203. Additionally, compact embankment materials to at least 98 percent of the maximum dry density in accordance with SS 863 Section 863.03.E "Fill Placement".

QUALIFICATIONS

It should be noted that if excavation and replacement occur entirely above the failure surface, it will have little to no effect on stability, and the repaired slope will merely become a part of the moving soil mass. The benches need to be cut through the existing failure surface, and deepened vertically and widened horizontally into the slope, until adequate stability is achieved. NEAS's recommendations are based on the results of the field explorations, laboratory tests, global stability analyses and our experience, and we estimate that the possible failure surface is located within the 10-ft surface weak layer. If the actual failure surface is observed during construction to be deeper than what was estimated, the conclusions and recommendations contained in this design memo or the GER should not be considered valid until they are reviewed and have been modified or verified in writing by a professional geotechnical engineer.

REFERENCES

AASHTO. (2020). *Standard Specifications for Highway Bridges, 9th Edition.* Washington, D.C.: American Association of State Highway and Transporation Officials.

ODOT. (2020). *2020 Geotechnical Bulletin*, OH: Ohio Department of Transportation: Office of Geotechnical Engineering.

ODOT. (2021). *2021 Bridge Design Manual.* Columbus, OH: Ohio Department of Transportation: Office of Structural Engineering. Retrieved from http://www.dot.state.oh.us/Divisions/Engineering/Structures/standard/Bridges/Pages/BDM2004.aspx

ODOT. (2014). *Supplemental Specification 863 (SS 863) – Reinforced Soil Slopes*. Ohio Department of Transportation: Office of Geotechnical Engineering.

APPENDIX A

RESSA ANALYSIS OF

REINFORCED SOIL SLOPE

OTIC Task 1 Genoa Slope

Report created by ReSSA(3.0): Update #4.21: Copyright (c) 2001-2016, ADAMA Engineering, Inc.

PROJECT IDENTIFICATION

Title:	OTIC Task 1 Genoa Slope
Project Number:	-
Client:	MS Consultants Inc.
Designer:	ZM
Station Number:	STA. 578+50

Description:

Company's information:

Name:	National Engineering & Architectural Services, Inc.
Street:	2800 Corporate Exchange Drive Suite 240 Columbus, Ohio 43231
Telephone #:	614-714-0299
Fax #:	614-714-0251
E-Mail:	contactus@neasinc.com

Original file path and name: P:\20-0107 ..... Analysis\ReSSA\Double Reinforcement\STA 578+50.MSE
Original date and time of creating this file: 03/24/21

PROGRAM MODE: Analysis of a General Slope using GEOSYNTHETIC as reinforcing material.

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INPUT DATA (EXCLUDING REINFORCEMENT LAYOUT)

SOIL DATA

========== Soil Layer #: ==========	Unit weight, γ [lb/ft ^{3}]	Internal angle of friction, ϕ [deg.]	Cohesion, c [lb/ft ^{2}]
1.....Item 203 Embankment Fill.....	120.0	26.0	200.0
2.....Subsoil layer 1: Sit and Clay A-6a.....	112.0	24.0	150.0
3.....Subsoil layer 2: Silty Clay A-6b.....	108.0	23.0	100.0
4.....	115.0	25.0	180.0

REINFORCEMENT

Reinforcement Type #	Geosynthetic Designated Name	Ultimate Strength, Tult [lb/ft]	Reduction Factor for Installation Damage, RFid	Reduction Factor for Durability, RFd	Reduction Factor for Creep, RFc	Additional Reduction Factor, RFa	Coverage Ratio, Rc
1	P1_ODOT_SS863	1300.00	1.00	1.00	1.00	1.00	1.00
2	S1_ODOT_SS863	1400.00	1.00	1.00	1.00	1.00	1.00

Interaction Parameters Type #	Geosynthetic Designated Name	== Direct Sliding == Cds-phi	Cds-c	==== Pullout ==== Ci	Alpha
1	P1_ODOT_SS863	0.67	0.00	0.67	0.80
2	S1_ODOT_SS863	0.67	0.00	0.67	0.80

Relative Orientation of Reinforcement Force, ROR = 0.00. Assigned Factor of Safety to resist pullout, Fs-po = 2.00
Design method for Global Stability: Comprehensive Bishop.

WATER

Unit weight of water = 62.45 [lb/ft ^{3}]
Water pressure is defined by phreatic surface in Effective Stress Analysis.

SEISMICITY

Not Applicable

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DRAWING OF SPECIFIED GEOMETRY - GENERAL - Quick Input

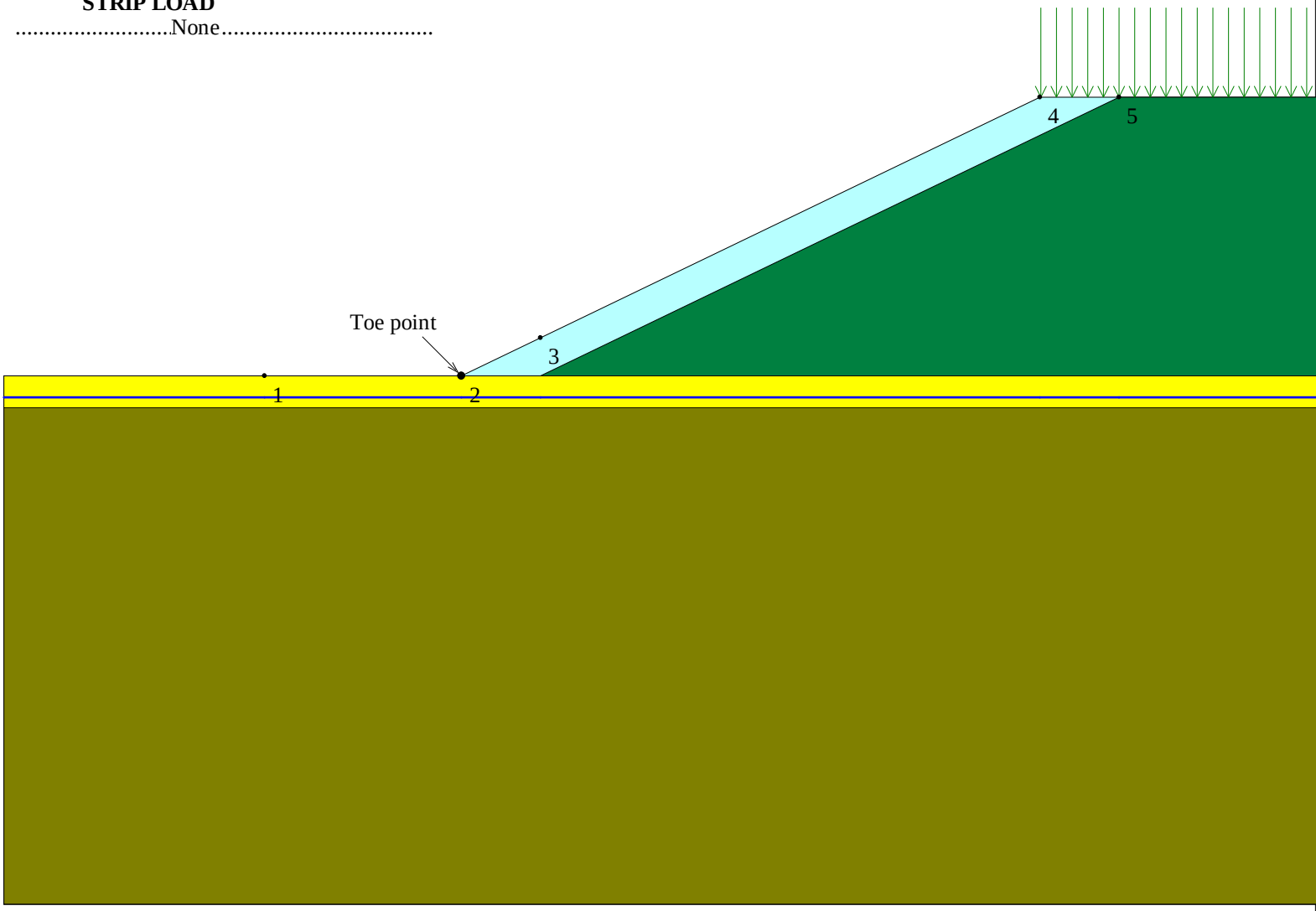
-- Problem geometry is defined along sections selected by user at x,y coordinates.
-- X1,Y1 represents the coordinates of soil surface. X2,Y2 represent the coordinates of the end of soil layer 1 and start of soil layer 2, and so on.
-- Xw,Yw represents the coordinates of phreatic surface.

GEOMETRY
Soil profile contains 4 layers (see details in next page)

WATER GEOMETRY
Phreatic line was specified.

UNIFORM SURCHARGE
Load Q1 = 250.00 [lb/ft²] inclined from verical at 0.00 degrees, starts at X1s = 98.20 and ends at X1e = 200.00 [ft].
Surcharge load, Q2.....None
Surcharge load, Q3.....None

STRIP LOAD
.....None.....



SCALE:

0 2 4 6 8 10[ft]

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TABULATED DETAILS OF GEMERAL SPECIFIED GEOMETRY

Soil profile contains 4 layers. Coordinates in [ft.]
Water was described by phreatic line.

	#	Xi	Yi
Top of Layer 1	1	24.90	623.72
	2	98.10	658.91
Top of Layer 2	3	34.90	623.72
	4	108.10	658.91
Top of Layer 3	5	0.00	623.72
	6	200.00	623.72
Top of Layer 4	7	0.00	619.70
	8	200.00	619.70
Top of Phreatic Line	10	0.00	621.00
	11	200.00	621.00

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TABULATED DETAILS OF SPECIFIED GEOMETRY

Soil profile contains 4 layers. Coordinates in [ft.]
Water was described by phreatic line. Y values are tabulated in the right most column.

#	X	Y1	Y2	Y3	Y4	(phreatic) Yw
1	0.00	623.72	623.72	623.72	619.70	621.00
2	24.90	623.72	623.72	623.72	619.70	621.00
3	34.90	628.53	623.72	623.72	619.70	621.00
4	98.10	658.91	654.10	623.72	619.70	621.00
5	108.10	658.91	658.91	623.72	619.70	621.00
6	200.00	658.91	658.91	623.72	619.70	621.00

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DISTRIBUTION OF AVAILABLE STRENGTH ALONG EACH REINFORCEMENT LAYER

A = Front-end of reinforcement (at face of slope)
B = Rear-end of reinforcement
AB = L1 + L2 + L3 = Embedded length of reinforcement

Tavailable = Long-term strength of reinforcement
Tfe = Available front-end strength (e.g., connection to facing)

L1 = Front-end 'pullout' length
L2 = Rear-end pullout length
Tavailable prevails along L3

Factor of safety on resistance to pullout on either end of reinforcement, Fs-po = 2.00

Reinforcement Layer #	Designated Name	Height Relative to Toe [ft]	L [ft]	L1 [ft]	L2 [ft]	L3 [ft]	Tfe [lb/ft]	Tavailable [lb/ft]
1	P1 ODOT SS863	0.00	10.00	5.60	4.40	0.00	0.00	927.96 (*)
2	S1 ODOT SS863	1.33	5.00	2.49	2.51	0.00	0.00	362.26 (*)
3	P1 ODOT SS863	2.67	10.00	5.60	4.40	0.00	0.00	927.96 (*)
4	S1 ODOT SS863	4.00	5.00	2.49	2.51	0.00	0.00	362.26 (*)
5	P1 ODOT SS863	5.33	10.00	5.60	4.40	0.00	0.00	927.96 (*)
6	S1 ODOT SS863	6.67	5.00	2.49	2.51	0.00	0.00	362.26 (*)
7	P1 ODOT SS863	8.00	10.00	5.60	4.40	0.00	0.00	927.96 (*)
8	S1 ODOT SS863	9.33	5.00	2.49	2.51	0.00	0.00	362.26 (*)
9	P1 ODOT SS863	10.67	10.00	5.60	4.40	0.00	0.00	927.96 (*)
10	S1 ODOT SS863	12.00	5.00	2.49	2.51	0.00	0.00	362.26 (*)
11	P1 ODOT SS863	13.33	10.00	5.60	4.40	0.00	0.00	927.96 (*)
12	S1 ODOT SS863	14.67	5.00	2.49	2.51	0.00	0.00	362.26 (*)
13	P1 ODOT SS863	16.00	10.00	5.60	4.40	0.00	0.00	927.96 (*)
14	S1 ODOT SS863	17.33	5.00	2.49	2.51	0.00	0.00	362.26 (*)
15	P1 ODOT SS863	18.67	10.00	5.60	4.40	0.00	0.00	927.96 (*)
16	S1 ODOT SS863	20.00	5.00	2.49	2.51	0.00	0.00	362.26 (*)
17	P1 ODOT SS863	21.33	10.00	5.60	4.40	0.00	0.00	927.96 (*)
18	S1 ODOT SS863	22.67	5.00	2.49	2.51	0.00	0.00	362.26 (*)
19	P1 ODOT SS863	24.00	10.00	5.60	4.40	0.00	0.00	927.96 (*)
20	S1 ODOT SS863	25.33	5.00	2.49	2.51	0.00	0.00	362.26 (*)
21	P1 ODOT SS863	26.67	10.00	5.60	4.40	0.00	0.00	927.96 (*)
22	S1 ODOT SS863	28.00	5.00	2.49	2.51	0.00	0.00	362.26 (*)
23	P1 ODOT SS863	29.33	10.00	5.60	4.40	0.00	0.00	927.96 (*)
24	S1 ODOT SS863	30.67	5.00	2.49	2.51	0.00	0.00	362.26 (*)
25	P1 ODOT SS863	32.00	10.00	5.41	4.59	0.00	0.00	892.43 (*)
26	S1_ODOT_SS863	33.33	5.00	2.49	2.51	0.00	0.00	357.37 (*)

(*) This Tavailable is dictated by the pullout resistance capacity, which is smaller than the long-term strength of the reinforcement that is related to its specified ultimate strength.

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RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.) The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

Critical circles for each entry point (considering all specified exit points)

Entry Point #	Entry Point (X,Y) [ft]		Exit Point (X,Y) [ft]		Critical Circle (Xc,Yc,R) [ft]			Fs	STATUS
1	60.00	640.60	20.39	623.91	34.49	645.80	26.04	1.91	
2	64.83	642.92	18.64	623.91	34.32	651.42	31.67	1.82	
3	69.66	645.24	18.91	623.75	35.28	655.75	35.94	1.74	
4	74.49	647.56	18.56	623.91	36.08	660.43	40.50	1.68	
5	79.31	649.88	16.99	623.83	36.02	665.89	46.16	1.63	
6	84.14	652.20	16.51	624.04	36.97	670.19	50.49	1.58	
7	88.97	654.52	16.73	623.93	37.83	674.69	54.97	1.55	
8	93.80	656.84	16.95	623.83	38.60	679.37	59.61	1.52	
9	98.62	658.91	17.16	623.75	39.32	684.37	64.54	1.48	
10	103.45	658.91	22.10	623.78	37.31	700.33	78.04	1.42	
11	108.28	658.91	22.14	623.77	37.50	709.27	86.86	1.41	OK
12	113.11	658.91	20.64	623.73	38.57	715.71	93.71	1.43	
13	117.93	658.91	11.45	623.90	39.29	718.66	98.76	1.46	
14	122.76	658.91	12.98	623.96	42.09	722.40	102.66	1.49	
15	127.59	658.91	9.39	623.98	40.49	736.21	116.45	1.54	
16	132.42	658.91	9.61	623.91	41.00	746.69	126.73	1.59	
17	137.24	658.91	9.83	623.85	42.69	753.46	133.72	1.64	
18	142.07	658.91	6.49	623.82	40.82	770.64	150.79	1.70	
19	146.90	658.91	7.78	623.92	43.64	775.39	155.66	1.75	
20	151.73	658.91	4.55	623.85	41.56	794.93	175.03	1.82	
21	156.55	658.91	4.82	623.79	43.28	802.99	183.28	1.88	
22	161.38	658.91	9.39	623.93	48.33	802.41	182.69	1.95	
23	166.21	658.91	-0.35	623.79	41.56	837.53	217.81	2.01	
24	171.04	658.91	3.93	623.97	46.61	836.89	217.16	2.08	
25	175.86	658.91	9.94	623.80	51.66	836.26	216.52	2.15	
26	180.69	658.91	-1.24	623.94	44.56	876.42	256.60	2.22	
27	185.52	658.91	1.52	623.76	47.40	882.74	263.02	2.29	
28	190.35	658.91	5.46	623.98	52.44	882.04	262.30	2.36	
29	195.17	658.91	-0.41	623.78	47.12	921.22	301.21	2.44	
30	200.00	658.91	-0.13	623.74	48.84	932.08	312.21	2.51	

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-entry' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

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RESULTS OF ROTATIONAL STABILITY ANALYSIS

Results in the tables below represent critical circles identified between specified points on entry and exit. (Theta-exit set to 50.00 deg.) The most critical circle is obtained from a search considering all the combinations of input entry and exit points.

Critical circles for each exit point (considering all specified entry points).

Exit Point #	Exit Point (X, Y) [ft]		Entry Point (X, Y) [ft]		Critical Circle (Xc, Yc, R) [ft]			Fs	STATUS
1	-0.53	623.87	108.28	658.91	28.06	721.57	101.79	1.46	
2	0.72	624.01	108.28	658.91	29.18	719.49	99.63	1.45	
3	3.14	623.81	108.28	658.91	30.32	717.42	97.47	1.44	
4	4.44	623.93	108.28	658.91	31.45	715.37	95.34	1.44	
5	6.89	623.72	108.28	658.91	33.50	710.72	90.98	1.43	
6	8.24	623.84	108.28	658.91	34.63	708.78	88.95	1.42	
7	9.62	623.95	108.28	658.91	35.76	706.85	86.93	1.42	
8	11.03	624.04	108.28	658.91	36.90	704.94	84.93	1.42	
9	13.52	623.81	108.28	658.91	38.86	700.86	81.11	1.41	
10	14.98	623.90	108.28	658.91	39.99	699.05	79.21	1.41	
11	16.47	623.90	108.28	658.91	36.81	708.46	86.97	1.41	
12	18.00	623.93	108.28	658.91	37.04	708.77	86.95	1.41	
13	20.55	623.75	108.28	658.91	37.27	709.04	86.92	1.41	
14	22.14	623.77	108.28	658.91	37.50	709.27	86.86	1.41	OK
15	23.76	623.78	108.28	658.91	37.72	709.44	86.79	1.41	
16	25.33	624.28	108.28	658.91	40.18	705.37	82.44	1.43	
17	27.16	625.12	108.28	658.91	45.26	695.92	73.08	1.47	
18	29.18	625.85	108.28	658.91	37.33	717.51	92.02	1.49	
19	30.84	626.69	108.28	658.91	38.89	716.49	90.17	1.50	
20	32.54	627.52	108.28	658.91	40.46	715.48	88.32	1.51	
21	34.27	628.35	108.28	658.91	43.23	711.54	83.68	1.52	
22	35.98	629.18	108.28	658.91	44.77	710.59	81.88	1.53	
23	37.70	630.01	108.28	658.91	46.30	709.63	80.08	1.54	
24	39.42	630.84	108.28	658.91	47.84	708.68	78.29	1.55	
25	40.72	631.73	108.28	658.91	50.41	705.19	74.10	1.56	
26	43.09	632.47	108.28	658.91	51.92	704.29	72.35	1.58	
27	44.80	633.30	108.28	658.91	53.43	703.39	70.61	1.59	
28	46.39	634.15	108.28	658.91	55.84	700.25	66.77	1.61	
29	47.98	635.00	108.28	658.91	57.33	699.40	65.08	1.62	
30	49.57	635.85	108.28	658.91	58.82	698.55	63.38	1.64	

Note: In the 'Status' column, OK means the critical circle was identified within the specified search domain. 'On extreme X-exit' means that the critical result is on the edge of the search domain; a lower Fs may result if the search domain is expanded.

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CRITICAL RESULTS OF ROTATIONAL AND TRANSLATIONAL STABILITY ANALYSES

Rotational (Circular Arc; Bishop) Stability Analysis

Minimum Factor of Safety = 1.41
Critical Circle: Xc = 37.50[ft], Yc = 709.27[ft], R = 86.86[ft]. (Number of slices used = 54)

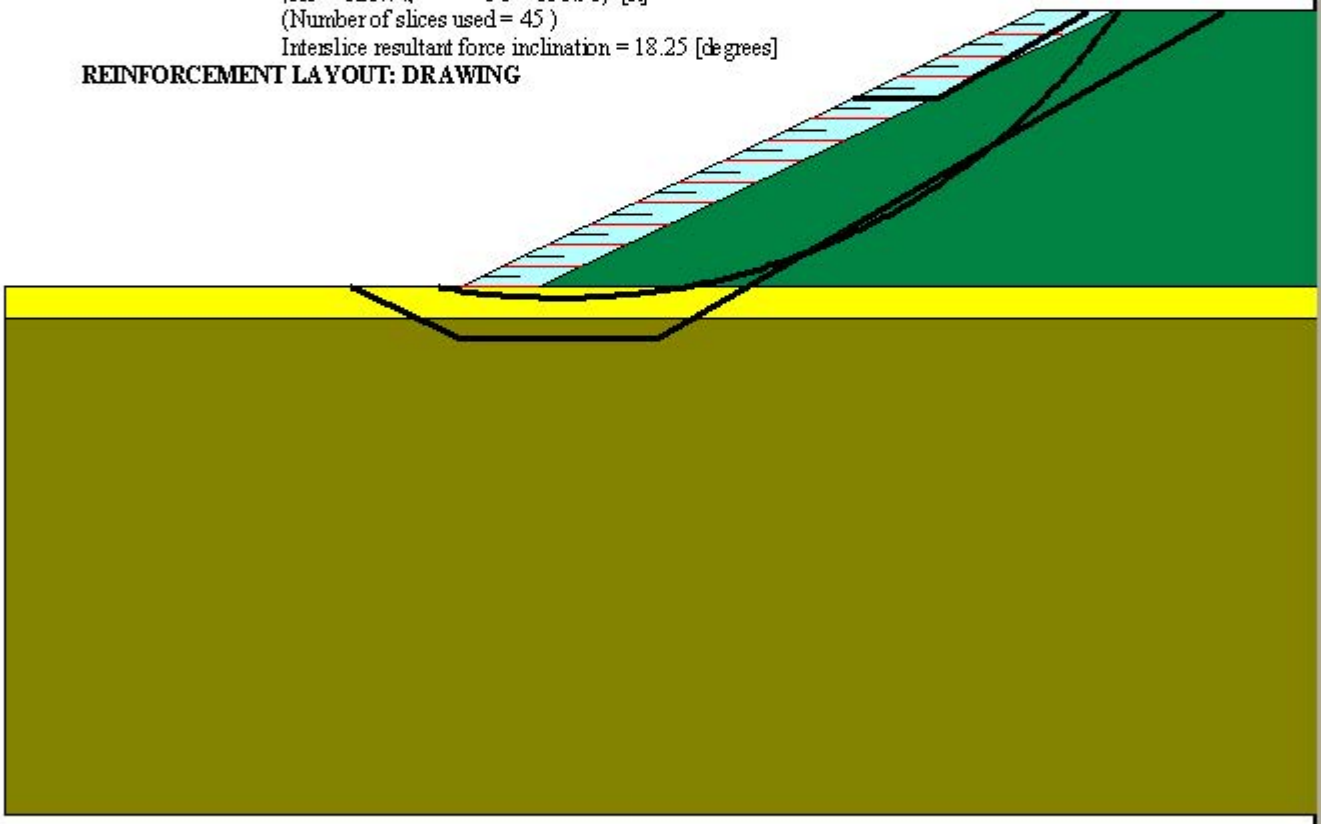
Translational (2-Part Wedge; Spencer), Direct Sliding, Stability Analysis

Minimum Factor of Safety = 2.77
Critical Two-Part Wedge: (Xa = 74.82, Ya = 647.72) [ft]
(Xb = 85.09, Yb = 647.72) [ft]
(Xc = 104.47, Yc = 658.91) [ft]
(Number of slices used = 30)
Interslice resultant force inclination = 20.27 [degrees]

Three-Part Wedge Stability Analysis

Minimum Factor of Safety = 1.59
Critical Three-Part Wedge: (X2 = 10.92, Y2 = 623.72) [ft]
(X-left = 24.90, Y-left = 617.20) [ft]
(X-right = 49.50, Y-right = 617.20) [ft]
(X1 = 121.74, Y1 = 658.91) [ft]
(Number of slices used = 45)
Interslice resultant force inclination = 18.25 [degrees]

REINFORCEMENT LAYOUT: DRAWING



SCALE:

0 2 4 6 8 10[ft]

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REINFORCEMENT LAYOUT: TABULATED DATA & QUANTITIES

Layer #	Reinf. Type #	Geosynthetic Designated Name	Height Relative to Toe [ft]	Embedded Length [ft]	Coverage Ratio, Rc	(X, Y) front [ft]		(X, Y) rear [ft]		Lsv * [ft]	Lse [ft]
1	1	P1_ODOT_SS863	0.00	10.00	1.00	81.69	2046.33	91.69	2046.33	0.00	0.00
2	2	S1_ODOT_SS863	1.33	5.00	1.00	84.46	2047.66	89.46	2047.66	0.00	0.00
3	1	P1_ODOT_SS863	2.67	10.00	1.00	87.25	2049.00	97.25	2049.00	0.00	0.00
4	2	S1_ODOT_SS863	4.00	5.00	1.00	90.01	2050.33	95.01	2050.33	0.00	0.00
5	1	P1_ODOT_SS863	5.33	10.00	1.00	92.78	2051.66	102.78	2051.66	0.00	0.00
6	2	S1_ODOT_SS863	6.67	5.00	1.00	95.57	2053.00	100.57	2053.00	0.00	0.00
7	1	P1_ODOT_SS863	8.00	10.00	1.00	98.33	2054.33	108.33	2054.33	0.00	0.00
8	2	S1_ODOT_SS863	9.33	5.00	1.00	101.10	2055.66	106.10	2055.66	0.00	0.00
9	1	P1_ODOT_SS863	10.67	10.00	1.00	103.89	2057.00	113.89	2057.00	0.00	0.00
10	2	S1_ODOT_SS863	12.00	5.00	1.00	106.65	2058.33	111.65	2058.33	0.00	0.00
11	1	P1_ODOT_SS863	13.33	10.00	1.00	109.42	2059.66	119.42	2059.66	0.00	0.00
12	2	S1_ODOT_SS863	14.67	5.00	1.00	112.21	2061.00	117.21	2061.00	0.00	0.00
13	1	P1_ODOT_SS863	16.00	10.00	1.00	114.98	2062.33	124.98	2062.33	0.00	0.00
14	2	S1_ODOT_SS863	17.33	5.00	1.00	117.74	2063.66	122.74	2063.66	0.00	0.00
15	1	P1_ODOT_SS863	18.67	10.00	1.00	120.53	2065.00	130.53	2065.00	0.00	0.00
16	2	S1_ODOT_SS863	20.00	5.00	1.00	123.30	2066.33	128.30	2066.33	0.00	0.00
17	1	P1_ODOT_SS863	21.33	10.00	1.00	126.06	2067.66	136.06	2067.66	0.00	0.00
18	2	S1_ODOT_SS863	22.67	5.00	1.00	128.85	2069.00	133.85	2069.00	0.00	0.00
19	1	P1_ODOT_SS863	24.00	10.00	1.00	131.62	2070.33	141.62	2070.33	0.00	0.00
20	2	S1_ODOT_SS863	25.33	5.00	1.00	134.38	2071.66	139.38	2071.66	0.00	0.00
21	1	P1_ODOT_SS863	26.67	10.00	1.00	137.17	2073.00	147.17	2073.00	0.00	0.00
22	2	S1_ODOT_SS863	28.00	5.00	1.00	139.94	2074.33	144.94	2074.33	0.00	0.00
23	1	P1_ODOT_SS863	29.33	10.00	1.00	142.70	2075.66	152.70	2075.66	0.00	0.00
24	2	S1_ODOT_SS863	30.67	5.00	1.00	145.49	2077.00	150.49	2077.00	0.00	0.00
25	1	P1_ODOT_SS863	32.00	10.00	1.00	148.26	2078.33	158.26	2078.33	0.00	0.00
26	2	S1_ODOT_SS863	33.33	5.00	1.00	151.02	2079.66	156.02	2079.66	0.00	0.00

* Vertical distance between layers.

QUANTITIES

Reinf. Type #	Designated Name	Coverage Ratio	Area of reinforcement [ft²] / length of slope [ft]
1	P1_ODOT_SS863	1.00	130.00
2	S1_ODOT_SS863	1.00	65.00

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FINAL REPORT
GEOTECHNICAL ENGINEERING REPORT
OTIC GES SLOPE REPAIR
NO. 99-20-04, TASK 1
WOOD COUNTY, OHIO

Prepared For:

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Prepared by:

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NEAS PROJECT 20-0107

March 15, 2021

EXECUTIVE SUMMARY

The Ohio Turnpike and Infrastructure Commission (OTIC) has proposed an OTIC GES Slope Repair project (No. 99-20-04, Task 1), located on the Ohio turnpike embankment between MM 73.75 and RR Bridge on both sides of the turnpike, Genoa, Ohio. The embankment slope at MM 73.75 to RR Bridge on both sides of the turnpike has failed as evidenced by pavement cracking, embankment side slope sloughing and erosion features.

National Engineering & Architectural Services, Inc. (dba) NEAS Inc. has been contracted to perform geotechnical engineering services for the project. The purpose of the geotechnical engineering services was to perform geotechnical explorations within the project limits to obtain information concerning the subsurface soil and groundwater conditions relevant to the slope stabilization and construction of the project. Between January 11, 2021 and January 14, 2021, NEAS performed the subsurface exploration program for the project. This report presents the results of the geotechnical exploration with respect to the OTIC GES slope repair project. As part of the project, NEAS Inc. advanced 10 project borings and conducted laboratory testing to characterize the soils for engineering purposes.

The subsurface profile at the project site consists of surficial materials comprised of either topsoil or existing pavement section (asphalt and granular base) ranging from 1.2 ft to 1.4 ft in thickness which is generally underlain by either embankment fill soils and/or natural overburden soils (A-4a, A-6a. A-6b and A-7-6). Bedrock was not encountered within the depths of all the ten borings performed.

To evaluate the slope global stability, NEAS developed five and three cross-sectional models along the eastbound and westbound, respectively. The five cross sections along the eastbound are at STA. 572+25, STA. 576+00, STA. 577+15.59 (middle of culvert), STA. 579+75, and STA. 583+00. The three cross sections along the westbound are STA. 575+81, STA. 578+75, and STA. 58+20.54 (middle of culvert). Based on our engineering experience and global stability analyses, it is NEAS's considered opinion that the embankment slope is shallow surface failure and not a deep slip surface failure.

Based on the soil characteristics, lab testing results, global stability analyses and our engineering experience, it is NEAS's opinion that the embankment slope was built with compacted engineered fills. The fills were composed of very stiff to hard, cohesive soils and have kept the embankment slope stable for many years. However, with repeated wet and dry periods and the mid-slope discharge of roadway surface drainage, the side slope embankment gradually swelled and grew softer and weaker. The shear strength of the surface fills decreased over time, which we trust to be the possible cause of the surficial embankment slope failure.

NEAS recommends stabilizing the unstable existing side slope embankment by removal and replacement of the failed soil mass in a uniform or benched excavation. The excavated *embankment* material shall be replaced with compacted engineered COHESIVE embankment fills (Item 203 Cohesive Embankment), per Item 203 of the ODOT Construction and Material Specifications. Slope groundwater drainage system is also recommended to be installed along the entire length of the excavation. Additional global stability analyses were carried out by replacing the weakened surface soil layer with Item 203 Cohesive Embankment fills. Based on these analyses, the minimum FOS for the stabilized embankment slope factor for short-term (Total Stress) and long-term (Effective Stress) conditions exceeded the desired value of 1.3.

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1. INTRODUCTION

1.1. General

NEAS presents our Geotechnical Engineering Report for the proposed OTIC GES Slope Repair project (No. 99-20-04, Task 1). The referenced project is located on Ohio turnpike embankment between MM 73.75 and RR Bridge on both sides of the turnpike, Genoa, Ohio. This report presents a summary of the encountered surficial and subsurface conditions and our recommendations for slope stabilization and construction in accordance with the Load and Resistance Factor Design (LRFD) method as set forth in AASHTO's Publication *LRFD Bridge Design Specifications, 9th Edition* with 2020 interim revisions (BDS) (AASHTO, 2020), *ODOT's 2021 LRFD Bridge Design Manual* (BDM) (ODOT, 2020) and *ODOT's 2020 Geotechnical Bulletin 2* (GB2) (ODOT, 2020).

The exploration was conducted in general accordance with Barr Engineering, Inc., (dba) National Engineering and Architectural Services Inc. (NEAS) proposal to MS Consultants Inc. dated December 10, 2020 and with the provisions of ODOT's *Specifications for Geotechnical Explorations* (SGE) (ODOT, 2020).

The scope of work performed by NEAS as part of the referenced project included: a review of published geotechnical information; performing 10 test borings; laboratory testing of soil samples in accordance with the SGE; performing geotechnical engineering analysis for slope repair, and construction considerations; and development of this summary report.

2. GEOLOGY AND OBSERVATIONS OF THE PROJECT

2.1. Geology and Physiography

The project site lies in the Woodville Lake-Plain Reefs, which is a very low relief lacustrine plain with low dunes and lake-margin features, punctuated by more than seventy-five ancient bedrock reefs rising 10 feet to 40 feet above the level of the plain and ranging in area from 0.1 to 3.0 square miles. The oblong reefs are thinly draped with drift. This region is at an elevation of 600 feet to 775 feet. The till in this region is described as thin to absent Wisconsinan-age wave-planed clay till, lacustrine deposits and sand over Silurian-age reefal lockport dolomite (ODGS, 1998).

Bedrock beneath the project site has been mapped as Silurian-age lockport dolomite. The dolomite at the project site is medium to massive bedded, with shades of white to medium gray, and fine to coarse crystalline (USGS & ODGS, 2005). Based on the ODNR bedrock topography map of Ohio, bedrock elevations at the project site can be expected to be at about 580 ft to 600 ft above mean sea level (amsl), putting bedrock within a depth of 30 ft to 80 ft below ground surface (bgs).

The soils at the project site have been mapped (Web Soil Survey) by the Natural Resources Conservation Service (USDA, 2015) as Hoytville silty clay loam with 0 to 1 percent slopes (HcA). Hoytville silty clay loam is primely farmland if well drained. These soil units are described as being very poorly drained and classified as cohesive A-4, A-6 and A-7 soils (AASHTO method of soil classification). (USDA, 2015).

2.2. Hydrology/Hydrogeology

Groundwater can be expected at an elevation consistent with that of the major local surface water bodies. The Packer Creek is across the project area and the flow line elevation varies from 619 ft to 621 ft.

Local variations in the groundwater table may exist for one of two reasons. First, if there has been extensive groundwater abstraction, water levels may be depressed by tens of feet over significantly large areas. Second, the presence of discontinuous bodies of glacial till provides the opportunity for localized pockets of perched groundwater to form.

The project site is located within a special flood hazard area or the 1% Annual Chance Flood Hazard area based on available mapping by the Federal Emergency Management Agency's (FEMA) National Flood Hazard mapping program (FEMA, 2019).

2.3. Mining and Oil/Gas Production

No abandoned mines are noted on ODNR's Abandoned Underground Mine Locator within the immediate vicinity of the project's boundaries (ODNR [1], 2016).

No oil or gas wells are noted on ODNR's Ohio Oil & Gas Locator within the immediate vicinity of the project's boundaries (ODNR [1], 2016).

2.4. Historical Records and Previous Phases of Project Exploration

The following historical report/plans were available for review and evaluation for this report.

- Ohio Turnpike Project NO. 1 Plan and Profile, C-43, 8-9, 1953
- Ohio Turnpike Project NO. 1 Box Culvert, C-43, 66-67, 1953

3. GEOTECHNICAL EXPLORATION

3.1. Field Exploration Program

The geotechnical exploration for the project was conducted by NEAS between January 11, 2021 and January 14, 2021, and included 10 borings drilled to depths between 29.1 ft and 60.0 ft below ground surface (bgs). Each as-drilled project boring location and corresponding ground surface elevation was surveyed in the field by the project surveyor following drilling. Each individual project boring log (included within Appendix B) includes the recorded boring latitude and longitude location (based on the surveyed Ohio State Plane North, NAD83, location) and the corresponding ground surface elevation. Coordinates, stationing, offset, depths and elevations of the borings are summarized within Table 1 below, and the boring locations are depicted on the Boring Location Plan provided in Appendix A.

Table 1: Project Boring Summary

Boring Number	Location (Sta/Offset)	Latitude	Longitude	Elevation (NAVD 88) (ft)	Depth (ft)	Substructure
B-001-0-20	572+11, 56' RT.	41.511464	-83.422943	652.2	45.0	Landslide
B-002-0-20	572+11, 133' RT.	41.511259	-83.423008	627.5	29.1	Landslide
B-003-0-20	576+08, 55' RT.	41.511229	-83.421526	657.1	50.0	Landslide
B-004-0-20	576+01, 155' RT.	41.510965	-83.421629	628.7	30.5	Landslide
B-005-0-20	579+75, 57' RT.	41.511006	-83.420218	660.0	60.0	Landslide
B-006-0-20	575+60, 58' LT.	41.511560	-83.421608	656.4	49.5	Landslide
B-007-0-20	575+55, 147' LT.	41.511802	-83.421556	627.0	29.2	Landslide
B-008-0-20	578+58, 56' LT.	41.511380	-83.420545	659.3	48.8	Landslide
B-009-0-20	578+60, 150' LT.	41.511629	-83.420466	627.0	30.0	Landslide
B-010-0-20	581+57, 57' LT.	41.511205	-83.419479	661.0	49.5	Landslide

Notes:
1. As-drilled boring Location (Sta/Offset) in reference to E.X. Ohio Turnpike.

Borings were drilled using a CME 55T or CME X truck mounted drilling rig utilizing 3.25-inch diameter hollow stem augers. Soil samples were recovered continuously to end of boring (EOB) using a split spoon sampler (AASHTO T-206 "Standard Method for Penetration Test and Split Barrel Sampling of Soils."). The soil samples obtained from the exploration program were visually observed in the field by an NEAS field representative and preserved for review by a Geologist and possible laboratory testing. Standard Penetration Tests (SPTs) were conducted using a CME auto hammer that has been calibrated to be 68.4% or 81.9% efficient on December 5, 2019 as indicated on the boring logs.

Field boring logs were prepared by drilling personnel, and included lithological description, SPT results recorded as blows per 6-inch increment of penetration and estimated unconfined shear strength values on specimens exhibiting cohesion (estimated by means of hand-penetrometer). Groundwater level observations were recorded both during and after the completion of drilling. These groundwater level observations are included on the individual boring logs. After completing the borings, the boreholes were backfilled with either auger cuttings, bentonite chips, or a combination of these materials and patched with asphalt cold patch and/or quick-set concrete where necessary.

3.2. Laboratory Testing Program

The laboratory testing program consisted of classification testing, moisture content determinations, and unconfined compressive strength of soil specimen testing. Data from the laboratory-testing program were incorporated onto the boring logs (Appendix B). Soil samples are retained at the laboratory for 60 days following report submittal, after which time they will be discarded.

3.2.1. Classification Testing

Representative soil samples were selected for index properties (Atterberg Limits) and gradation testing for classification purposes on approximately 11% of the soil samples obtained. At each boring location, samples were selected for testing with the intent of identification and classification of all significant soil units. Soils not selected for testing were compared to laboratory tested samples/strata and classified visually. Moisture content testing was conducted on all samples. The laboratory testing was performed in general accordance with applicable AASHTO specifications.

A final classification of the soil strata was made in accordance with AASHTO M-145 "Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," as modified by ODOT

"Classification of Soils" once laboratory test results became available. The results of the soil classification are presented on the boring logs in Appendix B.

3.2.2. Standard Penetration Test Results

Standard Penetration Tests and split-barrel (commonly known as split-spoon) sampling of soils were performed at 1.5-ft intervals in the project borings performed. To account for the high efficiency (automatic) hammers used during SPT sampling, field SPT N-values were converted based on the calibrated efficiency (energy ratio) of the specific drill rig's hammer. Field N-values were converted to an equivalent rod energy of 60% (N_{60}) for use in analysis or for correlation purposes. The resulting N_{60} values are presented on the boring logs provided in Appendix B.

3.2.3. Unconfined Compressive Strength of Cohesive Soil Results

Three relatively undisturbed (Shelby tube) samples were obtained from borings B-002-0-20, B-004-0-20 and B-008-0-20, respectively. The samples were extruded from the tube, visually described and trimmed into 6-inch specimens. Natural moisture contents were determined, and samples were subjected to engineering classification testing. Unconfined compression was conducted on the soil samples in accordance with ASTM D2166. However, it should be noted that a wax-filled core of approximately 1.5" diameter was discovered in almost the entire length of the soil specimen from boring B-004-0-20. The strength testing results of boring B-004-0-20 soil specimen are presumed to be invalid. The test results of B-002-0-20 and B-008-0-20 are listed in Table 2 and provided in Appendix B.

Table 2: Summary of Unconfined Compressive Strength Testing of Cohesive Soil Specimens

Boring Number	Depth of Test Specimen (ft)	Soil Type	Unconfined Compressive Strength (psf)	Strain (%)
B-002-0-20	19.0 - 19.5	A-6b	6,858	15.0
B-008-0-20	22.0 - 22.5	A-6a	5,479	15.0

4. GEOTECHNICAL FINDINGS

The subsurface conditions encountered during NEAS's explorations are described in the following subsections and on each boring log presented in Appendix B. The boring logs represent NEAS's interpretation of the subsurface conditions encountered at each boring location based on our site observations, field logs, visual review of the soil samples by NEAS's geologist, and laboratory test results. The lines designating the interfaces between various soil strata on the boring logs represent the approximate interface location; the actual transition between strata may be gradual and indistinct. The subsurface soil and groundwater characterizations included herein, including summary test data, are based on the subsurface findings from the geotechnical explorations performed by NEAS as part of the referenced project, and consideration of the geological history of the site.

4.1. Subsurface Conditions

The subsurface profile at the project site consists of surficial materials comprised of either topsoil or existing pavement section (asphalt and granular base) ranging from 1.2 ft to 1.4 ft in thickness which is generally underlain by either embankment fill soils and/or natural overburden soils (A-4a, A-6a. A-6b and A-7-6). Bedrock was not encountered within depths of all the ten borings performed.

4.1.1. Overburden Soil

The cohesive fills/natural soils were encountered throughout the project site, and no granular soils were encountered within depths of all the ten borings performed.

The cohesive fills/natural soils along the eastbound were classified on the project boring logs as Sandy Silt (A-4a), Silt and Clay (A-6a), Silty Clay (A-6b) and Clay (A-7-6). With respect to the soil strength of the cohesive soils, the soils can be described as having a consistency ranging from stiff to hard correlating to N_{60} values between 10 bpf and SPT-N refusal (i.e., greater than 50 blows per 6-inches of penetration). Natural moisture contents of the cohesive soil samples were measured to be between 9 and 24 percent. Based on Atterberg Limits test performed on representative samples of the cohesive soil obtained, the liquid and plastic limits were determined to be between about 25 and 50 percent and 15 and 24 percent, respectively.

The cohesive fills/natural soils along the westbound were classified on the project boring logs as Sandy Silt (A-4a), Silt and Clay (A-6a), Silty Clay (A-6b) and Clay (A-7-6). With respect to the soil strength of the cohesive soils, the soils can be described as having a consistency ranging from stiff to hard correlating to N_{60} values between 4 bpf and SPT-N refusal (i.e., greater than 50 blows per 6-inches of penetration). Natural moisture contents of the cohesive soil samples were measured to be between 8 and 36 percent. Based on Atterberg Limits test performed on representative samples of the cohesive soil obtained, the liquid and plastic limits were determined to be between about 19 and 58 percent and 14 and 29 percent, respectively.

4.1.2. Groundwater

Groundwater was not encountered in any of the project borings performed during or after drilling. It should be noted that groundwater is affected by many hydrologic characteristics in the area and may vary from those measured at the time of the exploration.

4.1.3. Bedrock

Bedrock was not encountered in any of the project borings performed.

5. ANALYSES AND RECOMMENDATIONS

We concluded that the embankment slope at MM 73.75 to RR Bridge on both sides of the turnpike has failed as evidenced by pavement cracking, slope sloughing off and erosion features. We arrived at this conclusion based on the aformentioned information, and additionally: 1) the soil characteristics gathered during the subsurface exploration (i.e., SPT results, laboratory test results, etc.) and our geotechnical experience; 2) the estimated soil types encountered at the site and their engineering properties, as well as other design assumptions presented in subsequent sections of this report; and finally, 3) the terrain/site survey data obtained in the field. A global stability review was completed for the turnpike embankment slope to investigate the slope failure cause and to stabilize the embankment slope.

The engineering analyses were performed in accordance with AASHTO's LRFD BDS (AASHTO LRFD, 2020), ODOT's BDM (ODOT BDM, 2021) and ODOT's GB2 (ODOT GB2, 2020). Slope stabilization recommendations are provided in the following sections.

5.1. Soil Properties for Analysis

For analysis purposes, we reviewed each boring log. Engineering properties for each soil strata were estimated based on the field (i.e., SPT N60 Values, hand penetrometer values, etc.) and laboratory test results (i.e., Atterberg Limits, grain size, etc.) using correlations provided in published engineering manuals, research reports and guidance documents. The estimated soil engineering properties for use in analysis (with cited correlation/reference material) are summarized in Tables 3 through 12. The project borings are presented in Appendix B.

Table 3: Soil Profile and Estimated Engineering Properties - At Boring B-001-0-20

Landslide: Soil Profile, B-001-0-20						
Soil Description	Unit Weight(1) (pcf)	Moist Unit Weight(1) (pcf)	Saturated Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)
Silty Clay Elevation (652.2 ft - 629.7 ft)	115	115	125	3,400	180	25
Silt and Clay Elevation (629.7 ft - 628.2 ft)	112	112	122	2,850	150	25
Clay Elevation (628.2 ft - 622.2 ft)	115	115	125	3,400	180	25
Silty Clay Elevation (622.2 ft - 607.2 ft)	120	120	130	5,100	225	27

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 4: Soil Profile and Estimated Engineering Properties - At Boring B-002-0-20

Landslide: Soil Profile, B-002-0-20						
Soil Description	Unit Weight(1) (pcf)	Moist Unit Weight(1) (pcf)	Saturated Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)
Clay Elevation (627.5 ft - 623 ft)	110	110	120	1,750	115	23
Silt and Clay Elevation (623 ft - 603 ft)	115	115	125	3,500	180	25
Silt and Clay Elevation (603 ft - 598.4 ft)	130	130	140	8,750	250	28

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 5: Soil Profile and Estimated Engineering Properties - At Boring B-003-0-20

Landslide: Soil Profile, B-003-0-20						
Soil Description	Unit Weight(1) (pcf)	Moist Unit Weight(1) (pcf)	Saturated Unit Weight(1) (pcf)	Undrained Shear Strength(2) (psf)	Effective Cohesion(3) (psf)	Effective Friction Angle(3) (degrees)
Silt and Clay Elevation (657.1 ft - 646.6 ft)	112	112	122	2,550	150	25
Sandy Silt Elevation (646.6 ft - 639.1 ft)	112	112	122	2,900	150	25
Silt and Clay Elevation (639.1 ft - 633.1 ft)	112	112	122	2,650	150	25
Silty Clay Elevation (633.1 ft - 619.6 ft)	115	115	125	3,600	180	25
Silt and Clay Elevation (619.6 ft - 607.1 ft)	120	120	130	4,800	225	27

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 6: Soil Profile and Estimated Engineering Properties - At Boring B-004-0-20

Landslide: Soil Profile, B-004-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Clay Elevation (628.7 ft - 619.7 ft)	110	110	120	2,200	115	24
Silty Clay Elevation (619.7 ft - 601.2 ft)	115	115	125	3,450	180	25
Silty Clay Elevation (601.2 ft - 598.2 ft)	118	118	128	3,900	200	26

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 7: Soil Profile and Estimated Engineering Properties - At Boring B-005-0-20

Landslide: Soil Profile, B-005-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Silt and Clay Elevation (660 ft - 643.5 ft)	112	112	122	2,850	150	25
Silt and Clay Elevation (643.5 ft - 631.5 ft)	110	110	120	2,000	115	24
Silty Clay Elevation (631.5 ft - 619.5 ft)	112	112	122	2,400	150	24
Silt and Clay Elevation (619.5 ft - 601.5 ft)	118	118	128	4,100	200	26
Silty Clay Elevation (601.5 ft - 600 ft)	122	112	122	2,850	150	25

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 8: Soil Profile and Estimated Engineering Properties - At Boring B-006-0-20

Landslide: Soil Profile, B-006-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Silt and Clay Elevation (656.4 ft - 635.4 ft)	110	110	120	2,250	115	24
Silty Clay Elevation (635.4 ft - 629.4 ft)	108	108	118	1,400	100	23
Silt and Clay Elevation (629.4 ft - 623.4 ft)	112	112	122	2,500	150	25
Silt and Clay Elevation (623.4 ft - 606.9 ft)	120	120	130	4,550	225	27

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 9: Soil Profile and Estimated Engineering Properties - At Boring B-007-0-20

Landslide: Soil Profile, B-007-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Clay Elevation (627 ft - 619.5 ft)	112	112	122	2,500	150	25
Silty Clay Elevation (619.5 ft - 604.5 ft)	112	112	122	2,900	150	25
Silty Clay Elevation (604.5 ft - 600 ft)	130	130	140	6,850	250	28
Sandy Silt Elevation (600 ft - 597.8 ft)	130	130	140	7,700	250	28

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 10: Soil Profile and Estimated Engineering Properties - At Boring B-008-0-20

Landslide: Soil Profile, B-008-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Silty Clay Elevation (659.3 ft - 633.3 ft)	112	112	122	2,450	150	24
Clay Elevation (633.3 ft - 619.8 ft)	112	112	122	2,600	150	25
Silt and Clay Elevation (619.8 ft - 610.5 ft)	125	125	135	6,150	250	28

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 11: Soil Profile and Estimated Engineering Properties - At Boring B-009-0-20

Landslide: Soil Profile, B-009-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Clay Elevation (627 ft - 619.5 ft)	108	108	118	1,450	100	23
Silt and Clay Elevation (619.5 ft - 604.5 ft)	115	115	125	3,250	180	25
Silt and Clay Elevation (604.5 ft - 597 ft)	130	130	140	7,500	250	28

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

Table 12: Soil Profile and Estimated Engineering Properties - At Boring B-010-0-20

Landslide: Soil Profile, B-010-0-20						
Soil Description	**Unit Weight(1) (pcf)**	**Moist Unit Weight(1) (pcf)**	**Saturated Unit Weight(1) (pcf)**	**Undrained Shear Strength(2) (psf)**	**Effective Cohesion(3) (psf)**	**Effective Friction Angle(3) (degrees)**
Silt and Clay Elevation (661 ft - 637 ft)	112	112	122	2,650	150	25
Silty Clay Elevation (637 ft - 625 ft)	112	112	122	2,750	150	25
Silt and Clay Elevation (625 ft - 611.5 ft)	120	120	130	5,300	225	27

Notes:
1. *Values interpreted from Geotechnical Bulletin 7 Table 1.*
2. *Values calculated from Terzaghi and Peck (1967) if $N1_{60}$<52, else Stroud and Butler (1975) was used.*
3. *Values interpreted from Geotechnical Bulletin 7 Table 2, modified when N_{60}>30.*

5.2. Global Stability Analysis

5.2.1. Geological Model

For purposes of evaluating the slope global stability, NEAS created cross-sections every 25 feet along both directions and reviewed site features/project boring logs to determine the subsurface soil conditions that posed the greatest potential for slope instability. In general, cross-sections along the existing roadway alignment were reviewed to determine if the section would represent the existing subsurface conditions that would be most critical to slope stability (i.e., maximum height measured from toe of slope to crest of slope, steepest slope, weak or thick soil layer, etc.).

Based on our review, NEAS developed five and three cross-sectional models along the eastbound and westbound, respectively, to use as the basis for global stability analyses. The five cross sections along the eastbound are STA. 572+25, STA. 576+00, STA. 577+15.59 (middle of culvert), STA. 579+75, and STA. 583+00. The three cross sections along the westbound are STA. 575+81, STA. 578+75, and STA. 58+20.54 (middle of culvert).

These models were developed from NEAS's interpretation of the available information which included: 1) the roadway cross sections (slope geometry) prepared by NEAS; 2) test borings and laboratory data (i.e., soil classifications, SPT data, and strata elevation/thickness information) developed as part of this report; 3) site geological setting, failure features observed in the field; and 4) a live load surcharge of 250 psf, accounting for traffic induced loads. The generalized soil profile in the cross-sectional models was developed by designating representative soil types based on the nearby borings.

The above referenced cross-sectional models were analyzed for long-term (Effective Stress) and short-term (Total Stress) slope stability utilizing the software entitled *Slide 7.0* by Rocscience, Inc. Specifically, the Simplified Bishop, Corrected Janbu, Spencer and GLE method were used to calculate a factor of safety (FOS) for circular type slope failures. The FOS is the ratio of the resisting forces and the driving forces, with the desired safety factor being more than about 1.3 (stable slope) which approximately equates to an AASHTO resistance factor less than 0.75 (per AASHTO's LRFD BDS, the specified resistance factors are essentially the inverse of the FOS that should be targeted in slope stability programs).

Based on our engineering experience and global stability analyses, it is NEAS's opinion that the embankment slope is likely shallow surface failure instead of deep slip surface failure due to the following reasons: 1) the soils encountered at the project site were primarily very stiff to hard cohesive soils, with no weak soil layers encountered in the embankment slope; 2) relatively weaker cohesive soils with high plastic index were encountered at the ground surface; 3) groundwater was not encountered in any of the project borings and water content in the soil samples were relatively low; 4) the slope sloughing off area is wide, long and distributed at both sides of the embankment slope; 5) deep slip surface failure for FOS less than 1.3 was not obtained in the global stability analyses.

Since slope failure features have been observed at the referenced embankment slope, the subsurface profile has been adjusted in order to match the slope failure features observed in the field and simultaneously have a FOS less than 1.3 (long-term) for the cross-sectional models at the existing condition for circular type slope failure. The embankment slope is a 2 Horizontal: 1 Vertical (2H:1V) slope with no project borings being drilled on the slope, a weak surface soil layer was therefore assumed along the embankment slope with the cohesion of 100 psf and internal friction angle of 21 degree, through which shallow slip surface will develop. The surface weak layer is about 10 feet deep. The global stability summary of the existing embankment slope is present in Table 13. The graphical outputs of the existing

slope stability (cross-sectional model, generalized soil profile, calculated factor of safety, and slip surface) are presented in Appendix C.

Table 13: Global Stability Analysis Summary for Existing Emabankment Slope

Global Stability Analsyses of Existing Embankment Slope						
Location	**Station**	**Boring No.**	**Description**	**Minimum Factor of Safety**	**Equivalent Resistance Factor**	**Status (OK/NG)**
Eastbound	STA. 572+25	B-001-0-20 & B-002-0-20	Short Term	4.630	0.22	Good
			Long Term	1.265	0.79	Not Good
	STA. 576+00	B-003-0-20 & B-004-0-20	Short Term	3.976	0.25	Good
			Long Term	1.270	0.79	Not Good
	STA. 577+15.59	B-003-0-20 & B-004-0-20	Short Term	4.034	0.25	Good
			Long Term	1.263	0.79	Not Good
	STA. 579+75	B-005-0-20	Short Term	3.945	0.25	Good
			Long Term	1.240	0.81	Not Good
	STA. 583+00	B-005-0-17	Short Term	4.080	0.25	Good
			Long Term	1.247	0.80	Not Good
Westbound	STA. 575+81	B-006-0-20 & B-007-0-20	Short Term	4.086	0.24	Good
			Long Term	1.273	0.79	Not Good
	STA. 578+75	B-008-0-20 & B-009-0-20	Short Term	4.118	0.24	Good
			Long Term	1.281	0.78	Not Good
	STA. 580+20.54	B-008-0-20 & B-009-0-20	Short Term	4.040	0.25	Good
			Long Term	1.298	0.77	Not Good

5.2.2. Validation with Analysis Results and Field Observation

The embankment slope shows similar failure features (pavement cracking, slope sloughing off and erosion features) on both directions. The global stability analysis results for eastbound STA. 577+15.59 are validated with the failure features observed in the field as an example.

At the STA. 577+15.59 along the turnpike eastbound where the culvert outlet headwall is located, tension cracks were observed at the edge of roadway shoulder (see Figure 1) and the slope has sloughed off and humped over the culvert outlet headwall (see Figure 2). The location where tension cracks were located can be considered as the slide head scarp; while the location where the soils humped over is regarded as the slide toe bulge. As can be seen in our cross-section model of STA. 577+15.59 shown in Figure 3, the slip surface matches the slide features observed in the field.

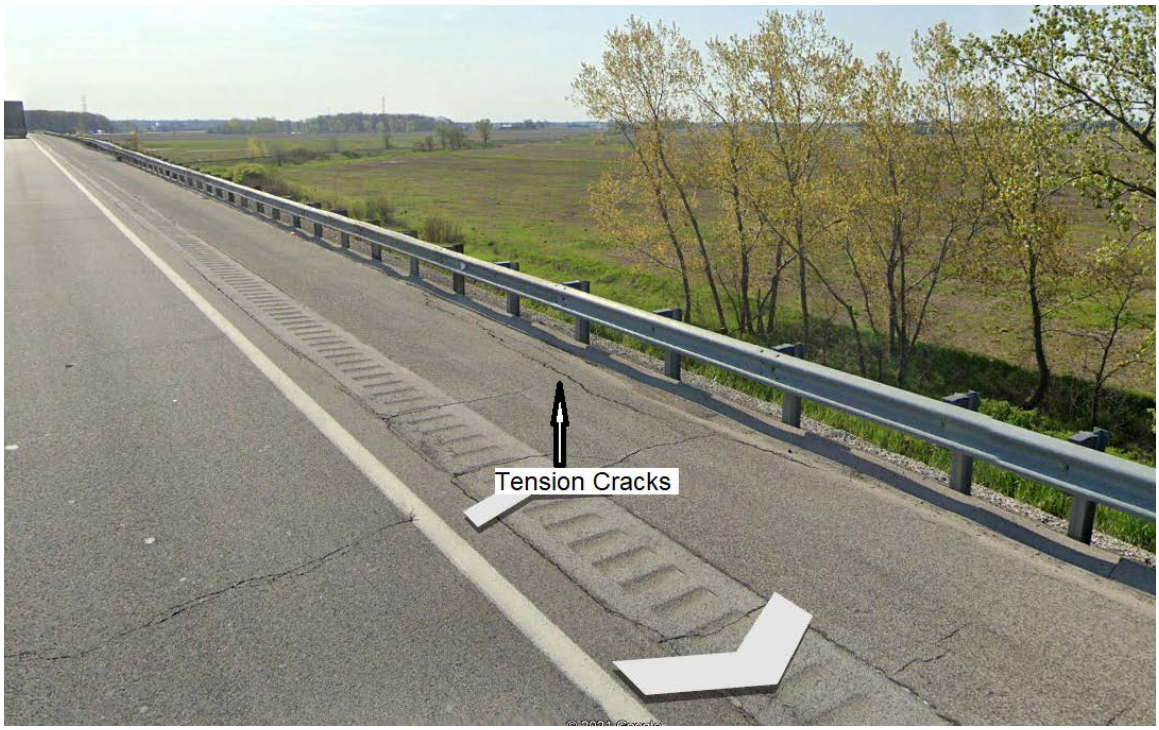

Figure 1: Tension Cracks Observed at STA. 577+15.59 along the turnpike eastbound

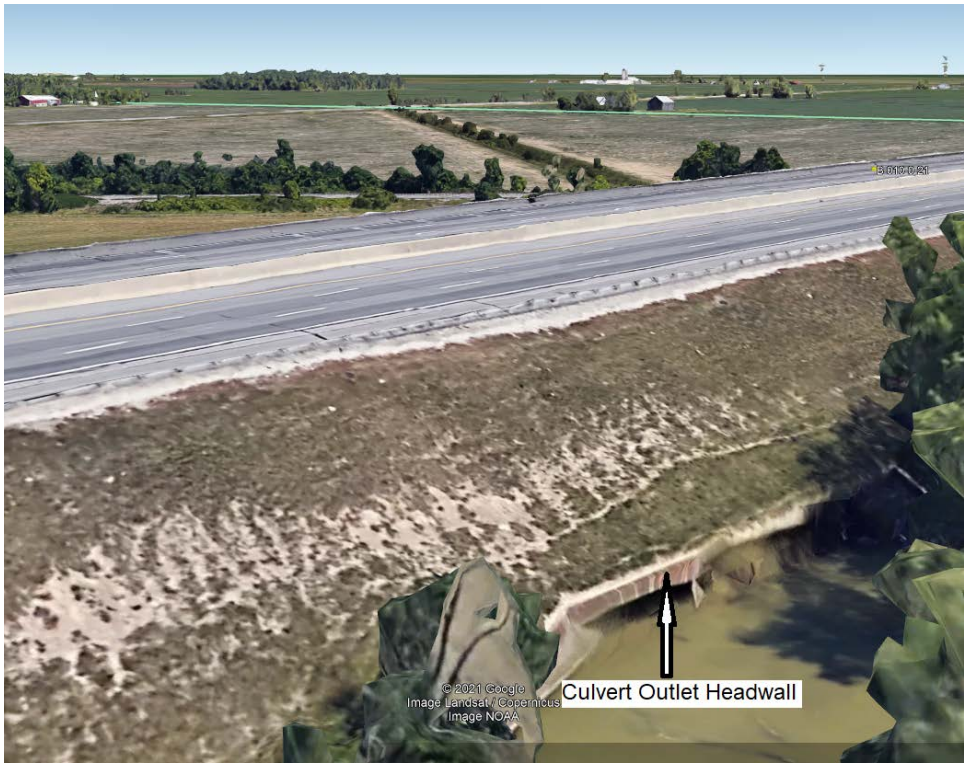

Figure 2: Slope Failure Features Above Culvert Outlet Headwall

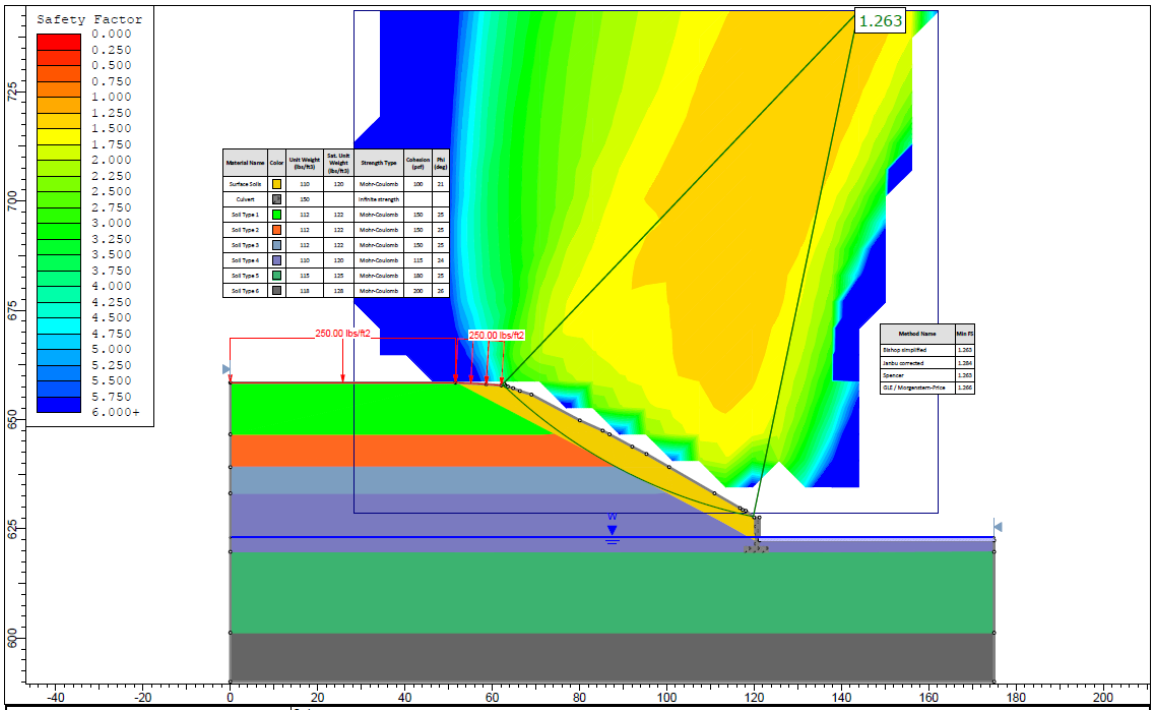

Figure 3: Global Stability Analysis Result at STA. 577+15.59

5.2.1. Possible Cause of Embankment Slope Failure

Based on the soil characteristics, lab testing results, global stability analyses and our engineering experience, it is NEAS's opinion that the embankment slope was built with compacted engineered fills. The fills were very stiff to hard cohesive soils and have kept the embankment slope stable for many years. However, as time went by and the surface fills were wetted and dried repeatedly during alternating rainy and dry periods, they gradually swelled and grew softer and weaker. The shear strength of the surface fills decreased gradually, which is the possible cause of the embankment slope failure.

5.3. Stabilization Recommendations

NEAS recommends stabilizing the existing embankment slope by digging out the failed soil mass in a benched excavation. The uniform or benched excavation shall be replaced with well-compacted engineered COHESIVE embankment fills (Item 203 Cohesive Embankment), per Item 203 of the ODOT Construction and Material Specifications. Item 203 Granular Embankment fills are not recommended, since it is a 2H:1V slope and they will not stabilize the embankment slope. Proper lift thicknesses and material density are to be maintained in the fills, per Item 203.06. Slope groundwater drain is also recommended to be installed for the back slope of each bench along the entire length of the excavation. This slope drain is typically made up of an 18-inch thick layer of Item 203 Granular Embankment, with Item 690E12010 SPECIAL Geotextile Fabric, 712.09 Type A, to prevent infiltration of fines into the drain.

Extra global stability analyses were carried out by replacing the surface weak soil layer with Item 203 Cohesive Embankment fills. The soil properties of Item 203 Cohesive Embankment fills are based on Geotechnical Bulletin 2- Special Benching and Sidehill Embankment Fills. Based on our analyses, the

minimum FOS for the stabilized embankment slope for short-term (Total Stress) and long-term (Effective Stress) conditions exceeded the desired value of 1.3. It is our opinion that the stabilized embankment slope can be considered to be stable at short-term and long-term condition. The global stability summary of the stabilized embankment slope is present in Table 14. The graphical outputs of the existing slope stability (cross-sectional model, generalized soil profile, calculated factor of safety, and slip surface) are presented in Appendix D.

Table 14: Global Stability Analysis Summary for Stabilized Emabankment Slope

Global Stability Analsyses of Stabilized Embankment Slope						
Location	**Station**	**Boring No.**	**Description**	**Minimum Factor of Safety**	**Equivalent Resistance Factor**	**Status (OK/NG)**
Eastbound	STA. 572+25	B-001-0-20 & B-002-0-20	Short Term	5.339	0.19	Good
			Long Term	1.463	0.68	Good
	STA. 576+00	B-003-0-20 & B-004-0-20	Short Term	4.317	0.23	Good
			Long Term	1.466	0.68	Good
	STA. 577+15.59	B-003-0-20 & B-004-0-20	Short Term	4.120	0.24	Good
			Long Term	1.342	0.75	Good
	STA. 579+75	B-005-0-20	Short Term	4.019	0.25	Good
			Long Term	1.442	0.69	Good
	STA. 583+00	B-005-0-17	Short Term	4.110	0.24	Good
			Long Term	1.432	0.70	Good
Westbound	STA. 575+81	B-006-0-20 & B-007-0-20	Short Term	4.313	0.23	Good
			Long Term	1.449	0.69	Good
	STA. 578+75	B-008-0-20 & B-009-0-20	Short Term	4.182	0.24	Good
			Long Term	1.441	0.69	Good
	STA. 580+20.54	B-008-0-20 & B-009-0-20	Short Term	1.359	0.74	Good
			Long Term	4.039	0.25	Good

5.4. Seismic Design Parameters

Based on the results of the subsurface exploration, laboratory test data, and the AASHTO Site Class Definitions indicated in Table 3.10.3.1-1 of the *LRFD Bridge Design Specifications, 9th Edition* (AASHTO LRFD, 2020), we recommend a project site classification of D – Stiff Soil. Following seismic site classification, seismic design parameters for the site were developed using the web-based ATC Hazards by Location (ATC, 2019) which references the 2016 AASHTO Guide Specifications for LRFD Seismic Bridge Design. The ATC Hazards by Location Maps generated LRFD Seismic Design parameters as presented in Table 15. The ATC Hazards by Location Maps detailed report can be found in Appendix E.

Table 15: Seismic Design Parameters

Variable	Symbol (AASHTO 3.10)	Value
Latitude		41.511464
Longitude		-83.422943
Site Class		D
Peak Ground Acceleration	PGA	0.07g
Short Period Acceleration	S_s	0.134g
Long Period Acceleration	S_1	0.054g
Site Factor (zero period)	F_{PGA}	1.6
Site Factor (short period)	F_a	1.6
Site Factor (long period)	F_v	2.4
Zero period response seismic coefficient	$A_s = F_{PGA} * PGA$	0.112g
Short period response seismic coefficient (0.2 seconds)	$S_{DS} = F_a * S_s$	0.143g
Long period response seismic coefficient (1.0 second)	$S_{D1} = F_v * S_1$	0.086g
Seismic Design Category	SDC	B

6. QUALIFICATIONS

This investigation was performed in accordance with accepted geotechnical engineering practice for the purpose of characterizing the subsurface conditions at the site of OTIC GES Slope Repair project (No. 99-20-04, Task 1). This report has been prepared for OTIC, MS Consultants Inc., and their design consultants, to be used solely in evaluating the soils underlying the project site and presenting geotechnical engineering recommendations specific to this project. The assessment of general site environmental conditions or the presence of pollutants in the soil, rock and groundwater of the site was beyond the scope of this geotechnical exploration. Our recommendations are based on the results of our field explorations, laboratory test results from representative soil samples, and geotechnical engineering analyses. The results of the field explorations and laboratory tests, which form the basis of our recommendations, are presented in the appendices as noted. This report does not reflect any variations that may occur between the borings or elsewhere on the site, or variations whose nature and extent may not become evident until a later stage of construction. In the event that any changes in the nature, design or location of the proposed project are made, the conclusions and recommendations contained in this report should not be considered valid until they are reviewed and have been modified or verified in writing by a professional geotechnical engineer.

It has been a pleasure to be of service to MS Consultants Inc. in performing this geotechnical exploration for the OTIC GES Slope Repair project (No. 99-20-04, Task 1). Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

National Engineering and Architectural Services Inc.

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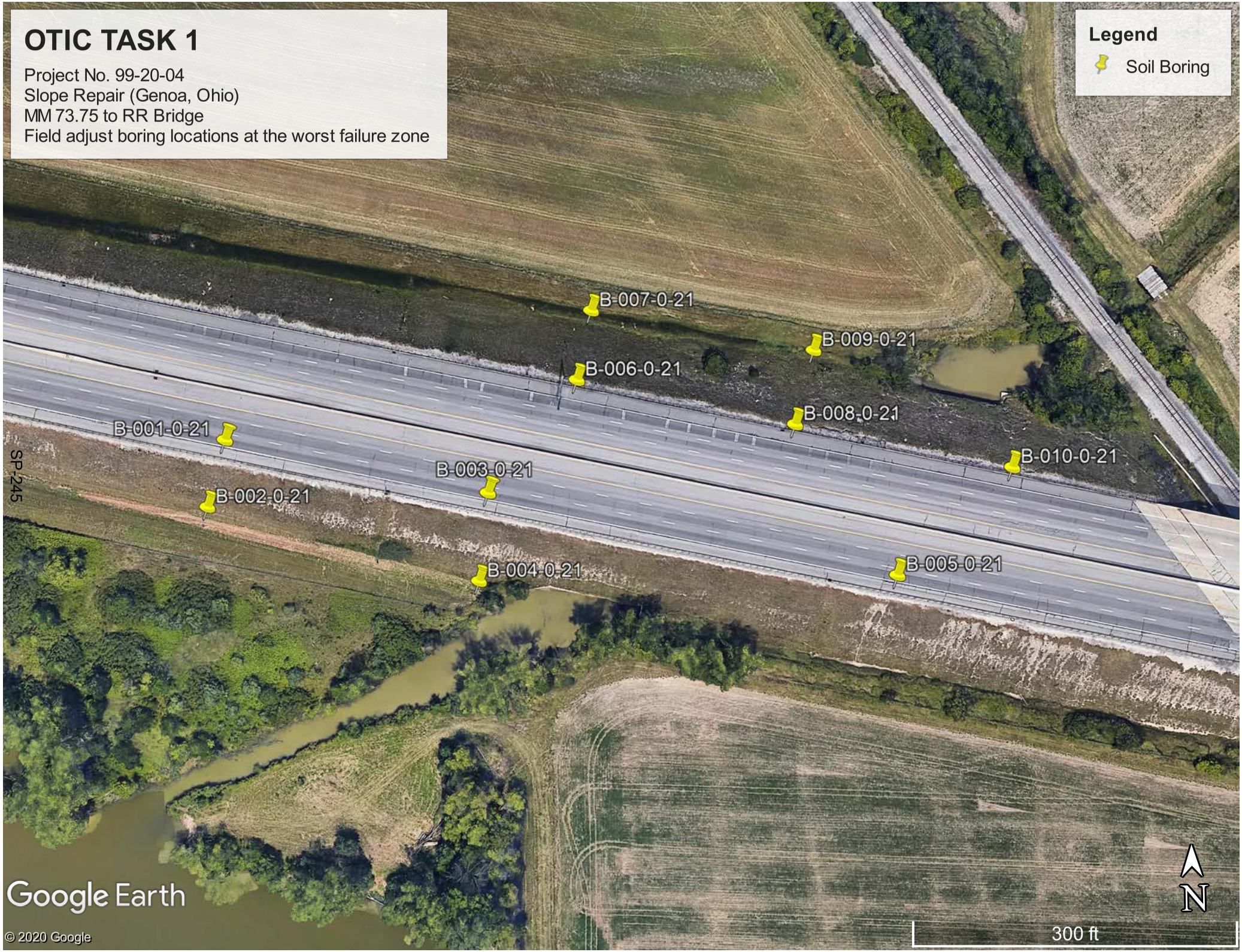
APPENDIX A

BORING PLAN


OTIC TASK 1
Project No. 99-20-04
Slope Repair (Genoa, Ohio)
MM 73.75 to RR Bridge
Field adjust boring locations at the worst failure zone
Legend
Soil Boring
B-007-0-21
B-009-0-21
B-006-0-21
B-008-0-21
B-001-0-21
B-010-0-21
B-003-0-21
B-002-0-21
B-004-0-21
B-005-0-21
SP-245
Google Earth
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N
300 ft

APPENDIX B

SOIL BORING LOGS AND LAB TEST REPORTS

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 572+11, 56' RT.	EXPLORATION ID B-001-0-20
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE	
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 652.2 (MSL) EOB: 45.0 ft.	PAGE 1 OF 2
START: 1/11/21 END: 1/11/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.511464, -83.422943	

MATERIAL DESCRIPTION AND NOTES	ELEV. 652.2	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
10.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	650.9	1																
HARD, BROWNISH GRAY, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP		2	8 10 13	26	56	SS-1	4.50	-	-	-	-	-	-	-	-	12	A-6b (V)	
		3																
		4	8 11 14	29	56	SS-2	4.50	-	-	-	-	-	-	-	-	12	A-6b (V)	
		5	10 12 15	31	50	SS-3	4.50	-	-	-	-	-	-	-	-	11	A-6b (V)	
		6																
		7	10 11 16	31	44	SS-4	4.50	13	7	11	34	35	31	15	16	10	A-6b (9)	
		8	8 14 16	34	39	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
		9	7 13 15	32	44	SS-6	4.50	-	-	-	-	-	-	-	-	12	A-6b (V)	
		10																
		11	6 6 9	17	44	SS-7	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
		12	10 10 14	27	89	SS-8	4.50	-	-	-	-	-	-	-	-	12	A-6b (V)	
		13																
		14	10 11 12	26	56	SS-9	4.50	-	-	-	-	-	-	-	-	11	A-6b (V)	
		15	7 9 11	23	67	SS-10	4.50	-	-	-	-	-	-	-	-	12	A-6b (V)	
		16																
		17	10 13 15	32	67	SS-11	4.50	-	-	-	-	-	-	-	-	12	A-6b (V)	
		18	10 13 12	29	89	SS-12	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		19																
		20	8 10 11	24	56	SS-13	4.25	3	7	14	35	41	37	18	19	16	A-6b (12)	
		21																
	629.7	22	9 11 11	25	50	SS-14	4.50	3	7	14	36	40	32	16	16	13	A-6b (10)	
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	628.2	23	8 11 9	23	72	SS-15	4.50	7	6	12	37	38	31	16	15	12	A-6a (10)	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN BECOMING BROWNISH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, SS-16 CONTAINS IRON STAINING, SS-17 CONTAINS RED BRICK FRAGMENTS, DAMP TO MOIST		24																
		25	9 10 13	26	83	SS-16	4.25	1	4	15	24	56	42	21	21	20	A-7-6 (13)	
		26	9 10 10	23	67	SS-17	3.50	-	-	-	-	-	-	-	-	25	A-7-6 (V)	
		27																
		28	10 12 12	27	56	SS-18	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		29																
	622.2		10 12 17	33	83	SS-19	4.25	-	-	-	-	-	-	-	-	18	A-7-6 (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 572+11, 56' RT.	START: 1/11/21	END: 1/11/21	PG 2 OF 2	B-001-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
HARD, GRAY AND BROWN BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	622.2	31	12 13 15	32	67	SS-20	4.25	3	7	13	28	49	32	17	15	15	A-6a (10)	
		32	15 17 20	42	89	SS-21	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		33	14 19 22	47	78	SS-22	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		34	15 20 21	47	89	SS-23	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		35	19 20 19	44	78	SS-24	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		36	15 17 21	43	89	SS-25	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		37	16 17 22	44	67	SS-26	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		38	15 19 24	49	56	SS-27	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		39	10 11 14	29	89	SS-28	4.50	3	6	12	29	50	28	16	12	14	A-6a (9)	
		40	12 12 16	32	100	SS-29	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
	607.2	EOB 45																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; POURED 2 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 572+11, 133' RT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 627.5 (MSL) EOB: 29.1 ft.
START: 1/11/21 END: 1/11/21	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 81.9	LAT / LONG: 41.511259, -83.423008

EXPLORATION ID B-002-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 627.5	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
STIFF TO VERY STIFF, BROWNISH GRAY, **CLAY**, SOME SILT, LITTLE TO SOME SAND, TRACE GRAVEL, CONTAINS ROOTS AND TRACE IRON STAINING, MOIST		1	3 3 4	10	39	SS-1	3.00	-	-	-	-	-	-	-	-	23	A-7-6 (V)	
		2	4 5 6	15	33	SS-2	2.00	1	4	19	29	47	45	19	26	23	A-7-6 (15)	
	623.0	3 4	5 6 7	18	100	SS-3	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
VERY STIFF TO HARD, BROWNISH GRAY AND GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, MOIST TO DAMP		5	3 8 14	30	100	SS-4	4.50	5	7	13	29	46	30	17	13	15	A-6a (9)	
		6 7	4 7 17	33	100	SS-5	4.50	-	-	-	-	-	-	-	-	23	A-6a (V)	
		8	5 11 19	41	89	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
@9.0'; BECOMES GRAY		9 10	7 10 16	35	100	SS-7	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		11	5 11 17	38	50	SS-8	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		12 13	7 11 15	35	39	SS-9	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		14	3 6 10	22	89	SS-10	4.50	2	6	12	32	48	27	15	12	12	A-6a (9)	
		15 16	3 3 7	14	100	SS-11	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		17	2 4 8	16	100	SS-12	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
@18.3'; ST-1 CONTAINS A >3.0" SHALE COBBLE @19.0'-19.5'; Qu = 6858 PSF @ >15.0%		18 19			77	ST-1	3.60	4	5	10	39	42	28	16	12	15	A-6a (9)	
		20	5 9 13	30	78	SS-13	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
	606.0	21																
VERY STIFF TO HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP		22	5 7 8	20	100	SS-14	3.00	5	7	17	35	36	22	14	8	14	A-4a (7)	
		23 24	4 8 11	26	100	SS-15	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		25	12 28 35	86	78	SS-16	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		26 27	21 30 40	96	100	SS-17	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		28	50/2"	-	50	SS-18	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
	598.4	EOB 29	50/1"	-	0	SS-19	-	-	-	-	-	-	-	-	-	-		
@29.0'; SS-19 CONTAINS NO RECOVERY																		

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED 1 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 576+08, 55' RT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 657.1 (MSL) EOB: 50.0 ft.
START: 1/11/21 END: 1/12/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.511229, -83.421526

EXPLORATION ID B-003-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 657.1	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
10.0" ASPHALT AND 7.0" BASE (DRILLERS DESCRIPTION)	655.7	1																
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP		2	4 5 6	13	56	SS-1	4.50	4	7	12	35	42	31	16	15	14	A-6a (10)	
		3	4 7 9	18	67	SS-2	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		4	4 8 9	19	56	SS-3	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		5	6 7 10	19	78	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		6	7 10 13	26	67	SS-5	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		7	7 11 14	29	67	SS-6	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
	646.6	8																
HARD, BROWNISH GRAY, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP TO MOIST		9	8 9 10	22	78	SS-7	4.50	5	8	15	37	35	25	15	10	11	A-4a (7)	
		10	10 12 10	25	89	SS-8	4.50	-	-	-	-	-	-	-	-	12	A-4a (V)	
		11	8 12 12	27	72	SS-9	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		12	10 10 13	26	83	SS-10	4.50	-	-	-	-	-	-	-	-	16	A-4a (V)	
		13	9 7 7	16	67	SS-11	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
	639.1	14																
HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP		15	7 9 11	23	83	SS-12	4.50	5	7	13	35	40	28	16	12	13	A-6a (9)	
		16	7 7 9	18	56	SS-13	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		17	6 8 9	19	67	SS-14	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		18	9 10 13	26	67	SS-15	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
	633.1	19																
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, CONTAINS IRON STAINING, SS-20 CONTAINS RED BRICK FRAGMENTS, DAMP TO MOIST		20	11 11 13	27	67	SS-16	4.50	3	7	14	34	42	33	17	16	15	A-6b (10)	
		21	7 8 10	21	72	SS-17	4.25	-	-	-	-	-	-	-	-	14	A-6b (V)	
		22	7 7 10	19	78	SS-18	3.25	-	-	-	-	-	-	-	-	19	A-6b (V)	
@28.5' TO 31.5'; SS-19 AND SS-20 BECOMES DARK BROWN MOTTLED WITH GRAY		23	8 10 11	24	72	SS-19	4.25	-	-	-	-	-	-	-	-	24	A-6b (V)	
		24																
		25																
		26																
		27																
		28																
		29																

SP-250

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 576+08, 55' RT.	START: 1/11/21	END: 1/12/21	PG 2 OF 2	B-003-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **SILTY CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, CONTAINS IRON STAINING, SS-20 CONTAINS RED BRICK FRAGMENTS, DAMP TO MOIST *(continued)* @31.5'; SS-21 CONTAINS NO RECOVERY @33.0' TO 37.5'; SS-22 TO SS-24 BECOME BROWN	627.1	31	7 11 11	25	56	SS-20	4.25	6	8	13	27	46	36	18	18	19	A-6b (11)	
		32	8 9 11	23	0	SS-21	-	-	-	-	-	-	-	-	-	-		
		33	5 8 10	21	83	SS-22	4.50	-	-	-	-	-	-	-	-	19	A-6b (V)	
		34	10 21 22	49	78	SS-23	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	
		35	12 22 24	52	61	SS-24	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		36																
		37																
HARD, BROWN AND GRAY BECOMING GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP	619.6	38	12 18 18	41	89	SS-25	4.50	5	6	12	36	41	31	17	14	13	A-6a (10)	
		39	11 16 21	42	94	SS-26	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		40	12 13 22	40	78	SS-27	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		41	12 15 21	41	72	SS-28	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		42	15 16 18	39	78	SS-29	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		43	16 19 21	46	78	SS-30	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
		44	10 12 14	30	78	SS-31	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		45	11 10 15	29	100	SS-32	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		46																
		47																
		48																
		49																
	607.1	EOB 50																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; POURED 2 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 576+01, 155' RT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 628.7 (MSL) EOB: 30.5 ft.
START: 1/11/21 END: 1/11/21	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 81.9	LAT / LONG: 41.510965, -83.421629

EXPLORATION ID B-004-0-20

PAGE 1 OF 2

MATERIAL DESCRIPTION AND NOTES	ELEV. 628.7	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
HARD, BROWNISH GRAY, **CLAY**, "AND" SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS ROOTS AND TRACE IRON STAINING, DAMP	619.7	1	3 4 5	12	56	SS-1	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		2	4 7 7	19	44	SS-2	4.25	0	2	10	37	51	50	24	26	22	A-7-6 (16)	
		3	3 5 5	14	100	SS-3	4.50	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
		4	3 5 8	18	100	SS-4	4.25	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		5	2 4 6	14	100	SS-5	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		6	4 7 14	29	100	SS-6	4.50	-	-	-	-	-	-	-	-	14	A-7-6 (V)	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, SS-7 CONTAINS TRACE IRON STAINING, DAMP	616.7	7	8 8 9	23	100	SS-7	4.50	4	6	12	31	47	28	16	12	13	A-6a (9)	
		8	9 9 13	30	100	SS-8	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
HARD, BROWNISH GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	614.7	9			69	ST-1	4.50	4	5	12	35	44	37	18	19	16	A-6b (12)	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		10	10 11 19	41	89	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		11	3 6 10	22	100	SS-10	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		12	4 7 11	25	100	SS-11	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		13	5 7 14	29	100	SS-12	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		14	6 7 12	26	100	SS-13	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		15	4 6 10	22	89	SS-14	4.50	5	9	11	29	46	28	16	12	13	A-6a (9)	
		16	8 9 12	29	100	SS-15	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		17	10 9 14	31	100	SS-16	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		18	7 7 14	29	89	SS-17	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		19	4 17 25	57	100	SS-18	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
		20	5 20	60	100	SS-19	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 576+01, 155' RT.	START: 1/11/21	END: 1/11/21	PG 2 OF 2	B-004-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
	598.7																	
	598.2	EOB	24															

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 579+75, 57' RT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 660.0 (MSL) EOB: 60.0 ft.
START: 1/12/21 END: 1/12/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.9	LAT / LONG: 41.511006, -83.420218

EXPLORATION ID B-005-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 660.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
10.0" ASPHALT AND 6.0" BASE (DRILLERS DESCRIPTION)	658.7	1																
VERY STIFF TO HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP		2	6 8 11	26	100	SS-1	4.50	4	8	14	33	41	27	15	12	12	A-6a (9)	
		3 4	4 7 9	22	100	SS-2	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		5 6	5 6 7	18	100	SS-3	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		7 8	6 6 8	19	100	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		9 10	6 9 11	27	100	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		11 12	7 7 9	22	100	SS-6	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		13 14	5 6 8	19	100	SS-7	4.50	3	7	15	34	41	25	14	11	11	A-6a (8)	
		15 16	5 7 9	22	100	SS-8	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		17 18	5 10 13	31	100	SS-9	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		19 20	6 8 9	23	100	SS-10	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
@16.5' TO 18.0'; SS-11 BECOMES BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, CONTAINS IRON STAINING		21 22	3 3 4	10	100	SS-11	4.00	4	5	13	35	43	32	17	15	16	A-6a (10)	
		23 24	4 5 7	16	100	SS-12	4.50	4	5	12	33	46	31	16	15	14	A-6a (10)	
		25 26	3 5 7	16	100	SS-13	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		27 28	5 5 7	16	100	SS-14	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		29	5 7 11	25	100	SS-15	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
			6 6 10	22	100	SS-16	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
			3 4 5	12	100	SS-17	4.25	-	-	-	-	-	-	-	-	15	A-6a (V)	
	631.5		5 5 5	14	100	SS-18	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
HARD, BROWNISH GRAY AND BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST			3 3 5	11	100	SS-19	4.25	5	6	13	35	41	34	17	17	16	A-6b (11)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 579+75, 57' RT.	START: 1/12/21	END: 1/12/21	PG 2 OF 2	B-005-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 630.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
HARD, BROWNISH GRAY AND BROWN, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST *(continued)*		31	4 3 6	12	100	SS-20	4.25	-	-	-	-	-	-	-	-	17	A-6b (V)	
		32	3 6 7	18	100	SS-21	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	
@33.0'; SS-22 BECOMES DARK BROWNISH GRAY AND BROWN		33	4 7 10	23	100	SS-22	4.50	-	-	-	-	-	-	-	-	22	A-6b (V)	
@34.5'; SS-23 THROUGH SS-26 BECOMES BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, CONTAINS IRON STAINING		34	3 4 4	11	100	SS-23	4.50	-	-	-	-	-	-	-	-	17	A-6b (V)	
		35	2 4 7	15	100	SS-24	4.25	-	-	-	-	-	-	-	-	20	A-6b (V)	
		36	2 10 13	31	100	SS-25	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
		37	3 9 15	33	100	SS-26	4.25	-	-	-	-	-	-	-	-	13	A-6b (V)	
	619.5	38																
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		39	7 11 18	40	100	SS-27	4.50	6	6	12	33	43	29	15	14	12	A-6a (10)	
		40	6 10 16	35	100	SS-28	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		41	7 10 14	33	100	SS-29	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		42	4 12 12	33	100	SS-30	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		43	6 9 15	33	100	SS-31	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		44	6 9 12	29	83	SS-32	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		45	8 10 12	30	89	SS-33	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		46	9 10 14	33	100	SS-34	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		47	9 12 16	38	89	SS-35	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
		48	8 11 17	38	89	SS-36	4.50	-	-	-	-	-	-	-	-	19	A-6a (V)	
	604.5	49																
VERY STIFF TO HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, MOIST		50	7 10 14	33	78	SS-37	4.50	-	-	-	-	-	-	-	-	16	A-4a (V)	
	601.5	51	5 7 9	22	100	SS-38	3.50	3	11	15	35	36	22	15	7	17	A-4a (7)	
VERY STIFF, GRAY, **SILTY CLAY**, TRACE SAND, TRACE GRAVEL, MOIST	600.0	52	6 7 10	23	100	SS-39	4.00	1	2	4	33	60	34	18	16	23	A-6b (10)	
		EOB 53																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; POURED 3 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 575+60, 58' LT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 656.4 (MSL) EOB: 49.5 ft.
START: 1/14/21 END: 1/14/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.9	LAT / LONG: 41.511560, -83.421608

EXPLORATION ID B-006-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 656.4	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
12.0" ASPHALT AND 5.0" BASE (DRILLERS DESCRIPTION)	655.0	1																
VERY STIFF TO HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP TO MOIST		2	2 3 5	11	100	SS-1	2.75	12	11	17	29	31	32	17	15	17	A-6a (7)	
		3 4	2 4 4	11	100	SS-2	2.75	-	-	-	-	-	-	-	-	15	A-6a (V)	
		5 6	2 4 11	20	100	SS-3	2.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
@6.0' TO 19.5'; SS-4 TO SS-12 BECOME BROWNISH GRAY		7	3 5 10	20	100	SS-4	4.50	7	5	12	35	41	30	15	15	12	A-6a (10)	
		8 9	6 9 8	23	100	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		10	5 7 7	19	100	SS-6	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	
		11 12	7 7 7	19	100	SS-7	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		13	7 7 8	20	100	SS-8	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		14 15	5 4 8	16	100	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		16	5 7 8	20	100	SS-10	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		17	7 8 8	22	100	SS-11	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		18 19	7 8 9	23	100	SS-12	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
@19.5' TO 27.0'; SS-13 TO SS-17 BECOME BROWNISH GRAY MOTTLED WITH GRAY AND ORANGISH BROWN, CONTAINS IRON STAINING		20	3 2 5	10	100	SS-13	4.50	4	6	13	38	39	29	15	14	14	A-6a (10)	
		21 22	4 4 5	12	100	SS-14	4.25	4	8	13	27	48	31	16	15	18	A-6a (10)	
		23 24	3 3 4	10	100	SS-15	3.00	-	-	-	-	-	-	-	-	20	A-6a (V)	
		25	2 4 5	12	100	SS-16	4.25	-	-	-	-	-	-	-	-	15	A-6a (V)	
		26	3 4 5	12	100	SS-17	3.50	-	-	-	-	-	-	-	-	20	A-6a (V)	
@27.0' TO 30.0'; SS-18 AND SS-19 BECOME DARK BROWNISH GRAY		27 28	2 6 8	19	100	SS-18	4.50	4	7	14	32	43	26	15	11	15	A-6a (8)	
		29	3 4 5	12	100	SS-19	4.50	-	-	-	-	-	-	-	-	19	A-6a (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 575+60, 58' LT.	START: 1/14/21	END: 1/14/21	PG 2 OF 2	B-006-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, BROWN AND GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE TO LITTLE GRAVEL, DAMP TO MOIST *(continued)*	626.4	31	4 7 10	23	100	SS-20	4.00	-	-	-	-	-	-	-	-	18	A-6a (V)	
@30.0' TO 33.0'; SS-20 AND SS-21 BECOME BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, CONTAINS HEAVY IRON STAINING		32	3 8 12	27	100	SS-21	4.50	-	-	-	-	-	-	-	-	16	A-6a (V)	
@33.0' TO 37.5'; SS-22 TO SS-24 BECOME BROWN AND BROWNISH GRAY		33	6 12 15	37	100	SS-22	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		35	8 13 17	41	100	SS-23	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		37	8 10 16	35	100	SS-24	4.25	-	-	-	-	-	-	-	-	14	A-6a (V)	
@37.5'; SS-25 CONTAINS NO RECOVERY		38	8 14 19	45	0	SS-25	-	-	-	-	-	-	-	-	-	-		
@39.0'; BECOMES GRAY		40	8 11 17	38	100	SS-26	4.50	5	6	12	35	42	29	15	14	13	A-6a (10)	
		41	8 10 19	40	100	SS-27	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		43	7 12 15	37	100	SS-28	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		44	7 10 15	34	100	SS-29	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		46	8 8 13	29	100	SS-30	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		47	8 12 16	38	100	SS-31	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
	606.9	49 EOB	7 11 11	30	100	SS-32	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; POURED 3 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 575+55, 147' LT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 627.0 (MSL) EOB: 29.2 ft.
START: 1/13/21 END: 1/13/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.9	LAT / LONG: 41.511802, -83.421556

EXPLORATION ID B-007-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 627.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN BECOMING BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, SS-1 CONTAINS TRACE ROOTS, SS-1 THROUGH SS-3 CONTAIN IRON STAINING, MOIST TO DAMP	619.5	1	3 4 5	12	44	SS-1	3.25	2	3	12	31	52	57	25	32	27	A-7-6 (19)	
		2	3 5 6	15	56	SS-2	4.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		3	3 4 5	12	100	SS-3	4.25	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		4	4 10 12	30	100	SS-4	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		5	6 9 14	31	100	SS-5	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
HARD, BROWNISH GRAY BECOMING GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP	609.0	6	6 9 15	33	100	SS-6	4.50	6	6	12	35	41	32	16	16	14	A-6b (10)	
		7	4 9 9	25	100	SS-7	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		8	5 9 11	27	100	SS-8	4.50	-	-	-	-	-	-	-	-	13	A-6b (V)	
		9	4 6 10	22	100	SS-9	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		10	4 7 12	26	100	SS-10	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		11	5 6 10	22	100	SS-11	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		12	6 7 9	22	100	SS-12	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
VERY STIFF TO HARD, GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP TO MOIST	600.0	13	3 4 7	15	100	SS-13	3.00	10	8	14	30	38	25	14	11	13	A-6a (7)	
		14	3 6 9	20	100	SS-14	3.75	-	-	-	-	-	-	-	-	20	A-6a (V)	
		15	3 6 10	22	100	SS-15	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		16	6 20 20	55	100	SS-16	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
		17	4 21 22	59	100	SS-17	4.50	-	-	-	-	-	-	-	-	9	A-6a (V)	
		18	10 17 31	66	100	SS-18	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	
HARD, GRAY, **SANDY SILT**, LITTLE CLAY, TRACE GRAVEL, DAMP	597.8	19	12 22 29	70	100	SS-19	4.50	9	18	25	34	14	19	14	5	8	A-4a (3)	
		EOB 20	46 50/2"	-	50	SS-20	4.50	-	-	-	-	-	-	-	-	8	A-4a (V)	

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED 1 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 578+58, 56' LT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 659.3 (MSL) EOB: 48.8 ft.
START: 1/14/21 END: 1/14/21	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 68.4	LAT / LONG: 41.511380, -83.420545

EXPLORATION ID B-008-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 659.3	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
9.5" ASPHALT AND 7.5" BASE (DRILLERS DESCRIPTION)	657.9	1																
HARD, GRAYISH BROWN BECOMING GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		2	4 4 5	10	78	SS-1	4.50	7	6	12	30	45	30	16	14	13	A-6a (10)	
		3																
		4	4 5 6	13	44	SS-2	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		5	6 8 8	18	56	SS-3	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		6																
		7	7 10 10	23	50	SS-4	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		8	7 11 9	23	61	SS-5	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		9																
		10	7 12 10	25	67	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		11	8 10 13	26	56	SS-7	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		12																
		13	8 12 14	30	61	SS-8	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		14	6 8 9	19	72	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		15																
	642.8	16	6 7 7	16	89	SS-10	4.50	3	5	12	29	51	28	15	13	12	A-6a (9)	
VERY STIFF TO HARD, GRAY BECOMING BROWNISH GRAY MOTTLED WITH GRAY, **SILTY CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		17	7 8 9	19	94	SS-11	4.50	-	-	-	-	-	-	-	-	14	A-6b (V)	
		18																
		19	6 8 8	18	100	SS-12	4.50	-	-	-	-	-	-	-	-	15	A-6b (V)	
		20	6 7 9	18	100	SS-13	4.25	-	-	-	-	-	-	-	-	16	A-6b (V)	
		21																
@22.0'-22.5'; Qu = 5479 PSF @ >15.0%		22			79	ST-1	3.90	3	4	13	36	44	35	18	17	18	A-6b (11)	
		23																
		24	7 7 10	19	89	SS-14	4.25	-	-	-	-	-	-	-	-	19	A-6b (V)	
		25	7 9 10	22	89	SS-15	3.75	-	-	-	-	-	-	-	-	17	A-6b (V)	
	633.3	26																
VERY STIFF TO HARD, BROWNISH GRAY MOTTLED WITH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST		27	5 6 8	16	100	SS-16	3.00	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		28	6 5 10	17	94	SS-17	3.25	2	4	14	33	47	42	21	21	21	A-7-6 (13)	
		29	7 7	19	83	SS-18	3.75	-	-	-	-	-	-	-	-	22	A-7-6 (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 578+58, 56' LT.	START: 1/14/21	END: 1/14/21	PG 2 OF 2	B-008-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, BROWNISH GRAY MOTTLED WITH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, DAMP TO MOIST *(continued)*	629.3	31	10 7 8 9	19	78	SS-19	4.50	-	-	-	-	-	-	-	-	15	A-7-6 (V)	
		32																
		33	7 8 10	21	89	SS-20	4.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		34	7 8 12	23	100	SS-21	4.50	0	3	14	29	54	44	21	23	19	A-7-6 (14)	
		35																
		36	8 10 10	23	89	SS-22	4.00	-	-	-	-	-	-	-	-	22	A-7-6 (V)	
		37	9 10 12	25	100	SS-23	3.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		38																
	619.8	39	10 10 13	26	94	SS-24	4.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
HARD, GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		40	12 14 15	33	83	SS-25	4.50	4	6	12	36	42	31	16	15	13	A-6a (10)	
		41																
		42	11 19 20	44	78	SS-26	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		43	10 20 23	49	56	SS-27	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		44																
		45	12 19 26	51	44	SS-28	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		46	14 23 24	54	50	SS-29	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		47																
		48	16 27 30	65	100	SS-30	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
@48.5'; SS-31 CONTAINS NO RECOVERY	610.5	EOB	50/3"	-	0	SS-31	-	-	-	-	-	-	-	-	-	-		

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; POURED 2 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / J. HODGES	DRILL RIG: CME 55X	STATION / OFFSET: 578+60, 150' LT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / J. HODGES	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 627.0 (MSL) EOB: 30.0 ft.
START: 1/13/21 END: 1/13/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 81.9	LAT / LONG: 41.511629, -83.420466

EXPLORATION ID B-009-0-20

PAGE 1 OF 1

MATERIAL DESCRIPTION AND NOTES	ELEV. 627.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
4.0" TOPSOIL (DRILLERS DESCRIPTION)	626.7	1	1 1 2	4	56	SS-1	3.25	5	5	13	35	42	58	29	29	36	A-7-6 (19)	
VERY STIFF TO HARD, DARK BROWN BECOMING BROWN AND BROWNISH GRAY, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING AND ROOTS, MOIST TO DAMP		2	3 6 7	18	89	SS-2	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		3	3 3 5	11	67	SS-3	3.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	
		4	4 4 6	14	67	SS-4	2.75	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
	619.5	5	3 4 5	12	100	SS-5	4.25	-	-	-	-	-	-	-	-	16	A-7-6 (V)	
HARD, GRAY AND BROWNISH GRAY, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, DAMP		6	3 6 10	22	100	SS-6	4.50	6	6	12	36	40	28	15	13	13	A-6a (9)	
		7	6 10 15	34	100	SS-7	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		8	5 9 16	34	100	SS-8	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		9	4 10 10	27	100	SS-9	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		10	5 8 9	23	100	SS-10	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		11	10 14 16	41	44	SS-11	4.50	-	-	-	-	-	-	-	-	15	A-6a (V)	
		12	4 8 10	25	100	SS-12	4.25	-	-	-	-	-	-	-	-	16	A-6a (V)	
		13	5 5 7	16	100	SS-13	4.50	1	6	12	30	51	28	16	12	14	A-6a (9)	
		14	4 6 10	22	100	SS-14	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
	604.5	15	4 7 7	19	100	SS-15	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
HARD, GRAY, **SANDY SILT**, "AND" CLAY, TRACE GRAVEL, DAMP		16	6 12 19	42	100	SS-16	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		17	6 17 25	57	100	SS-17	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	
		18	10 20 26	63	100	SS-18	4.50	-	-	-	-	-	-	-	-	10	A-4a (V)	
		19	7 19 24	59	100	SS-19	4.50	6	10	16	31	37	23	14	9	9	A-4a (7)	
	597.0	20	21 35 40	102	100	SS-20	4.50	-	-	-	-	-	-	-	-	9	A-4a (V)	

EOB

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: POURED 1 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:47 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PROJECT: OTIC TASK 1	DRILLING FIRM / OPERATOR: NEAS / ASHBAUGH	DRILL RIG: CME 55T	STATION / OFFSET: 581+57, 57' LT.
TYPE: LANDSLIDE	SAMPLING FIRM / LOGGER: NEAS / ASHBAUGH	HAMMER: CME AUTOMATIC	ALIGNMENT: OHIO TURNPIKE
PID: SFN:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 12/5/19	ELEVATION: 661.0 (MSL) EOB: 49.5 ft.
START: 1/13/21 END: 1/13/21	SAMPLING METHOD: SPT	ENERGY RATIO (%): 68.4	LAT / LONG: 41.511205, -83.419479

EXPLORATION ID B-010-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV. 661.0	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
8.0" ASPHALT AND 6.5" BASE (DRILLERS DESCRIPTION)	659.8																	
VERY STIFF TO HARD, BROWNISH GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, DAMP		1																
		2	7 7 9	18	56	SS-1	4.50	6	9	13	34	38	28	15	13	12	A-6a (9)	
		3																
		4	6 8 10	21	67	SS-2	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		5	7 10 10	23	56	SS-3	4.50	-	-	-	-	-	-	-	-	11	A-6a (V)	
		6																
		7	7 11 12	26	28	SS-4	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		8	8 10 13	26	50	SS-5	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		9	7 11 12	26	72	SS-6	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		10																
		11	8 10 10	23	56	SS-7	4.50	6	10	13	27	44	27	15	12	12	A-6a (8)	
		12																
		13	9 9 9	21	61	SS-8	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		14	5 8 9	19	67	SS-9	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		15																
		16	6 9 10	22	72	SS-10	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		17	5 6 8	16	100	SS-11	4.00	3	6	12	36	43	31	16	15	15	A-6a (10)	
		18																
		19	7 7 8	17	100	SS-12	3.75	-	-	-	-	-	-	-	-	13	A-6a (V)	
@19.5'-21.0'; SS-13 BECOMES SOME STONE FRAGMENTS, CONTAINS 1.0" LIMESTONE FRAGMENTS		20	7 8 10	21	72	SS-13	4.25	-	-	-	-	-	-	-	-	15	A-6a (V)	
		21																
	638.5	22	6 8 9	19	67	SS-14	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP TO MOIST		23	7 9 10	22	89	SS-15	4.25	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		24																
		25	8 10 10	23	83	SS-16	4.25	-	-	-	-	-	-	-	-	17	A-7-6 (V)	
		26	4 6 6	14	67	SS-17	3.25	1	3	14	26	56	44	20	24	22	A-7-6 (14)	
@27.0'-36.0'; SS-18 THROUGH SS-23 BECOME DARK BROWN MOTTLED WITH GRAY AND ORANGISH BROWN		27																
		28	5 6 8	16	56	SS-18	3.50	-	-	-	-	-	-	-	-	20	A-7-6 (V)	
		29	6 6 9	17	100	SS-19	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:48 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

PID:	SFN:	PROJECT: OTIC TASK 1	STATION / OFFSET: 581+57, 57' LT.	START: 1/13/21	END: 1/13/21	PG 2 OF 2	B-010-0-20

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	BACK FILL
VERY STIFF TO HARD, BROWN MOTTLED WITH GRAY AND ORANGISH BROWN, **CLAY**, SOME SILT, LITTLE SAND, TRACE GRAVEL, CONTAINS IRON STAINING, DAMP TO MOIST *(continued)*	631.0	31	7 6 10	18	100	SS-20	4.25	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		32	6 12 10	25	56	SS-21	4.50	-	-	-	-	-	-	-	-	19	A-7-6 (V)	
		33	7 10 13	26	56	SS-22	4.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	
		34	10 14 20	39	67	SS-23	4.50	-	-	-	-	-	-	-	-	24	A-7-6 (V)	
		35	11 12 16	32	78	SS-24	4.50	3	7	13	30	47	33	18	15	15	A-6a (10)	
		36	10 12 12	27	0	SS-25	-	-	-	-	-	-	-	-	-	-		
		37	10 15 21	41	61	SS-26	4.50	-	-	-	-	-	-	-	-	13	A-6a (V)	
		38	11 13 20	38	67	SS-27	4.50	-	-	-	-	-	-	-	-	14	A-6a (V)	
		39	11 17 21	43	78	SS-28	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		40	13 20 23	49	72	SS-29	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		41	15 21 24	51	78	SS-30	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		42	14 22 20	48	67	SS-31	4.50	2	6	11	33	48	30	16	14	13	A-6a (10)	
		43	16 24 25	56	50	SS-32	4.50	-	-	-	-	-	-	-	-	12	A-6a (V)	
		44																
		45																
		46																
		47																
		48																
		49																
	625.0																	
HARD, BROWN MOTTLED WITH GRAY, **SILT AND CLAY**, LITTLE TO SOME SAND, TRACE GRAVEL, CONTAINS TRACE IRON STAINING, DAMP @37.5'; SS-25 CONTAINS NO RECOVERY @43.5'; BECOMES GRAY																		
	611.5	EOB																

NOTES: GROUNDWATER NOT ENCOUNTERED DURING DRILLING. HOLE DID NOT CAVE.

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED 0.5 BAG ASPHALT PATCH; POURED 2 BAG BENTONITE CHIPS; SHOVELED SOIL CUTTINGS

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 3/11/21 12:48 - X:\ACTIVE PROJECTS\ACTIVE SOIL PROJECTS\OTIC TASK 1\GINT FILES\OTIC TASK 1.GPJ

5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Cohesive Soil (ASTM D2166)

(Project: OTIC TASK 1, Boring Location: B-002-0-20, ST-1, Depth: 19.0 - 19.5ft)

Tested Date: 2/1/2021

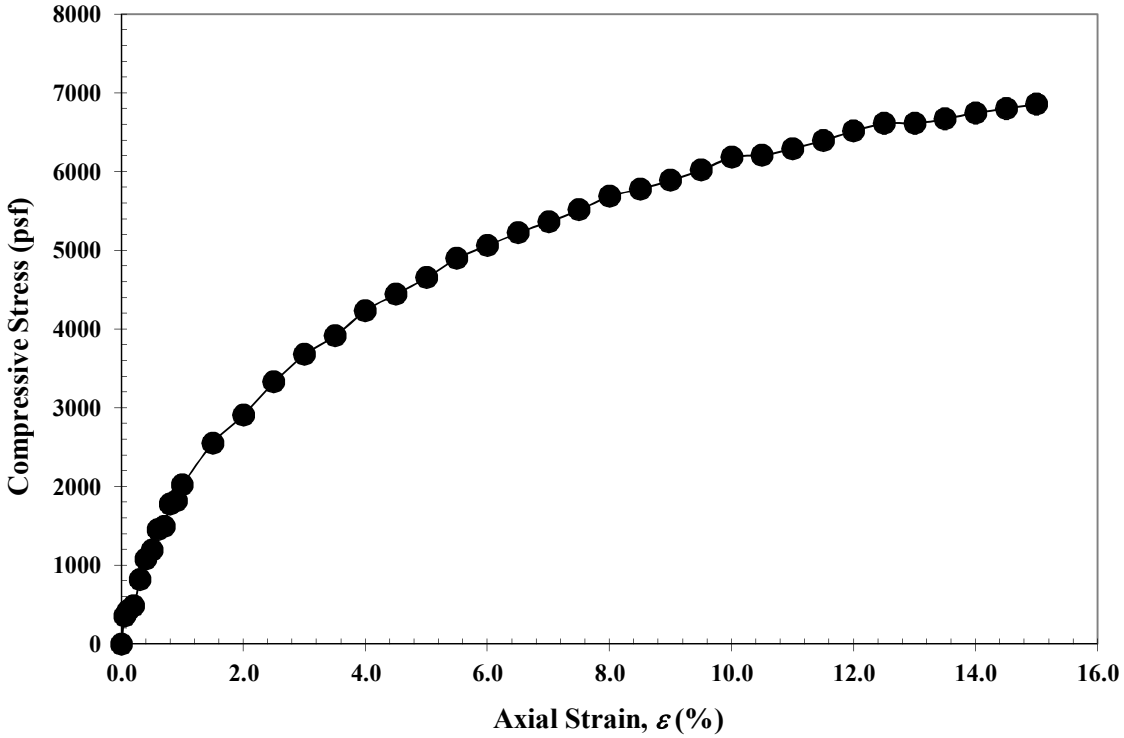
Specimen Properties

Average Dia., D_{avg} (in):	2.88
Average Height, H_{avg} (in):	5.74
Area, A (in^2):	6.50
Volume, V (in^3):	37.30
Wet Mass of Specimen (lb):	3.0
Moisture Content (%):	15.2
Dry Mass of Specimen (lb):	2.6
Wet Unit Weight, γ (lb/ft^3):	137.0
Dry Unit Weight, γ_d (lb/ft^3):	118.9

Final Specimen Figure

Results

Unconfined Compressive Strength (psf):	**6858**
Strain (%):	**15.0**



Notes: Very stiff, brownish gray, SILT AND CLAY, little sand, trace gravel, damp. Specimen did not fail. Exceeded equipment strain of 15%.

5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Cohesive Soil (ASTM D2166)

(Project: OTIC TASK 1, Boring Location: B-004-0-20, ST-1, Depth: 12.1 - 12.6ft)

Tested Date: 2/1/2021

Specimen Properties

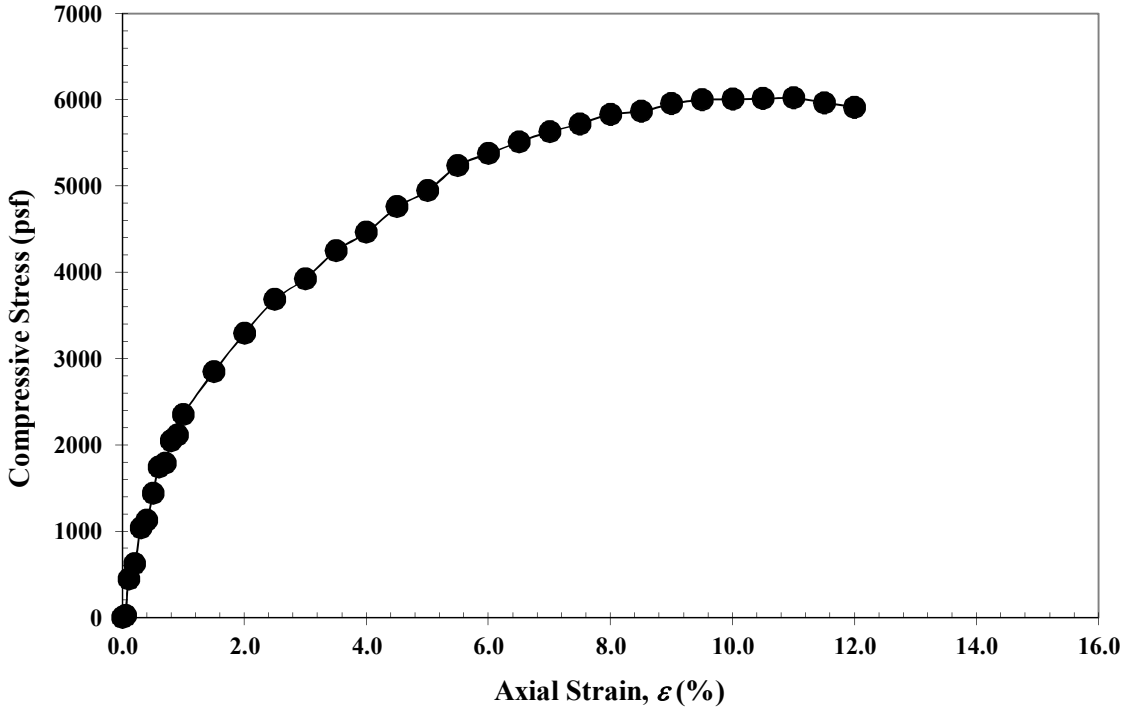
Average Dia., D_{avg} (in):	2.87
Average Height, H_{avg} (in):	5.76
Area, A (in^2):	6.47
Volume, V (in^3):	37.25
Wet Mass of Specimen (lb):	2.7
Moisture Content (%):	16.0
Dry Mass of Specimen (lb):	2.3
Wet Unit Weight, γ (lb/ft^3):	125.0
Dry Unit Weight, γ_d (lb/ft^3):	107.7

Final Specimen Figure

Results

Unconfined Compressive Strength (psf): **6021**

Strain (%): **11.0**



Notes: Very stiff, brownish gray, SILTY CLAY, little sand, trace gravel, damp. Upon completion of compression and then splitting, it was discovered that the specimen had a wax-filled core approximately 1.5" diameter for nearly its entire length. Strength testing results are presumed to be invalid.

5710 Westbourne Avenue
Columbus, OH 43213
614-892-0162

Unconfined Compressive Strength of Cohesive Soil (ASTM D2166)

(Project: OTIC TASK 1, Boring Location: B-008-0-20, ST-1, Depth: 22.0 - 22.5ft)

Tested Date: 2/1/2021

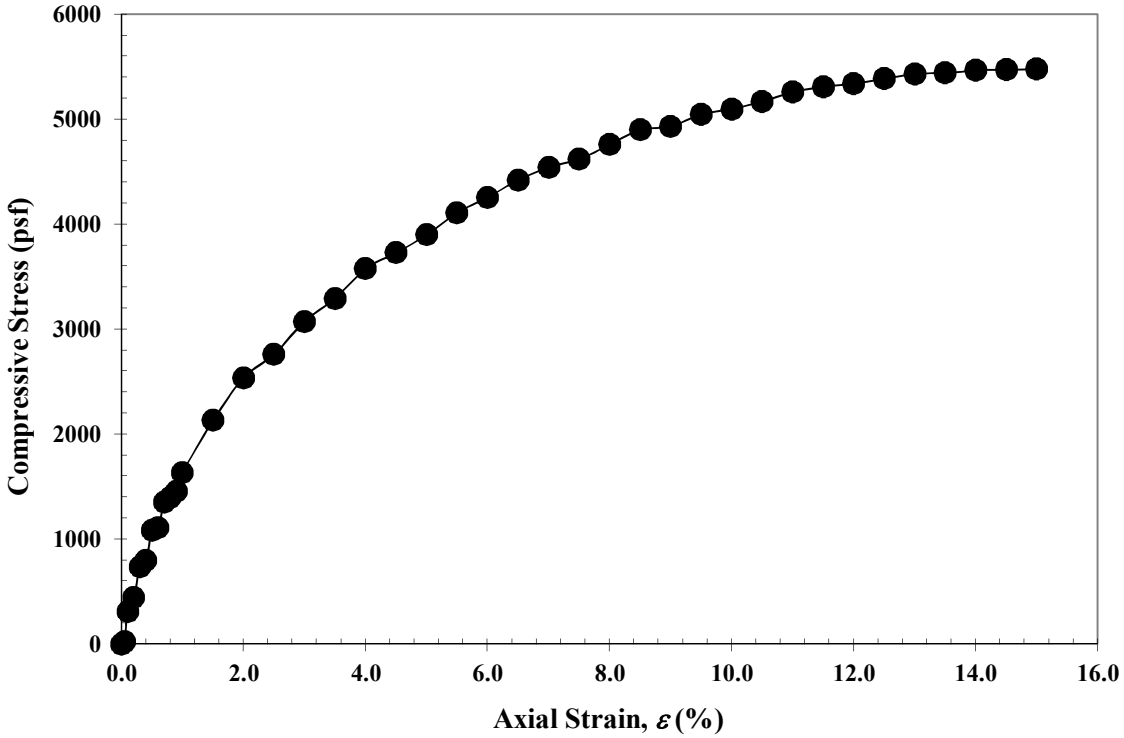
Specimen Properties

Average Dia., D_{avg} (in):	2.87
Average Height, H_{avg} (in):	5.75
Area, A (in^2):	6.46
Volume, V (in^3):	37.11
Wet Mass of Specimen (lb):	2.9
Moisture Content (%):	18.6
Dry Mass of Specimen (lb):	2.4
Wet Unit Weight, γ (lb/ft^3):	134.7
Dry Unit Weight, γ_d (lb/ft^3):	113.5

Final Specimen Figure

Results

Unconfined Compressive Strength (psf):	**5479**
Strain (%):	**15.0**

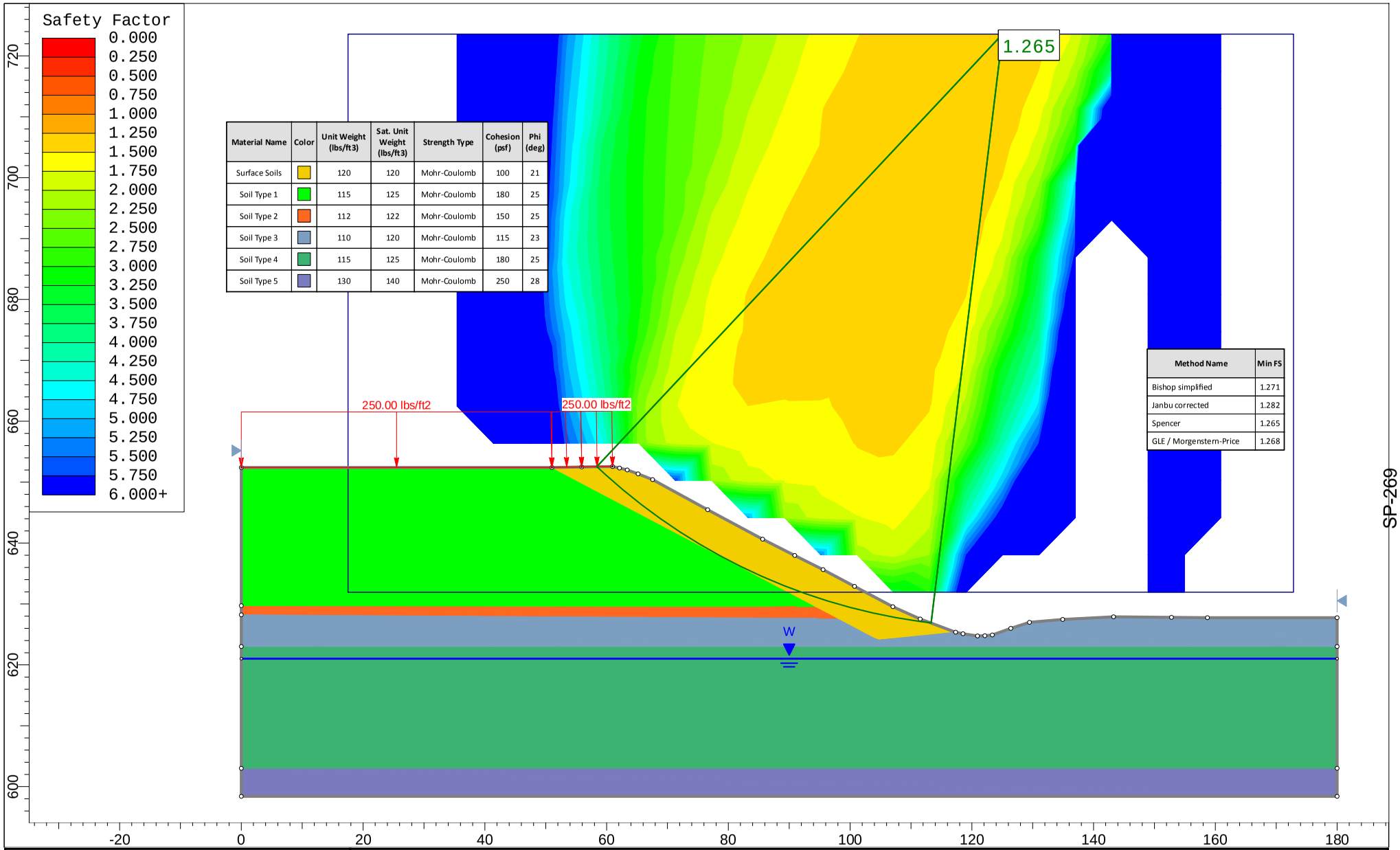


Notes: Very stiff, brownish gray mottled with gray, SILTY CLAY, little sand, trace gravel, moist. Specimen did not fail. Exceeded equipment strain of 15%.

APPENDIX C

GLOBAL STABILITY ANALYSES OF EXISTING EMBANKMENT SLOPE

EASTBOUND



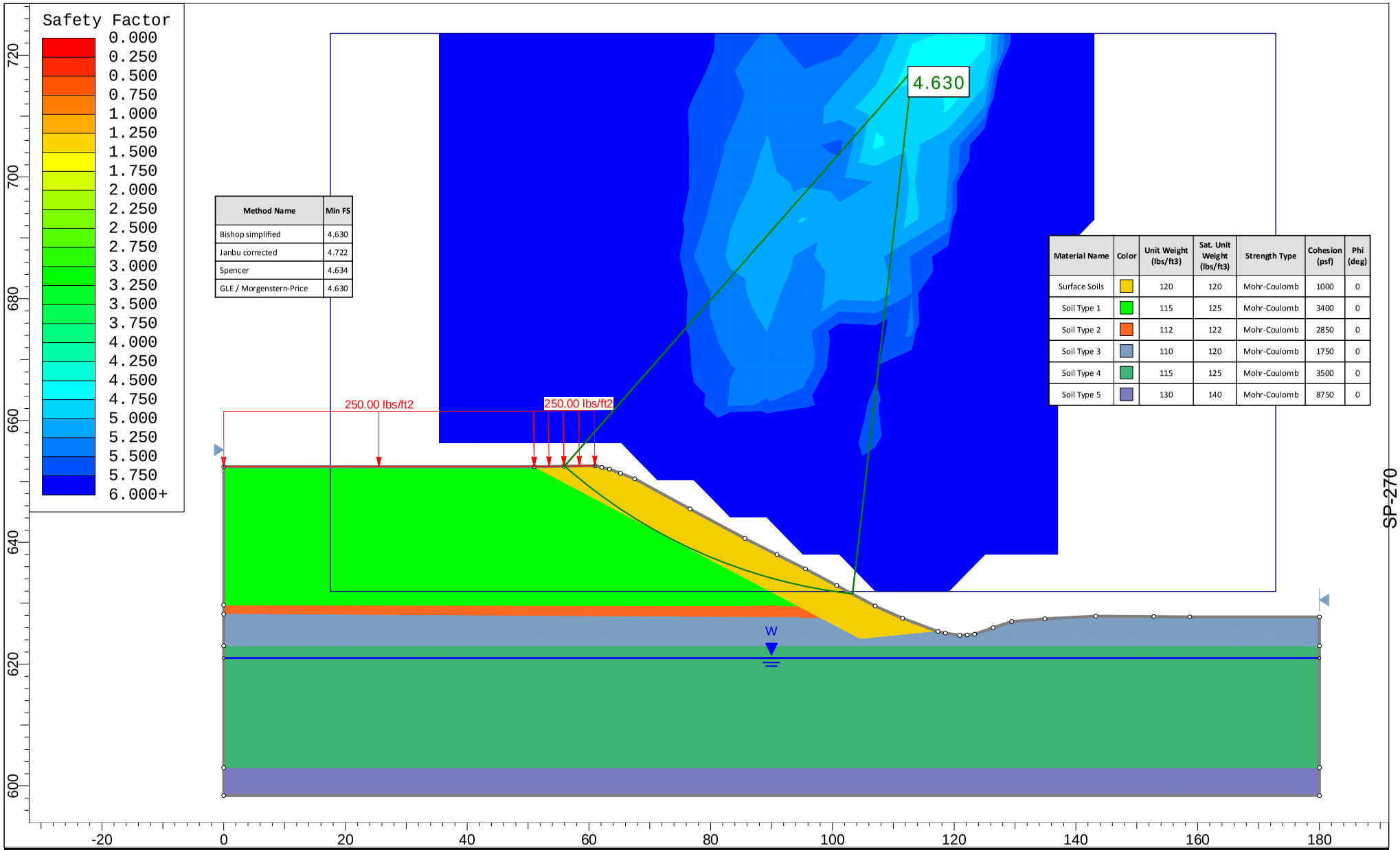
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	100	21
Soil Type 1		115	125	Mohr-Coulomb	180	25
Soil Type 2		112	122	Mohr-Coulomb	150	25
Soil Type 3		110	120	Mohr-Coulomb	115	23
Soil Type 4		115	125	Mohr-Coulomb	180	25
Soil Type 5		130	140	Mohr-Coulomb	250	28

Method Name	Min FS
Bishop simplified	1.271
Janbu corrected	1.282
Spencer	1.265
GLE / Morgenstern-Price	1.268

SP-269

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 572+25		
Drawn By ZM	*Scale* 1:260	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope EB STA. 572+25_B1&B2_Effective.slim	



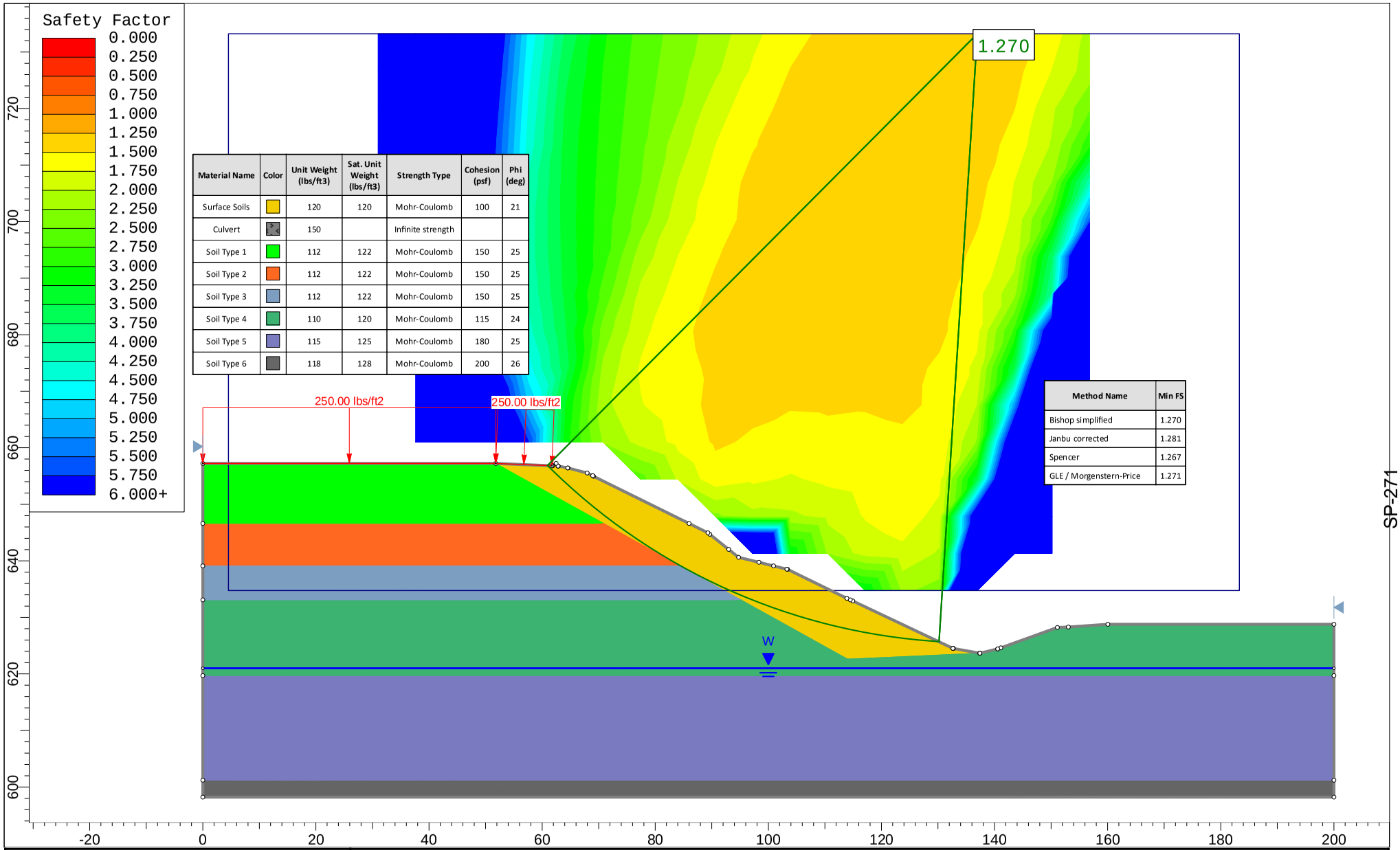
Method Name	Min FS
Bishop simplified	4.630
Janbu corrected	4.722
Spencer	4.634
GLE / Morgenstern-Price	4.630

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	1000	0
Soil Type 1		115	125	Mohr-Coulomb	3400	0
Soil Type 2		112	122	Mohr-Coulomb	2850	0
Soil Type 3		110	120	Mohr-Coulomb	1750	0
Soil Type 4		115	125	Mohr-Coulomb	3500	0
Soil Type 5		130	140	Mohr-Coulomb	8750	0

SP-270

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 572+25		
Drawn By	ZM	*Scale* 1:260	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope EB STA. 572+25_B1&B2_Total.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	100	21
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		112	122	Mohr-Coulomb	150	25
Soil Type 3		112	122	Mohr-Coulomb	150	25
Soil Type 4		110	120	Mohr-Coulomb	115	24
Soil Type 5		115	125	Mohr-Coulomb	180	25
Soil Type 6		118	128	Mohr-Coulomb	200	26

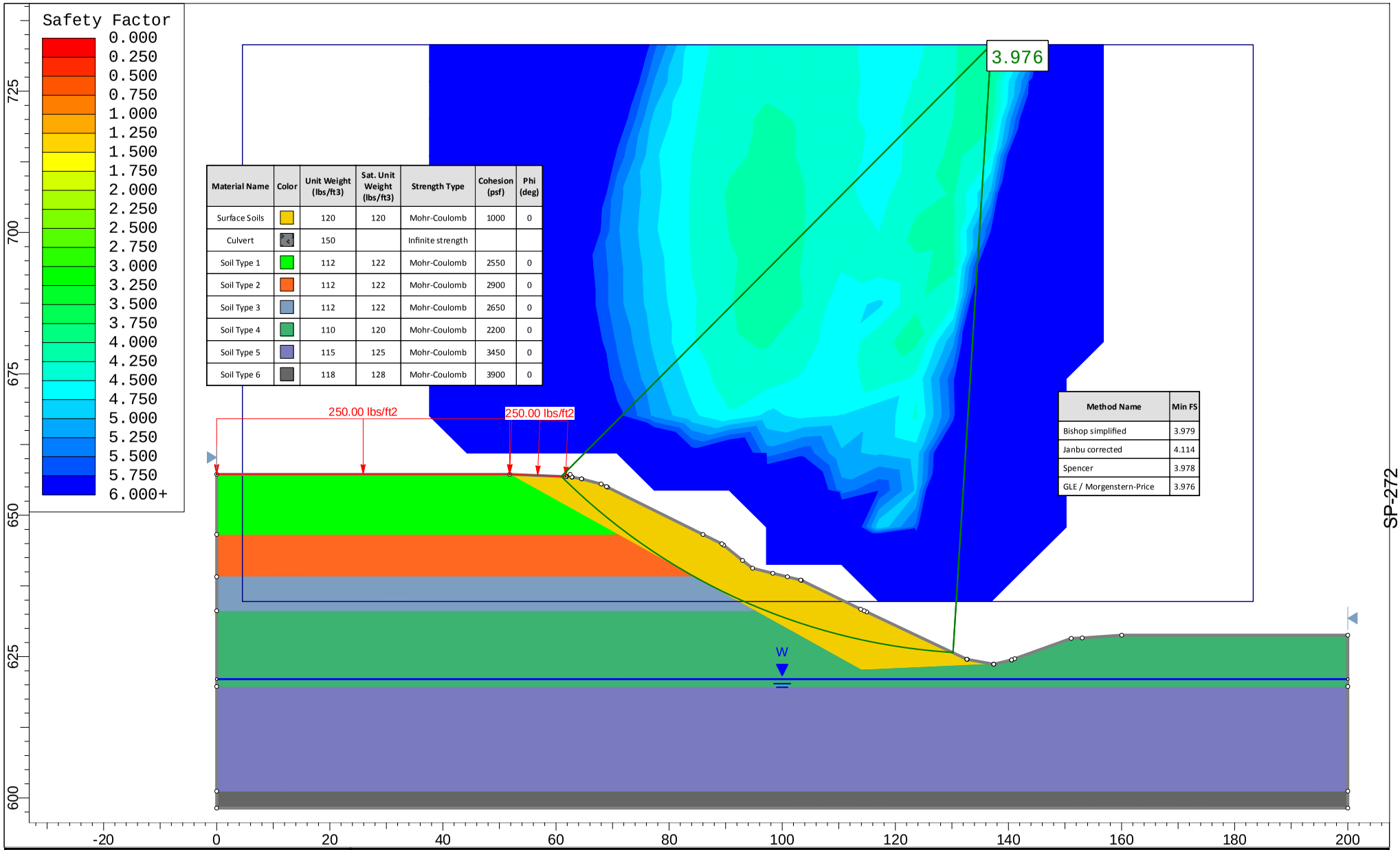
Method Name	Min FS
Bishop simplified	1.270
Janbu corrected	1.281
Spencer	1.267
GLE / Morgenstern-Price	1.271

SP-271

rocscience

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 576+00		
Drawn By	ZM	Scale	1:280
Company	NEAS Inc.		
Date	02/24/21	File Name	OTIC Genoa Slope EB STA. 576+00_Effective.slim



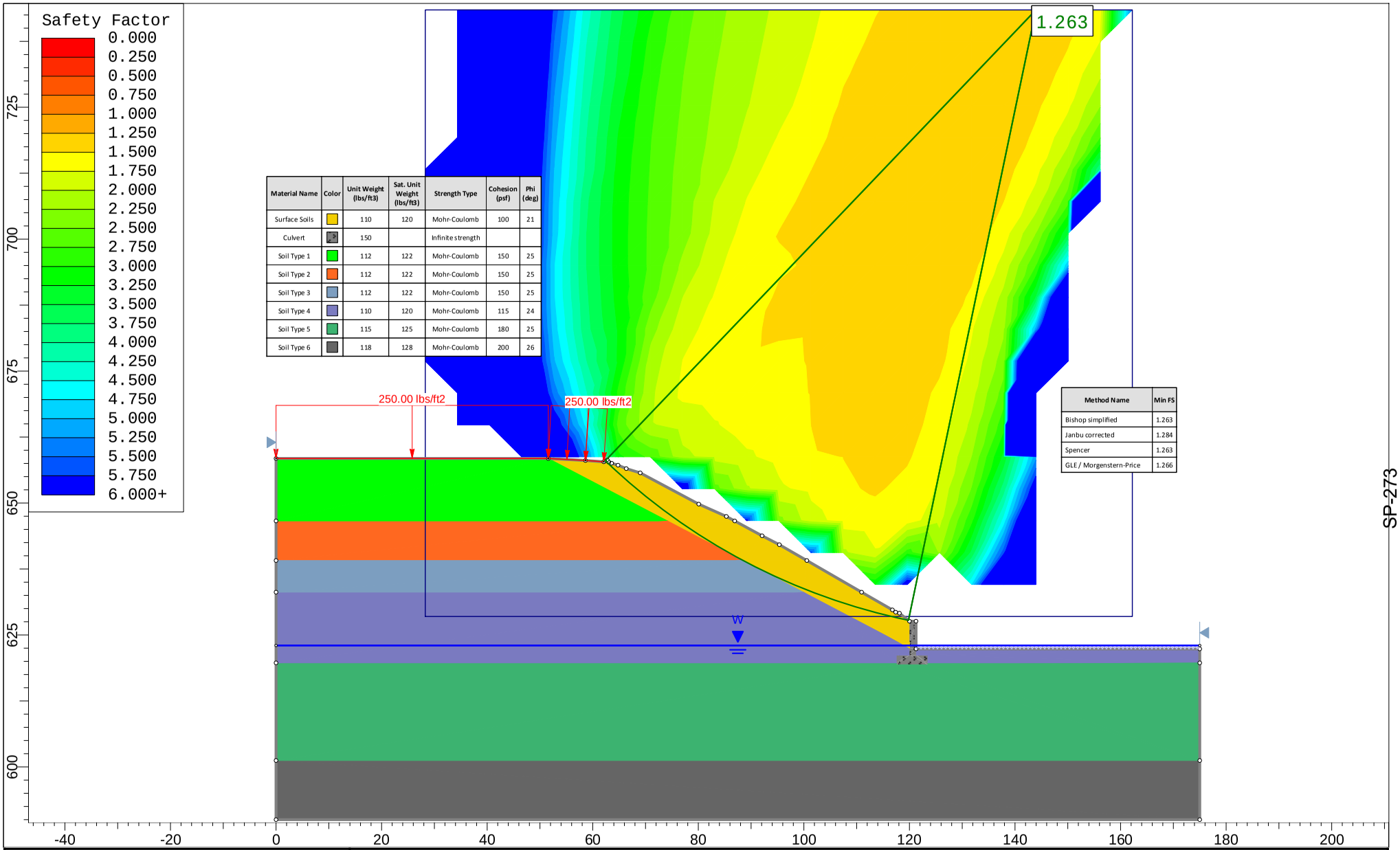
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	1000	0
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	2550	0
Soil Type 2		112	122	Mohr-Coulomb	2900	0
Soil Type 3		112	122	Mohr-Coulomb	2650	0
Soil Type 4		110	120	Mohr-Coulomb	2200	0
Soil Type 5		115	125	Mohr-Coulomb	3450	0
Soil Type 6		118	128	Mohr-Coulomb	3900	0

Method Name	Min FS
Bishop simplified	3.979
Janbu corrected	4.114
Spencer	3.978
GLE / Morgenstern-Price	3.976

SP-272

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 576+00		
Drawn By ZM	*Scale* 1:280	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope EB STA. 576+00_B3&B4_Total.slim	



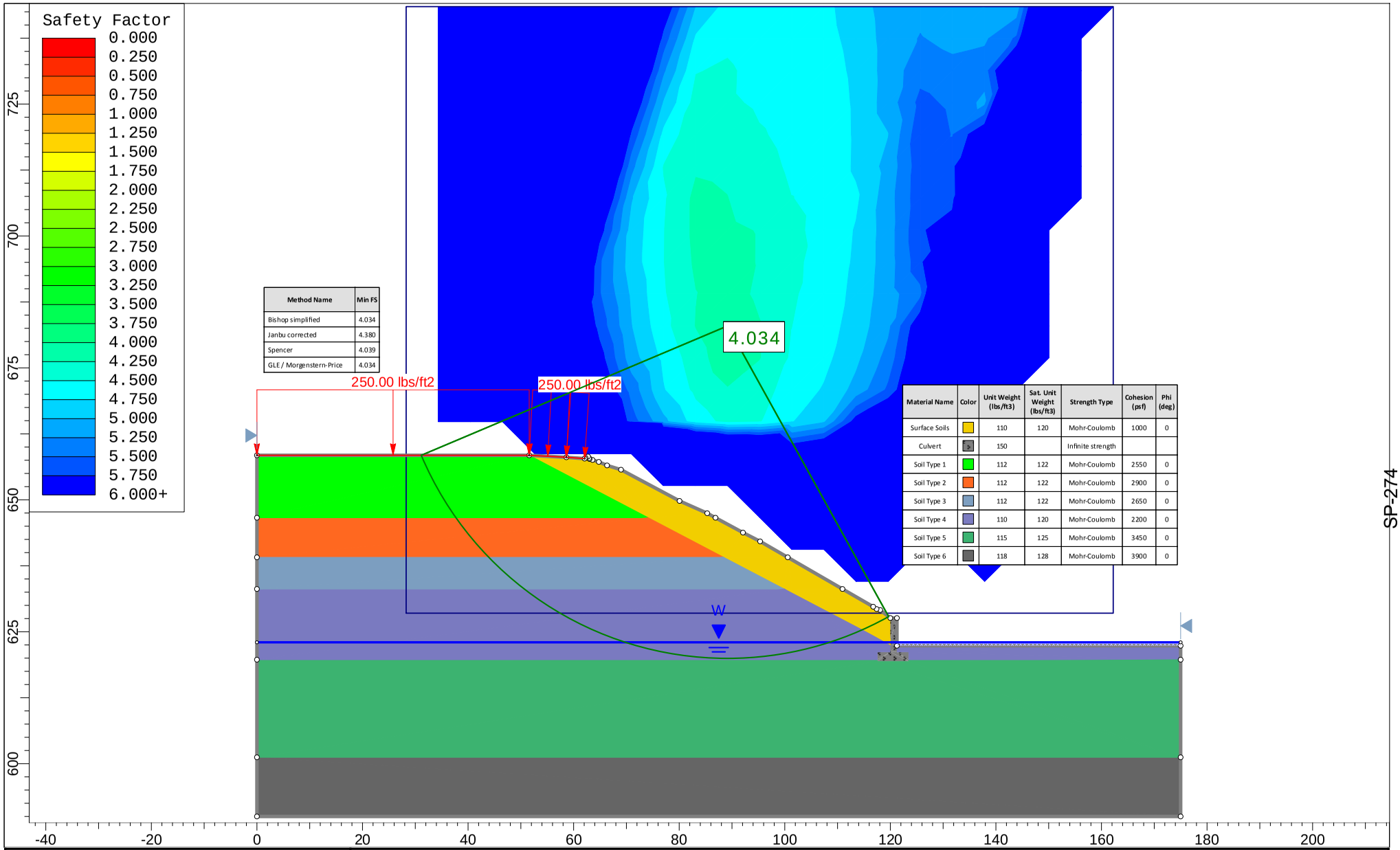
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	100	21
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		112	122	Mohr-Coulomb	150	25
Soil Type 3		112	122	Mohr-Coulomb	150	25
Soil Type 4		110	120	Mohr-Coulomb	115	24
Soil Type 5		115	125	Mohr-Coulomb	180	25
Soil Type 6		118	128	Mohr-Coulomb	200	26

Method Name	Min FS
Bishop simplified	1.263
Janbu corrected	1.284
Spencer	1.263
GLE / Morgenstern-Price	1.266

SP-273

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 577+15.59		
Drawn By	ZM	Scale 1:300	Company NEAS Inc.
Date	02/24/21		File Name OTIC Genoa Slope EB Culvert STA. 577+15.59_Effective.slim



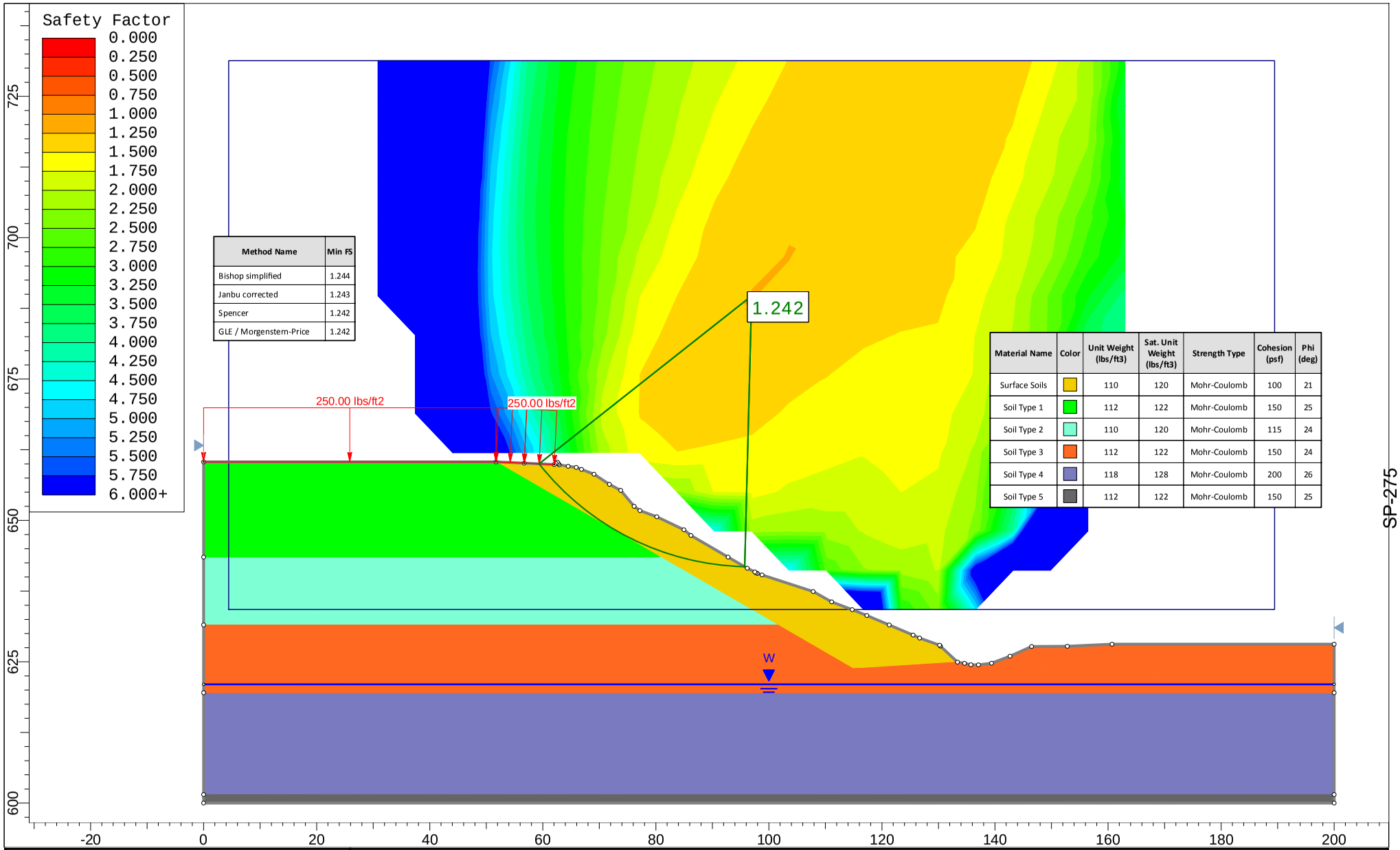
Method Name	Min FS
Bishop simplified	4.034
Janbu corrected	4.380
Spencer	4.039
GLE / Morgenstern-Price	4.034

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	1000	0
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	2550	0
Soil Type 2		112	122	Mohr-Coulomb	2900	0
Soil Type 3		112	122	Mohr-Coulomb	2650	0
Soil Type 4		110	120	Mohr-Coulomb	2200	0
Soil Type 5		115	125	Mohr-Coulomb	3450	0
Soil Type 6		118	128	Mohr-Coulomb	3900	0

SP-274

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 577+15.59		
Drawn By ZM	*Scale* 1:300	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope EB Culvert STA. 577+15.59_Total.slim	



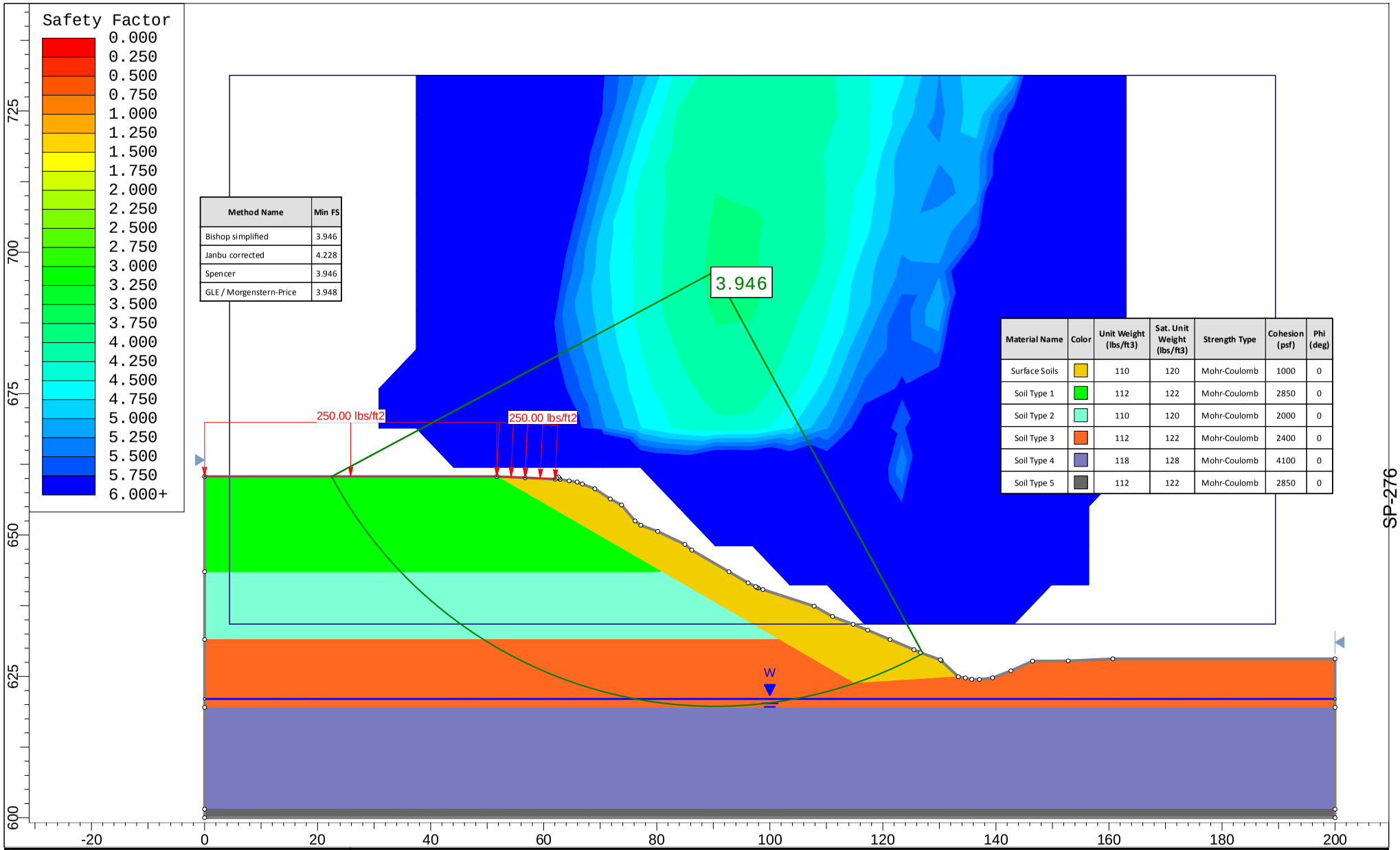
Method Name	Min FS
Bishop simplified	1.244
Janbu corrected	1.243
Spencer	1.242
GLE / Morgenstern-Price	1.242

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	100	21
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		110	120	Mohr-Coulomb	115	24
Soil Type 3		112	122	Mohr-Coulomb	150	24
Soil Type 4		118	128	Mohr-Coulomb	200	26
Soil Type 5		112	122	Mohr-Coulomb	150	25

SP-275

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 579+75		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope EB STA. 579+75_Effective.slim



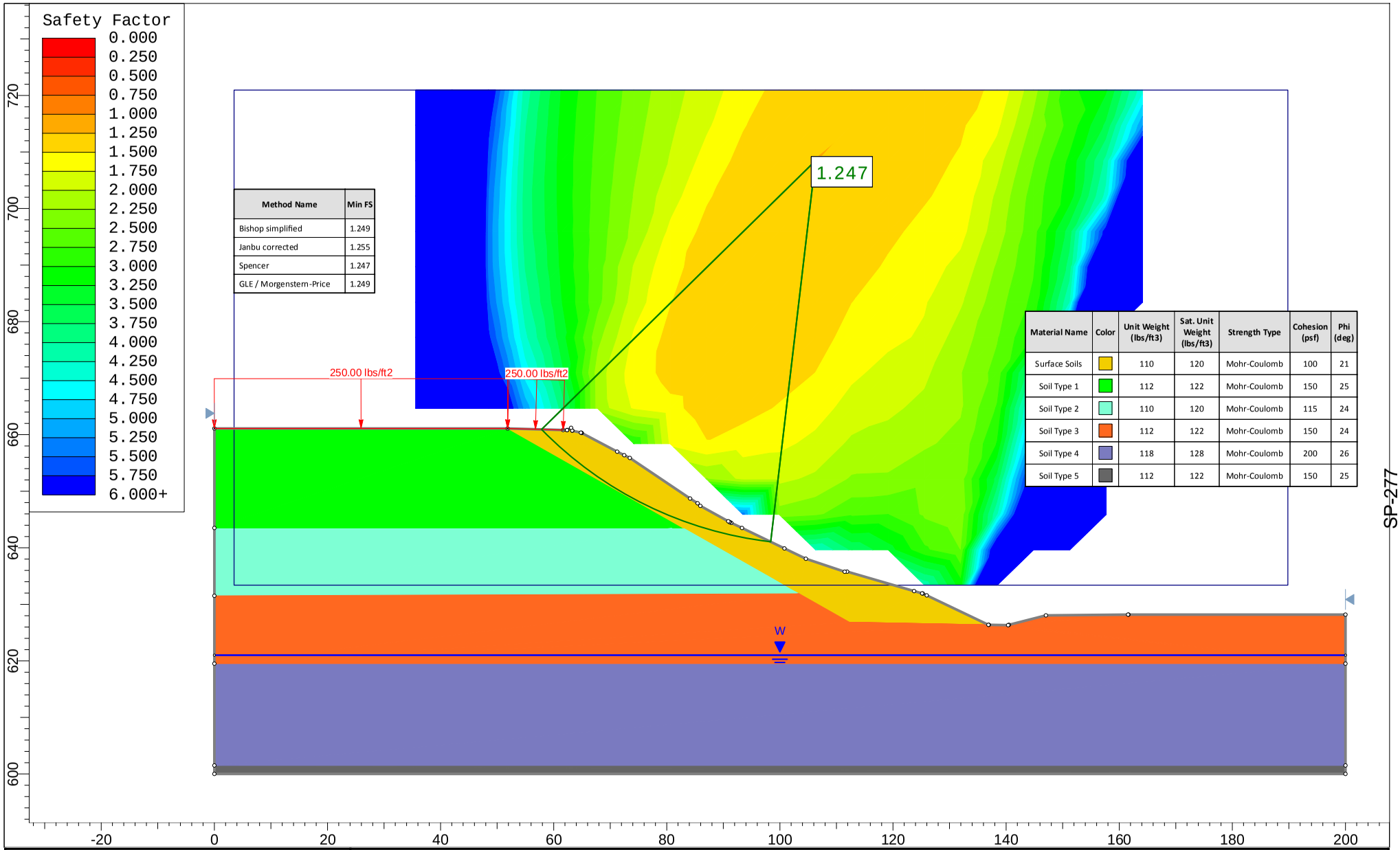
Method Name	Min FS
Bishop simplified	3.946
Janbu corrected	4.228
Spencer	3.946
GLE / Morgenstern-Price	3.948

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	1000	0
Soil Type 1		112	122	Mohr-Coulomb	2850	0
Soil Type 2		110	120	Mohr-Coulomb	2000	0
Soil Type 3		112	122	Mohr-Coulomb	2400	0
Soil Type 4		118	128	Mohr-Coulomb	4100	0
Soil Type 5		112	122	Mohr-Coulomb	2850	0

SP-276

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 579+75		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope EB STA. 579+75_Total.slim



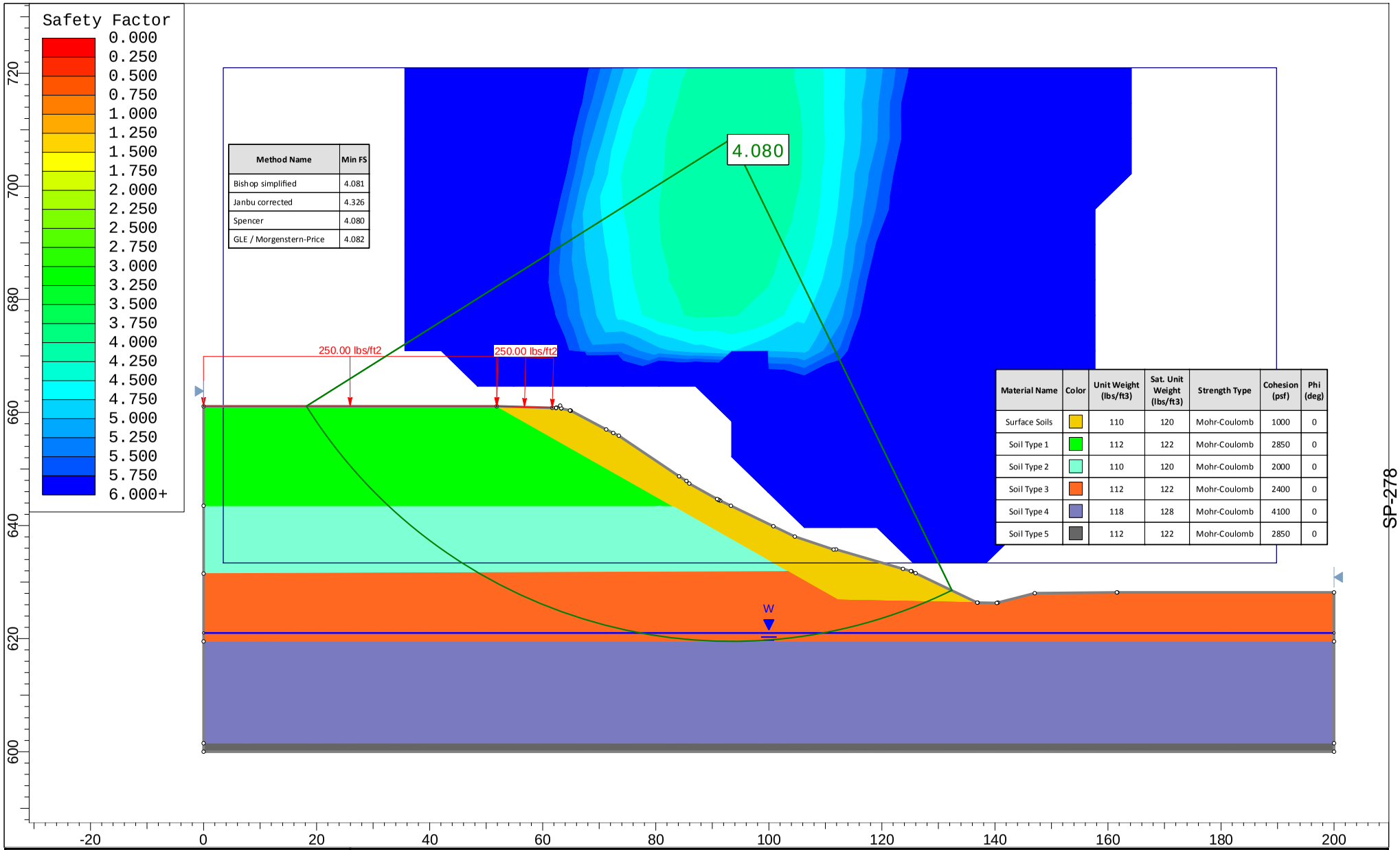
Method Name	Min FS
Bishop simplified	1.249
Janbu corrected	1.255
Spencer	1.247
GLE / Morgenstern-Price	1.249

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	100	21
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		110	120	Mohr-Coulomb	115	24
Soil Type 3		112	122	Mohr-Coulomb	150	24
Soil Type 4		118	128	Mohr-Coulomb	200	26
Soil Type 5		112	122	Mohr-Coulomb	150	25

SP-277

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 583+00		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope EB STA. 583+00_Effective.slim



Method Name	Min FS
Bishop simplified	4.081
Janbu corrected	4.326
Spencer	4.080
GLE / Morgenstern-Price	4.082

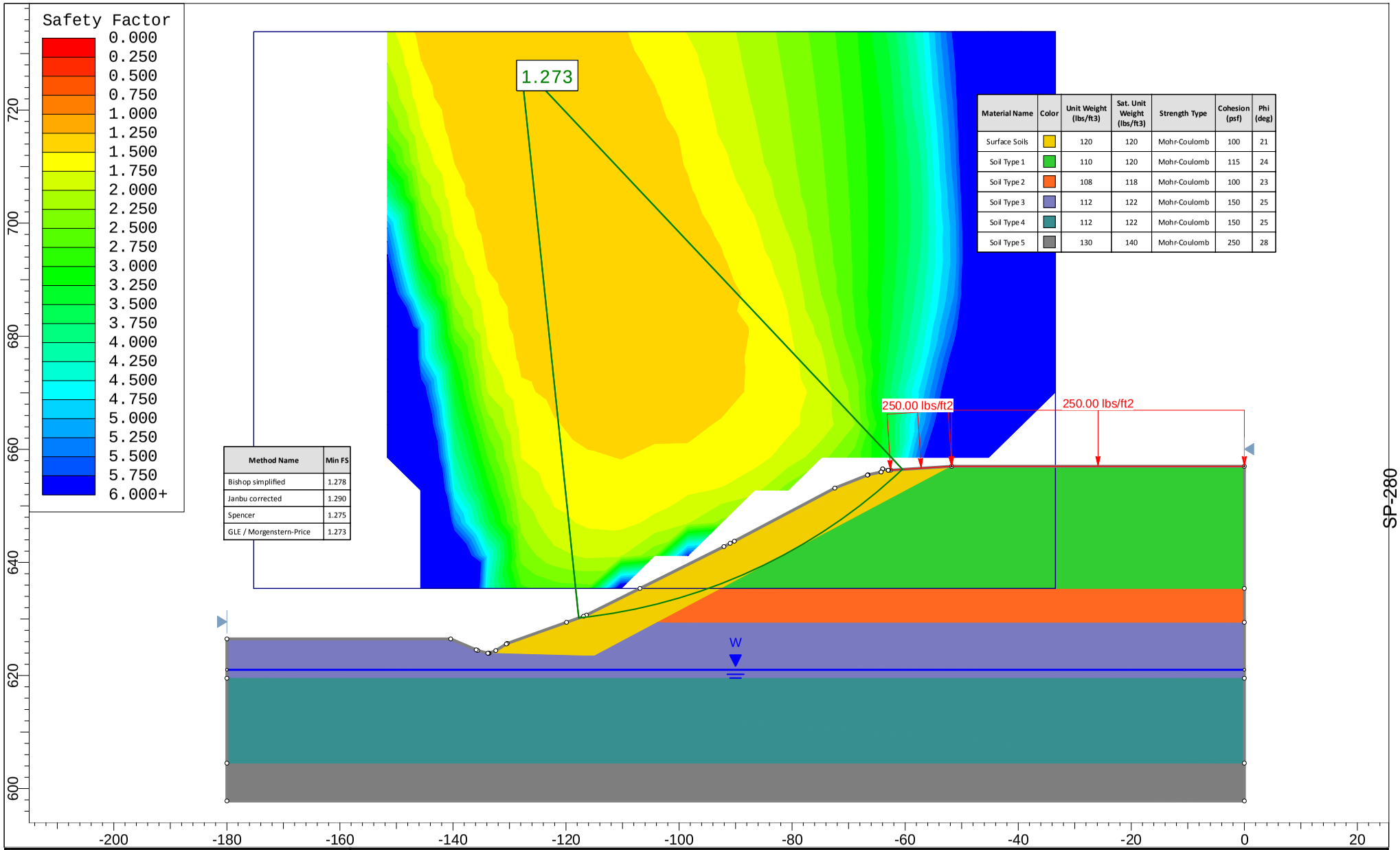
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	1000	0
Soil Type 1		112	122	Mohr-Coulomb	2850	0
Soil Type 2		110	120	Mohr-Coulomb	2000	0
Soil Type 3		112	122	Mohr-Coulomb	2400	0
Soil Type 4		118	128	Mohr-Coulomb	4100	0
Soil Type 5		112	122	Mohr-Coulomb	2850	0

SP-278

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 583+00		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope EB STA. 583+00_Total.slim

WESTBOUND



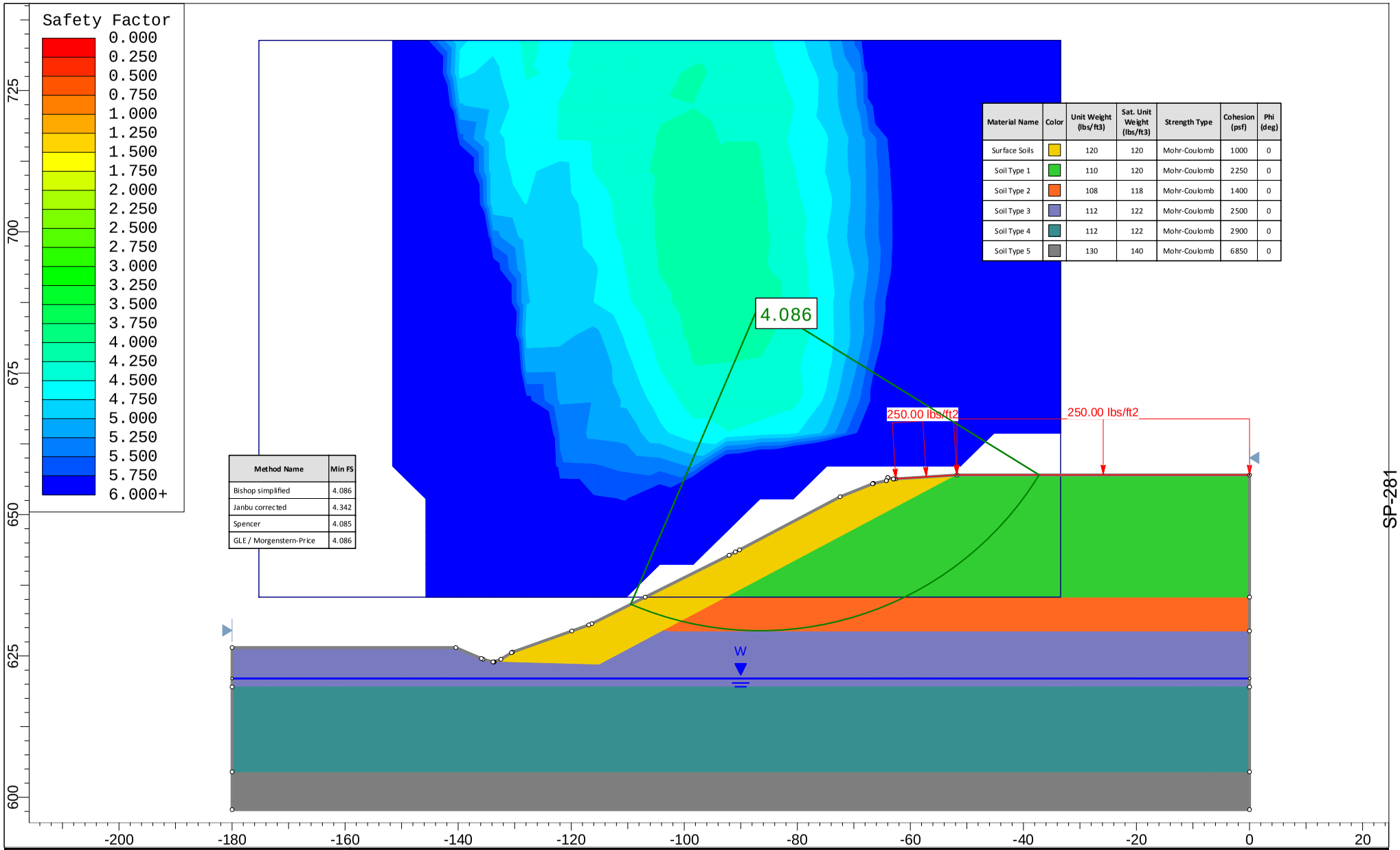
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	100	21
Soil Type 1		110	120	Mohr-Coulomb	115	24
Soil Type 2		108	118	Mohr-Coulomb	100	23
Soil Type 3		112	122	Mohr-Coulomb	150	25
Soil Type 4		112	122	Mohr-Coulomb	150	25
Soil Type 5		130	140	Mohr-Coulomb	250	28

Method Name	Min FS
Bishop simplified	1.278
Janbu corrected	1.290
Spencer	1.275
GLE / Morgenstern-Price	1.273

SP-280

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 575+81		
Drawn By ZM	*Scale* 1:280	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope WB STA. 575+81_B6&B7_Effective.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	1000	0
Soil Type 1		110	120	Mohr-Coulomb	2250	0
Soil Type 2		108	118	Mohr-Coulomb	1400	0
Soil Type 3		112	122	Mohr-Coulomb	2500	0
Soil Type 4		112	122	Mohr-Coulomb	2900	0
Soil Type 5		130	140	Mohr-Coulomb	6850	0

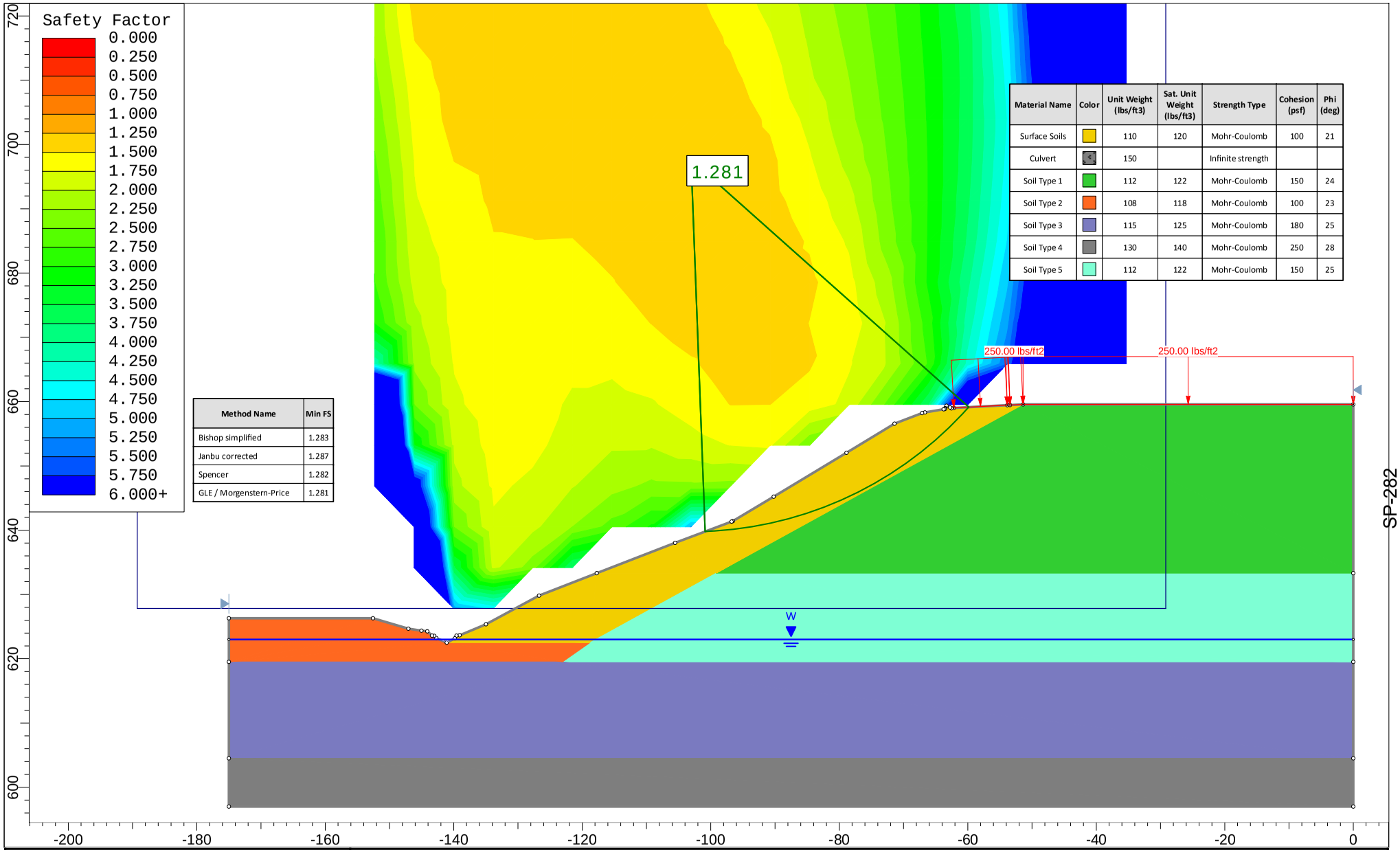
Method Name	Min FS
Bishop simplified	4.086
Janbu corrected	4.342
Spencer	4.085
GLE / Morgenstern-Price	4.086

SP-281

rocscience

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 575+81		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope WB STA. 575+81_B6&B7_Total.slim



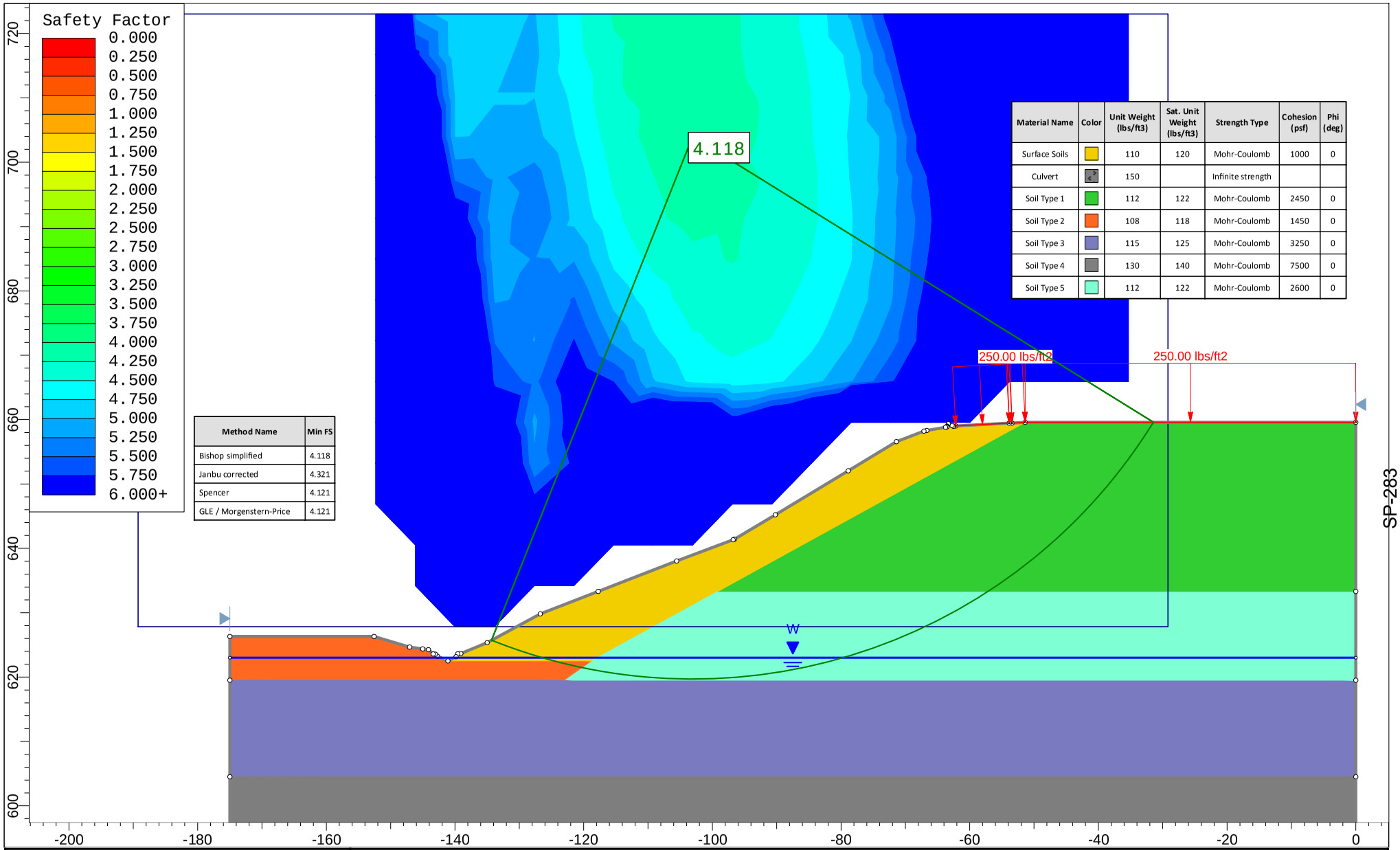
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	100	21
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	150	24
Soil Type 2		108	118	Mohr-Coulomb	100	23
Soil Type 3		115	125	Mohr-Coulomb	180	25
Soil Type 4		130	140	Mohr-Coulomb	250	28
Soil Type 5		112	122	Mohr-Coulomb	150	25

Method Name	Min FS
Bishop simplified	1.283
Janbu corrected	1.287
Spencer	1.282
GLE / Morgenstern-Price	1.281

SP-282

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 578+75		
Drawn By	ZM	Scale	1:246
Company	NEAS Inc.		
Date	02/24/21	File Name	OTIC Genoa Slope WB STA. 578+75_B8&B9_Effective.slim



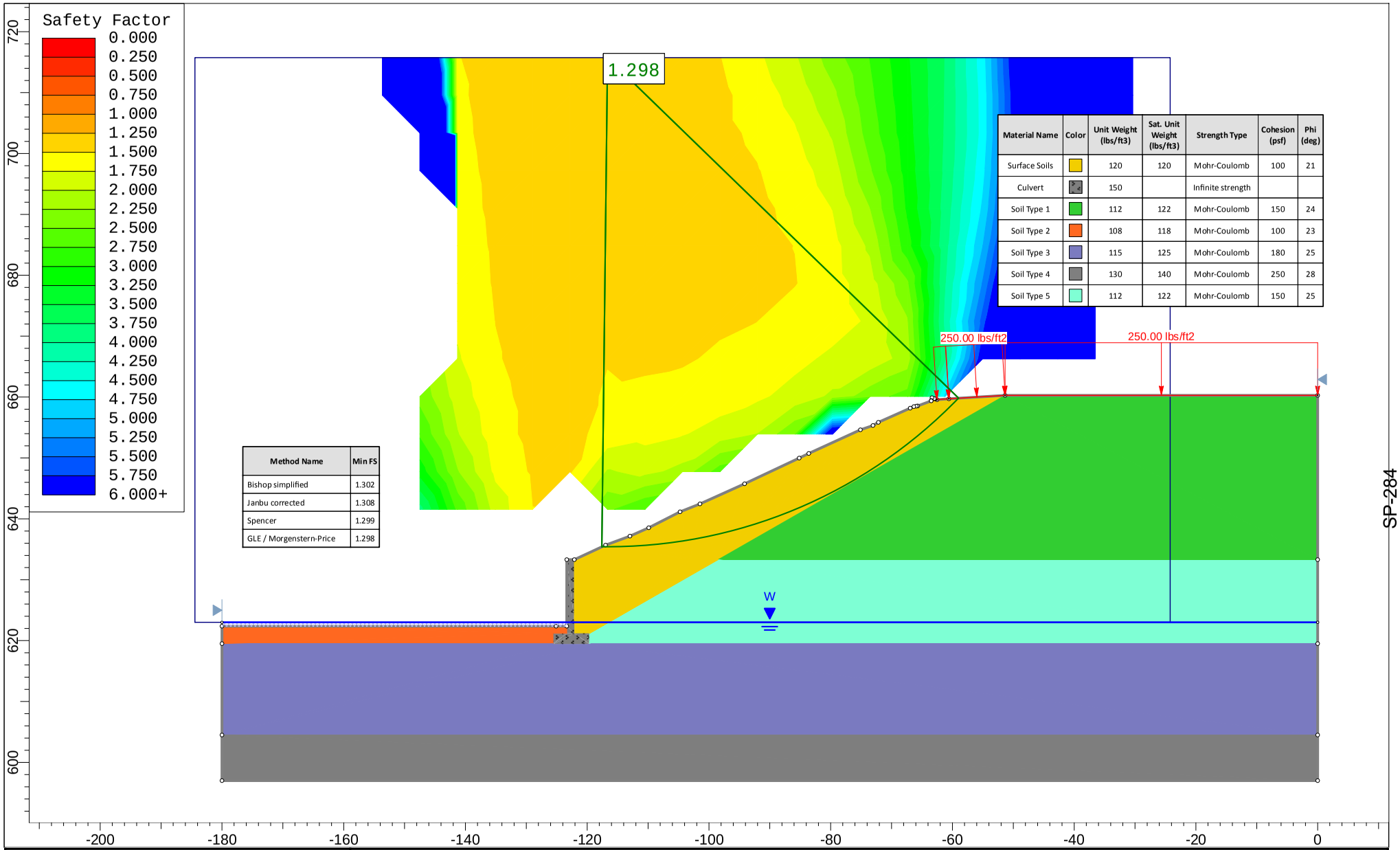
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		110	120	Mohr-Coulomb	1000	0
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	2450	0
Soil Type 2		108	118	Mohr-Coulomb	1450	0
Soil Type 3		115	125	Mohr-Coulomb	3250	0
Soil Type 4		130	140	Mohr-Coulomb	7500	0
Soil Type 5		112	122	Mohr-Coulomb	2600	0

Method Name	Min FS
Bishop simplified	4.118
Janbu corrected	4.321
Spencer	4.121
GLE / Morgenstern-Price	4.121

SP-283

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 578+75		
Drawn By	ZM	*Scale* 1:246	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope WB STA. 578+75_B8&B9_Total.slim



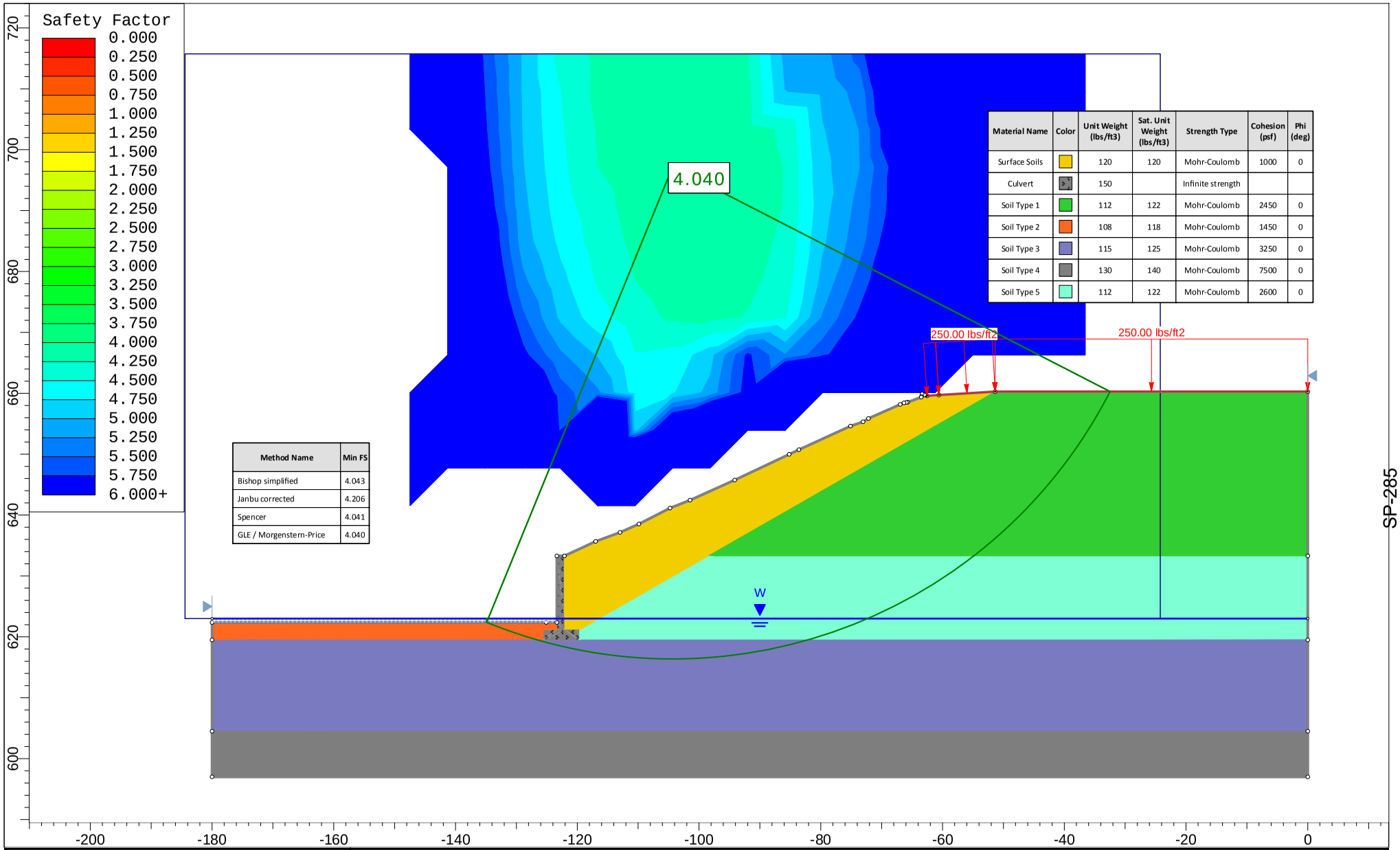
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	100	21
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	150	24
Soil Type 2		108	118	Mohr-Coulomb	100	23
Soil Type 3		115	125	Mohr-Coulomb	180	25
Soil Type 4		130	140	Mohr-Coulomb	250	28
Soil Type 5		112	122	Mohr-Coulomb	150	25

Method Name	Min FS
Bishop simplified	1.302
Janbu corrected	1.308
Spencer	1.299
GLE / Morgenstern-Price	1.298

SP-284

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 580+75		
Drawn By ZM	*Scale* 1:260	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope WB Culvert STA. 580+20.54_B8&B9_Effective.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Surface Soils		120	120	Mohr-Coulomb	1000	0
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	2450	0
Soil Type 2		108	118	Mohr-Coulomb	1450	0
Soil Type 3		115	125	Mohr-Coulomb	3250	0
Soil Type 4		130	140	Mohr-Coulomb	7500	0
Soil Type 5		112	122	Mohr-Coulomb	2600	0

Method Name	Min FS
Bishop simplified	4.043
Janbu corrected	4.206
Spencer	4.041
GLE / Morgenstern-Price	4.040

SP-285

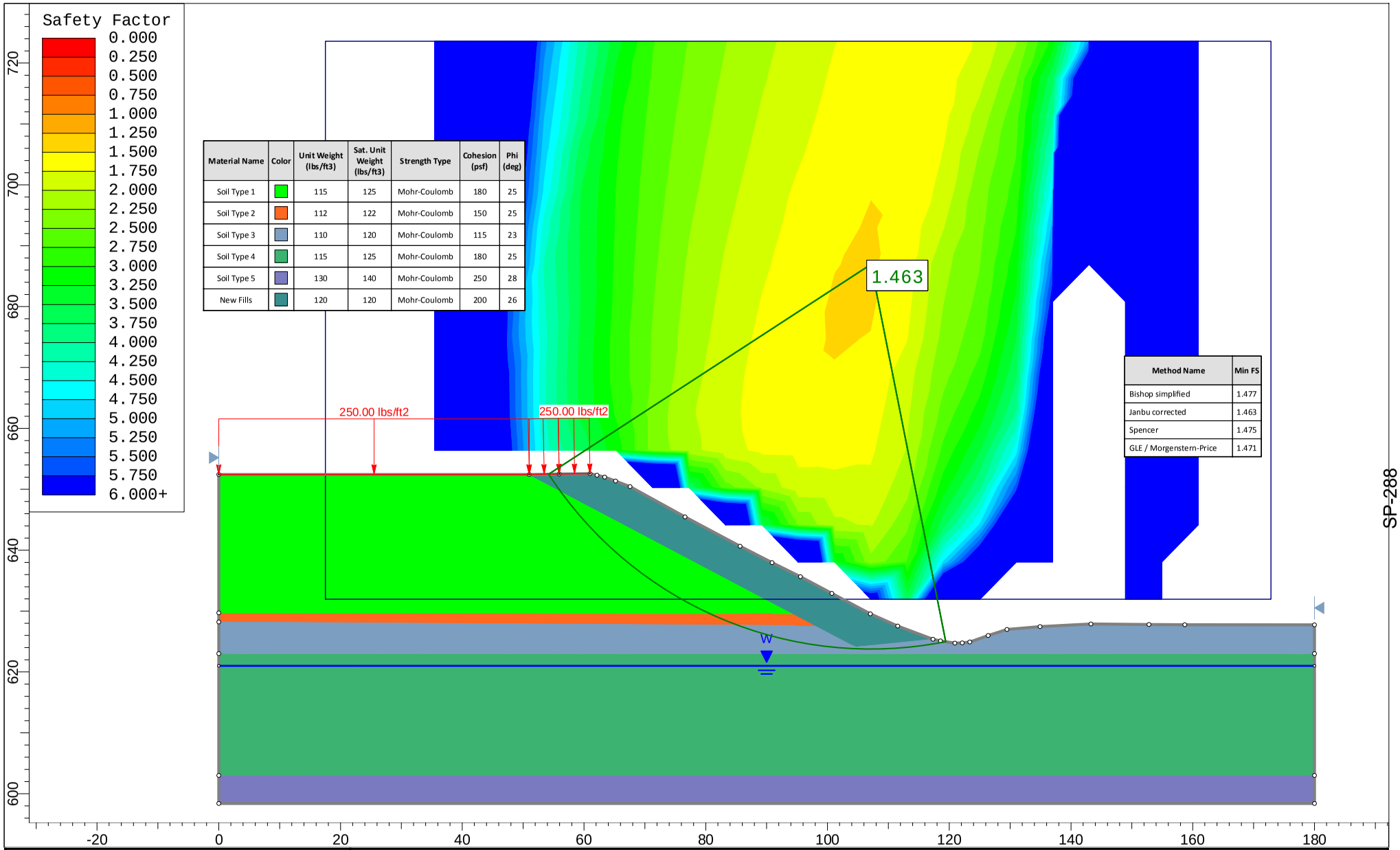
SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 580+75		
Drawn By ZM	*Scale* 1:260	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope WB Culvert STA. 580+20.54_B8&B9_Total.slim	

APPENDIX D

GLOBAL STABILITY ANALYSES OF STABILIZED EMBANKMENT SLOPE

EASTBOUND



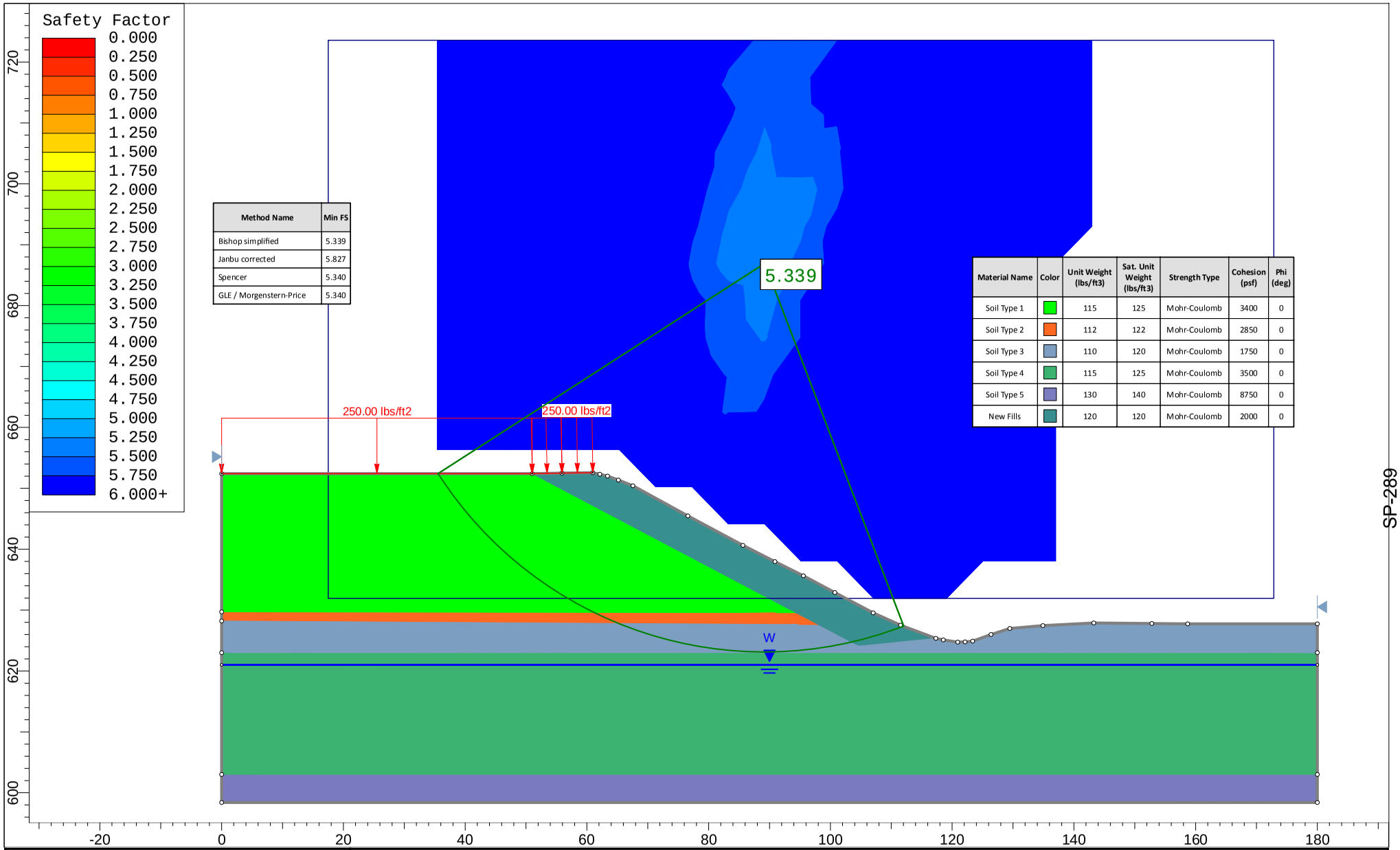
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		115	125	Mohr-Coulomb	180	25
Soil Type 2		112	122	Mohr-Coulomb	150	25
Soil Type 3		110	120	Mohr-Coulomb	115	23
Soil Type 4		115	125	Mohr-Coulomb	180	25
Soil Type 5		130	140	Mohr-Coulomb	250	28
New Fills		120	120	Mohr-Coulomb	200	26

Method Name	Min FS
Bishop simplified	1.477
Janbu corrected	1.463
Spencer	1.475
GLE / Morgenstern-Price	1.471

SP-288

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 572+25		
Drawn By ZM	*Scale* 1:260	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Slope EB STA. 572+25_B1&B2_Effective.slim	



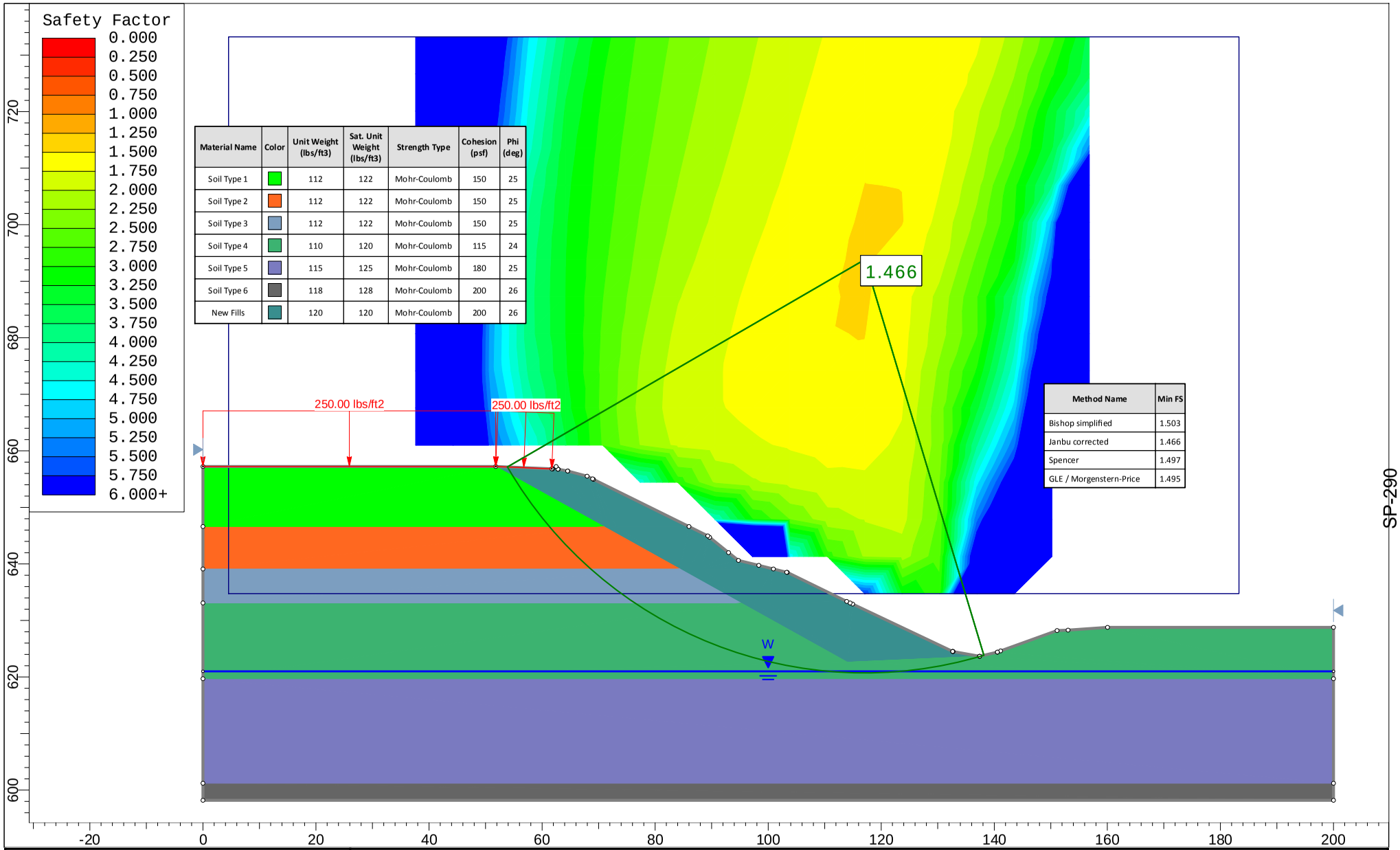
Method Name	Min FS
Bishop simplified	5.339
Janbu corrected	5.827
Spencer	5.340
GLE / Morgenstern-Price	5.340

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		115	125	Mohr-Coulomb	3400	0
Soil Type 2		112	122	Mohr-Coulomb	2850	0
Soil Type 3		110	120	Mohr-Coulomb	1750	0
Soil Type 4		115	125	Mohr-Coulomb	3500	0
Soil Type 5		130	140	Mohr-Coulomb	8750	0
New Fills		120	120	Mohr-Coulomb	2000	0

SP-289

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 572+25		
Drawn By ZM	*Scale* 1:260	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Stabilized Slope EB STA. 572+25_B1&B2_Total.slim	



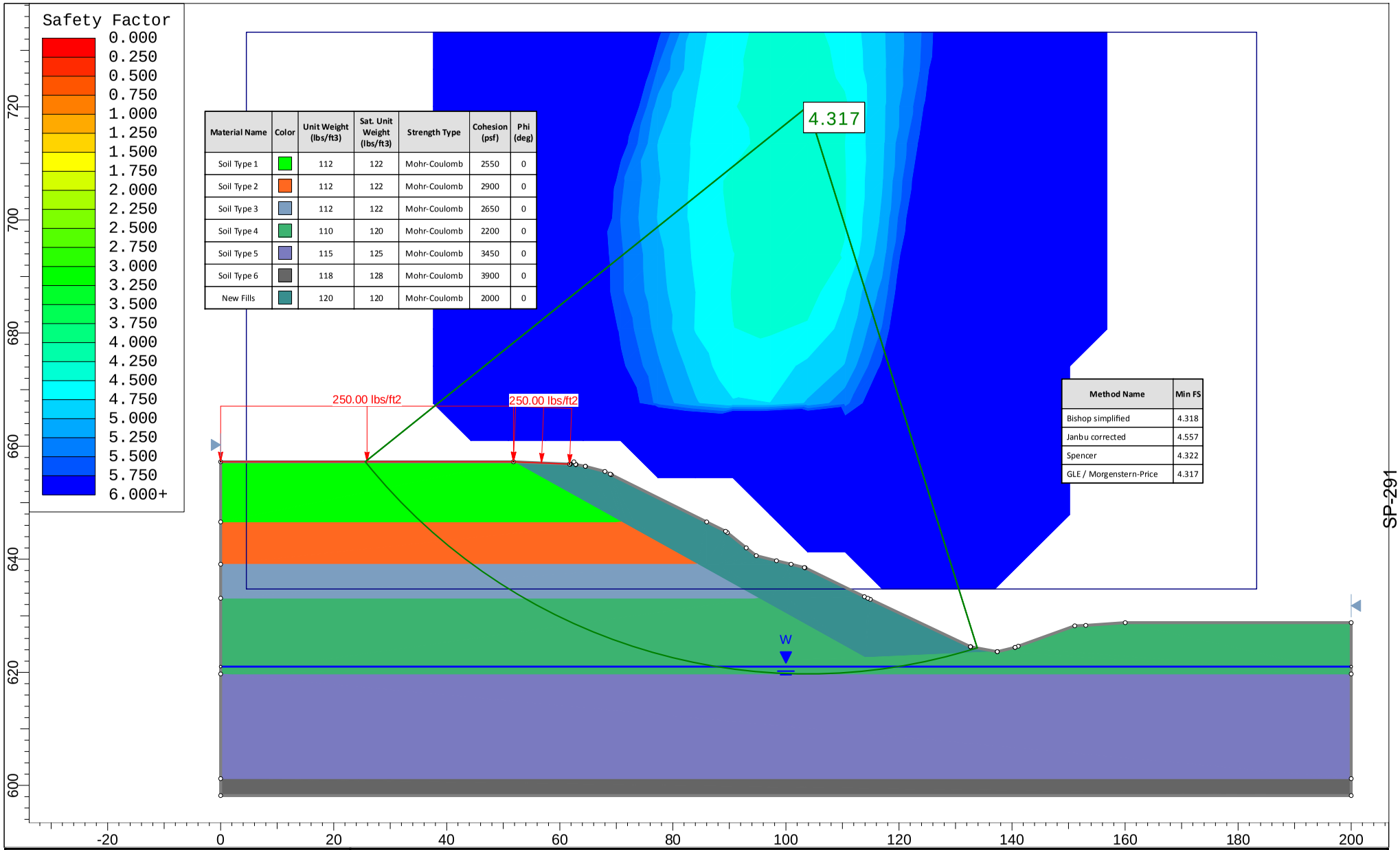
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		112	122	Mohr-Coulomb	150	25
Soil Type 3		112	122	Mohr-Coulomb	150	25
Soil Type 4		110	120	Mohr-Coulomb	115	24
Soil Type 5		115	125	Mohr-Coulomb	180	25
Soil Type 6		118	128	Mohr-Coulomb	200	26
New Fills		120	120	Mohr-Coulomb	200	26

Method Name	Min FS
Bishop simplified	1.503
Janbu corrected	1.466
Spencer	1.497
GLE / Morgenstern-Price	1.495

SP-290

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 576+00		
Drawn By ZM	*Scale* 1:280	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC Genoa Stabilized Slope EB STA. 576+00_B3&B4_Effective.slim	



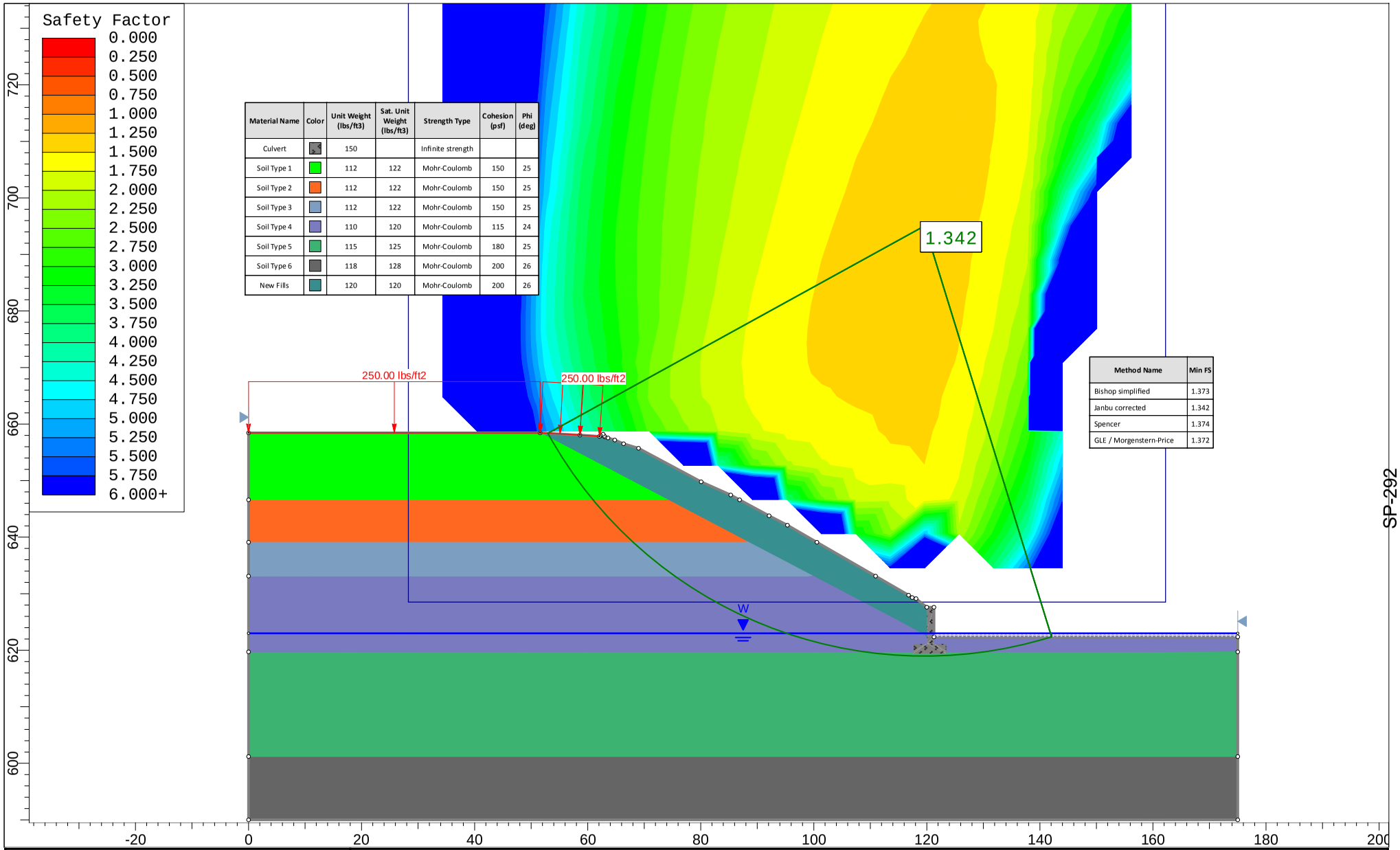
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	2550	0
Soil Type 2		112	122	Mohr-Coulomb	2900	0
Soil Type 3		112	122	Mohr-Coulomb	2650	0
Soil Type 4		110	120	Mohr-Coulomb	2200	0
Soil Type 5		115	125	Mohr-Coulomb	3450	0
Soil Type 6		118	128	Mohr-Coulomb	3900	0
New Fills		120	120	Mohr-Coulomb	2000	0

Method Name	Min FS
Bishop simplified	4.318
Janbu corrected	4.557
Spencer	4.322
GLE / Morgenstern-Price	4.317

SP-291

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 576+00		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Slope EB STA. 576+00_B3&B4_Total.slim



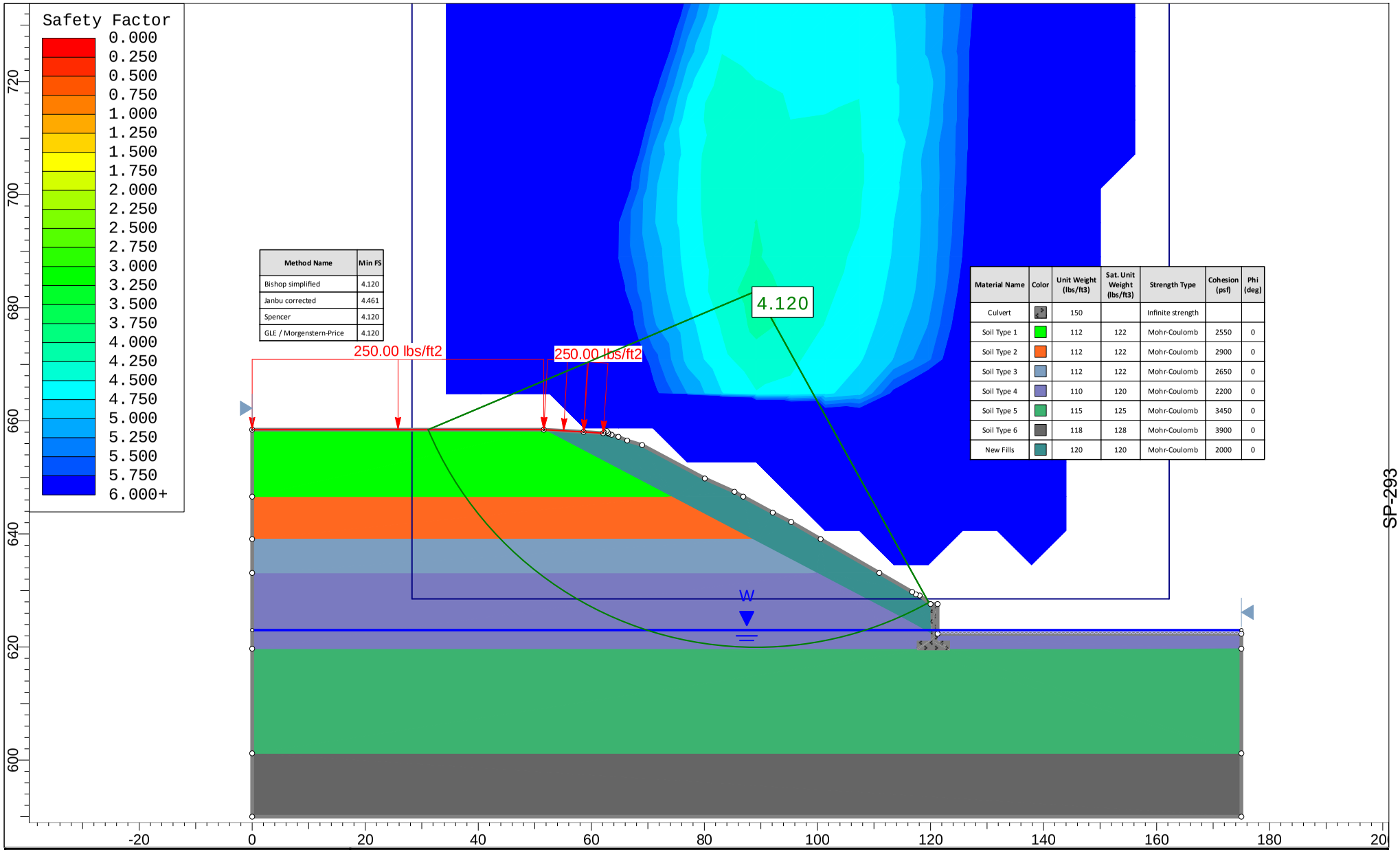
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		112	122	Mohr-Coulomb	150	25
Soil Type 3		112	122	Mohr-Coulomb	150	25
Soil Type 4		110	120	Mohr-Coulomb	115	24
Soil Type 5		115	125	Mohr-Coulomb	180	25
Soil Type 6		118	128	Mohr-Coulomb	200	26
New Fills		120	120	Mohr-Coulomb	200	26

Method Name	Min FS
Bishop simplified	1.373
Janbu corrected	1.342
Spencer	1.374
GLE / Morgenstern-Price	1.372

SP-292

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 577+15.59		
Drawn By ZM	*Scale* 1:280	*Company*	NEAS Inc.
Date 02/24/21		*File Name*	OTIC Genoa Stabilized Slope EB Culvert_STA. 577+15.59_B3&B4_Effective slim



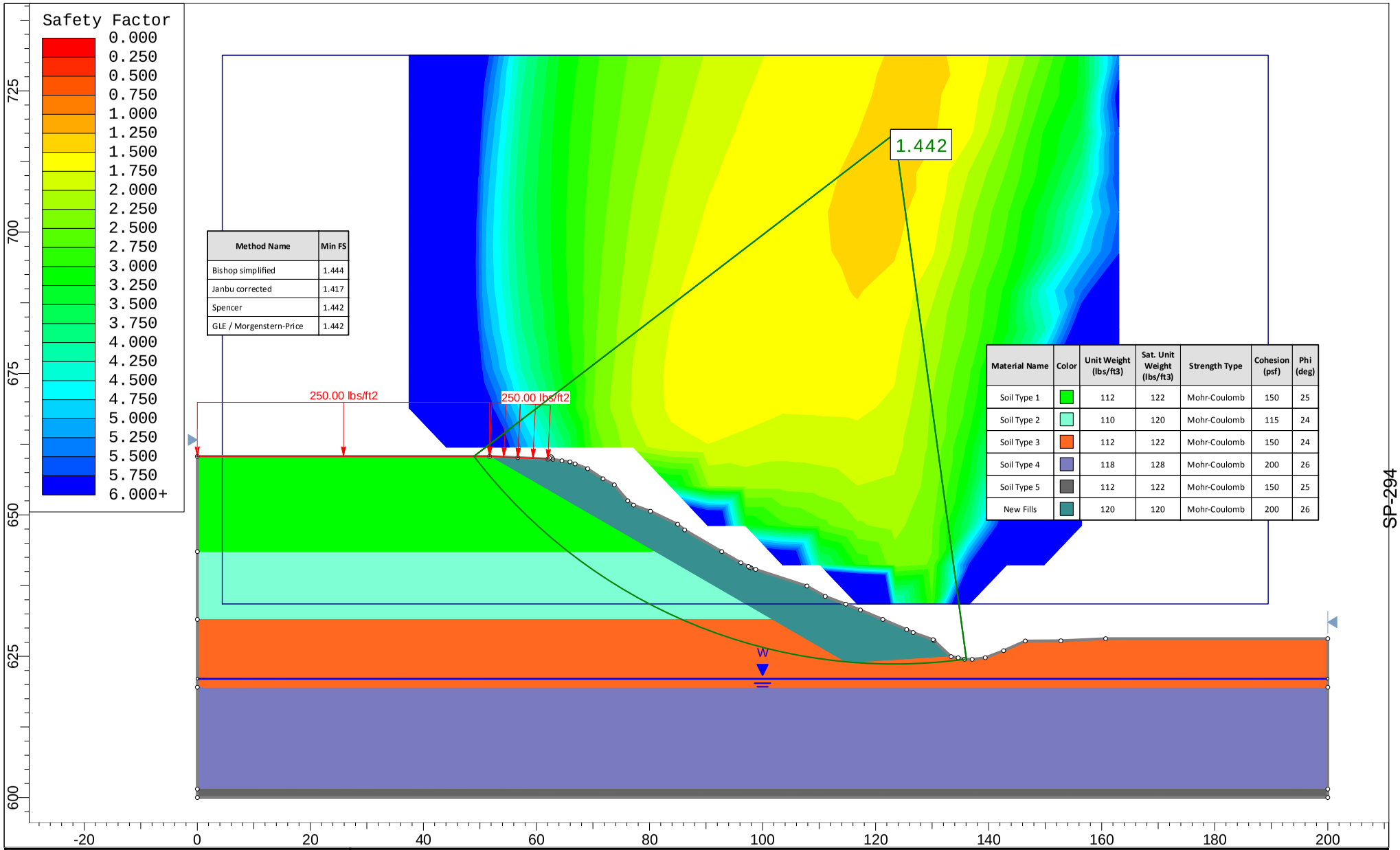
Method Name	Min FS
Bishop simplified	4.120
Janbu corrected	4.461
Spencer	4.120
GLE / Morgenstern-Price	4.120

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	2550	0
Soil Type 2		112	122	Mohr-Coulomb	2900	0
Soil Type 3		112	122	Mohr-Coulomb	2650	0
Soil Type 4		110	120	Mohr-Coulomb	2200	0
Soil Type 5		115	125	Mohr-Coulomb	3450	0
Soil Type 6		118	128	Mohr-Coulomb	3900	0
New Fills		120	120	Mohr-Coulomb	2000	0

SP-293

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound Culvert STA. 577+15.59		
Drawn By	ZM	Scale	1:280
Company	NEAS Inc.		
Date	02/24/21	File Name	OTIC Genoa Stabilized Slope EB Culvert_STA. 577+15.59_B3&B4_Total.slim



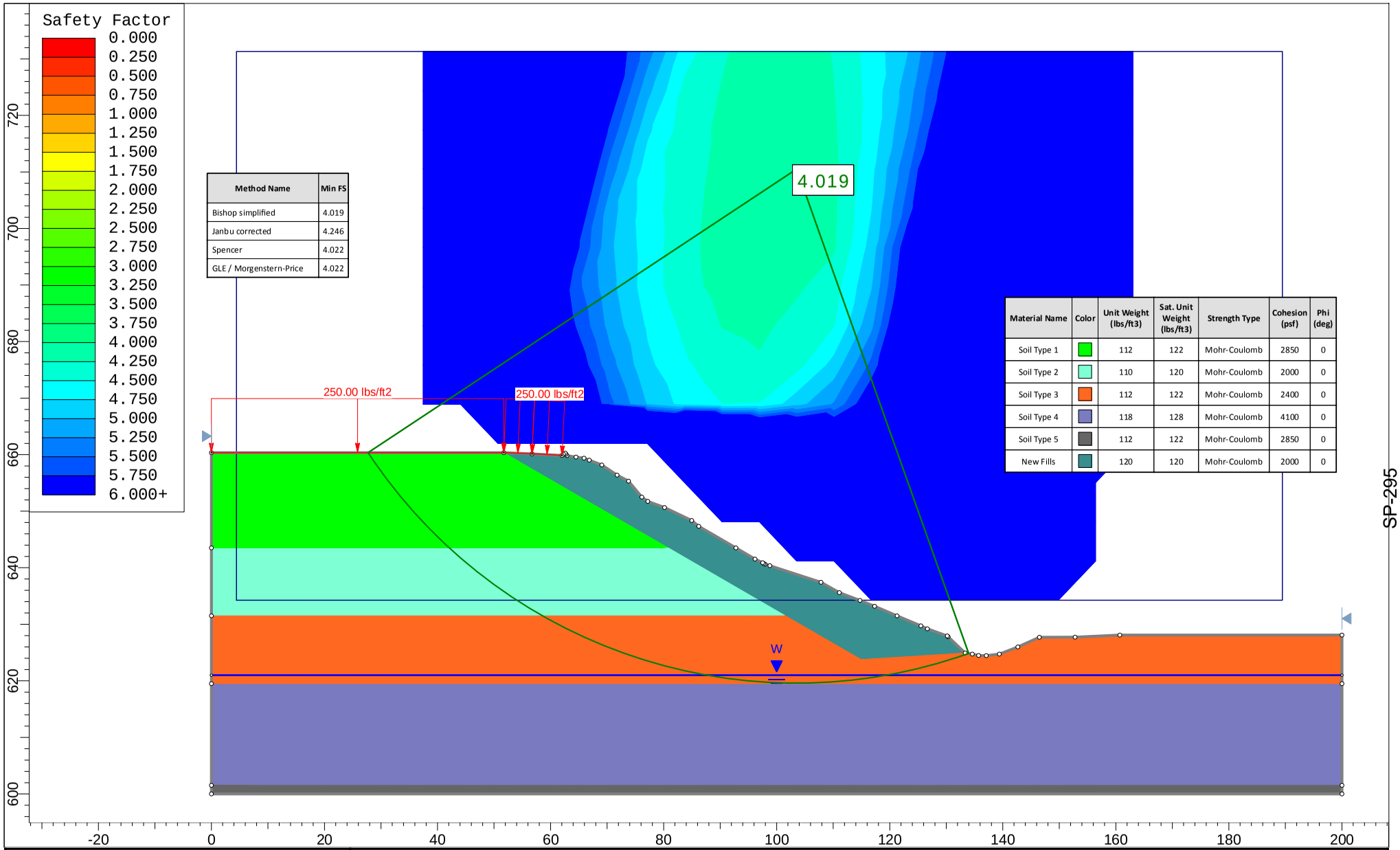
Method Name	Min FS
Bishop simplified	1.444
Janbu corrected	1.417
Spencer	1.442
GLE / Morgenstern-Price	1.442

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		110	120	Mohr-Coulomb	115	24
Soil Type 3		112	122	Mohr-Coulomb	150	24
Soil Type 4		118	128	Mohr-Coulomb	200	26
Soil Type 5		112	122	Mohr-Coulomb	150	25
New Fills		120	120	Mohr-Coulomb	200	26

SP-294

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 579+75		
Drawn By	ZM	Scale	1:280
Company	NEAS Inc.		
Date	02/24/21	File Name	OTIC Genoa Stabilized Slope EB STA. 579+75_B10_Effective.slim



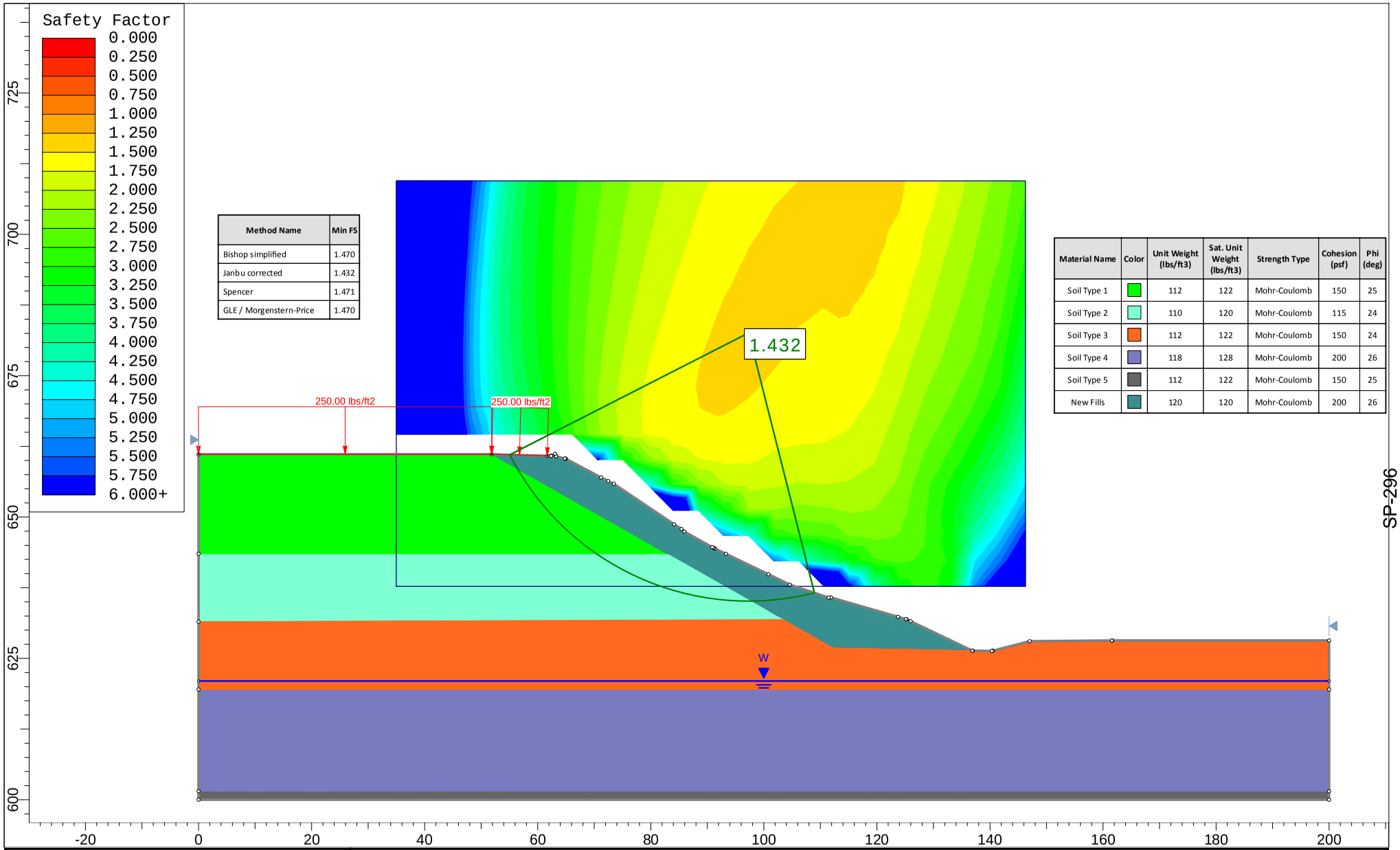
Method Name	Min FS
Bishop simplified	4.019
Janbu corrected	4.246
Spencer	4.022
GLE / Morgenstern-Price	4.022

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	2850	0
Soil Type 2		110	120	Mohr-Coulomb	2000	0
Soil Type 3		112	122	Mohr-Coulomb	2400	0
Soil Type 4		118	128	Mohr-Coulomb	4100	0
Soil Type 5		112	122	Mohr-Coulomb	2850	0
New Fills		120	120	Mohr-Coulomb	2000	0

SP-295

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 579+75		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Stabilized Slope EB STA. 579+75_B10_Total.slim



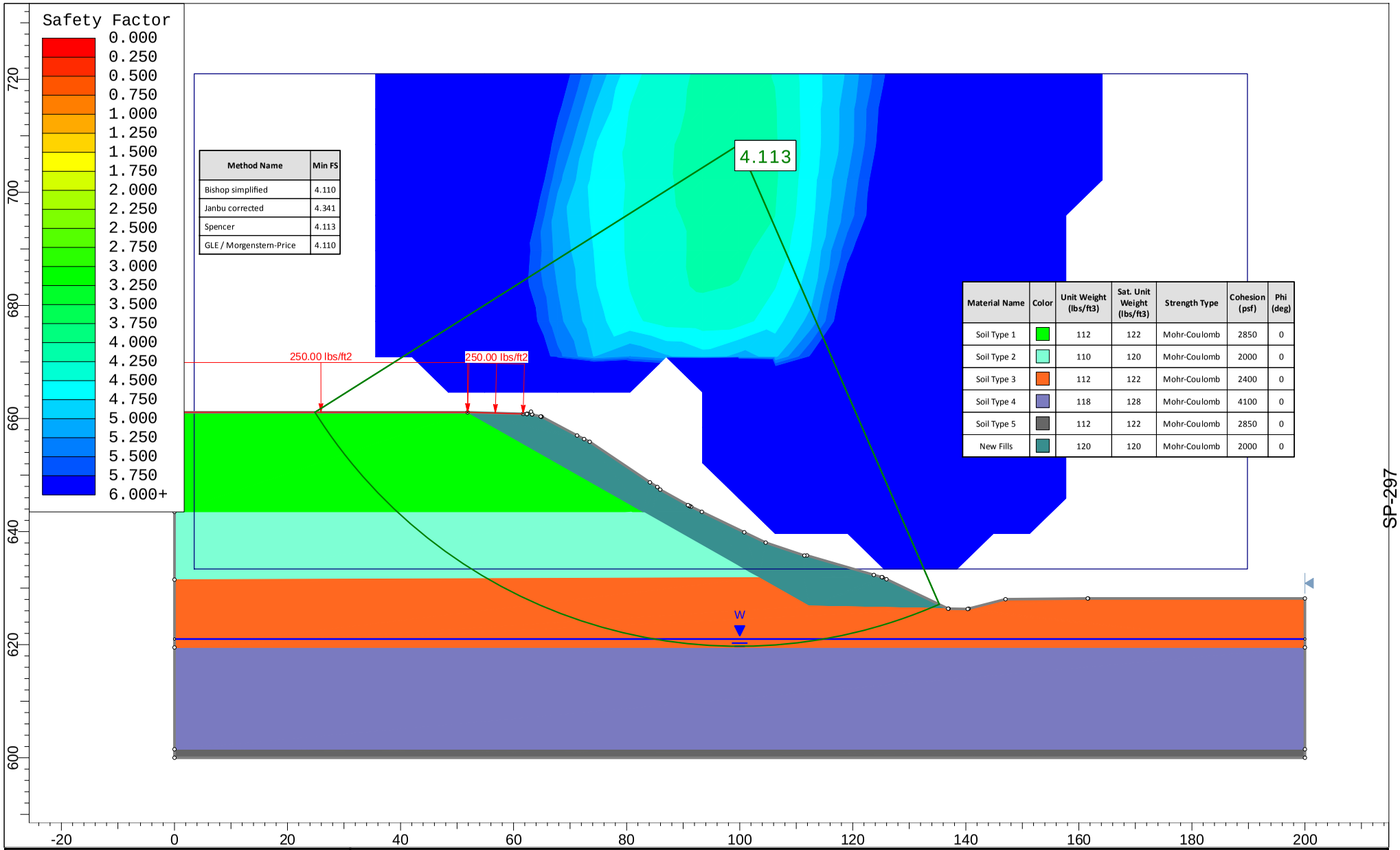
Method Name	Min FS
Bishop simplified	1.470
Janbu corrected	1.432
Spencer	1.471
GLE / Morgenstern-Price	1.470

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	150	25
Soil Type 2		110	120	Mohr-Coulomb	115	24
Soil Type 3		112	122	Mohr-Coulomb	150	24
Soil Type 4		118	128	Mohr-Coulomb	200	26
Soil Type 5		112	122	Mohr-Coulomb	150	25
New Fills		120	120	Mohr-Coulomb	200	26

SP-296

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 583+00		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Stabilized Slope EB STA. 583+00_B10_Effective.slim



Method Name	Min FS
Bishop simplified	4.110
Janbu corrected	4.341
Spencer	4.113
GLE / Morgenstern-Price	4.110

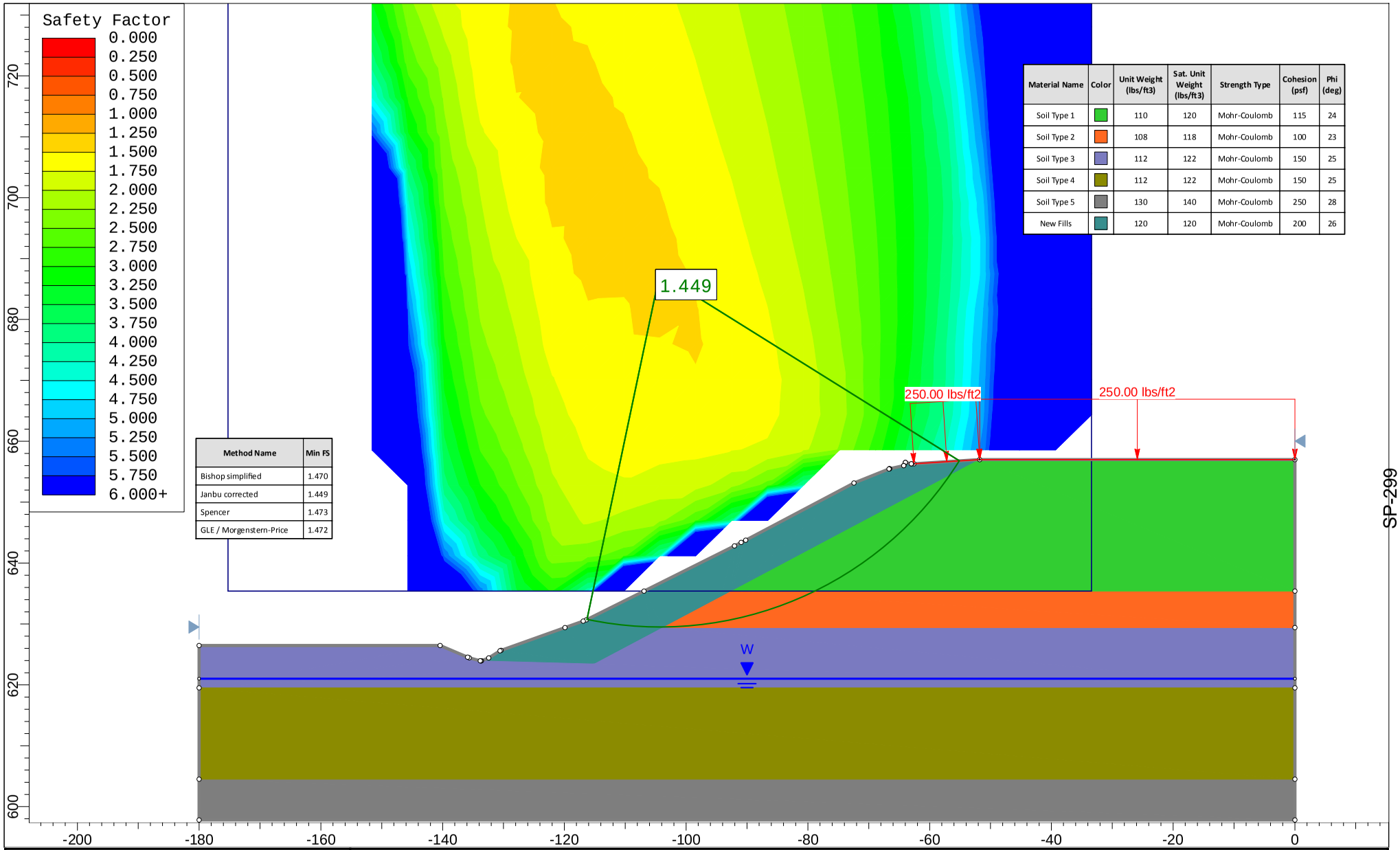
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	2850	0
Soil Type 2		110	120	Mohr-Coulomb	2000	0
Soil Type 3		112	122	Mohr-Coulomb	2400	0
Soil Type 4		118	128	Mohr-Coulomb	4100	0
Soil Type 5		112	122	Mohr-Coulomb	2850	0
New Fills		120	120	Mohr-Coulomb	2000	0

SP-297

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Eastbound STA. 583+00		
Drawn By	ZM	*Scale* 1:280	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Stabilized Slope EB STA. 583+00_B10_Total.slim

WESTBOUND



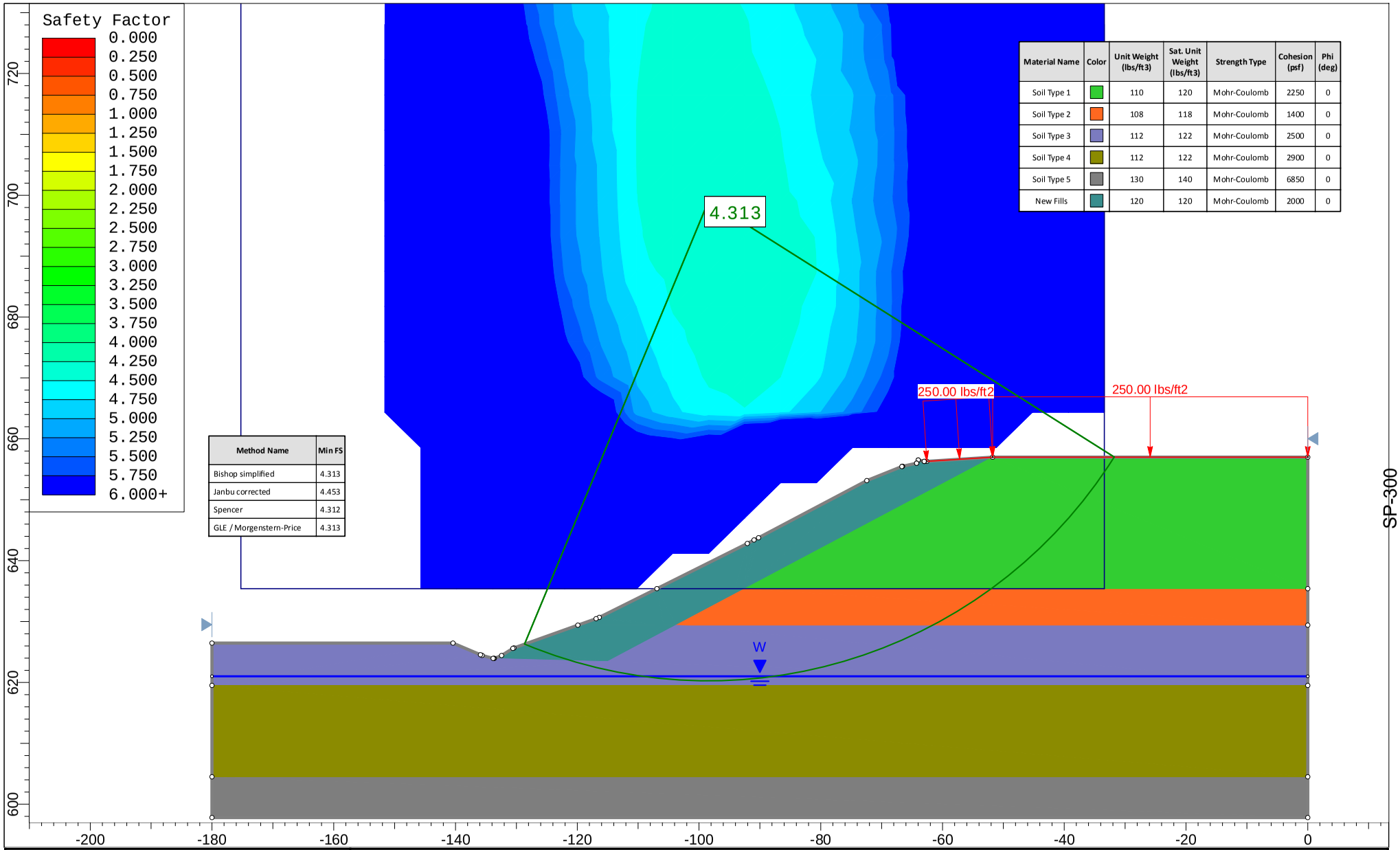
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		110	120	Mohr-Coulomb	115	24
Soil Type 2		108	118	Mohr-Coulomb	100	23
Soil Type 3		112	122	Mohr-Coulomb	150	25
Soil Type 4		112	122	Mohr-Coulomb	150	25
Soil Type 5		130	140	Mohr-Coulomb	250	28
New Fills		120	120	Mohr-Coulomb	200	26

Method Name	Min FS
Bishop simplified	1.470
Janbu corrected	1.449
Spencer	1.473
GLE / Morgenstern-Price	1.472

SP-299

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 575+81		
Drawn By ZM	*Scale* 1:260	*Company* NEAS Inc.	
Date 02/24/21		*File Name* OTIC GenoaStabilized Slope WB STA. 575+81_B6&B7_Effective.slim	



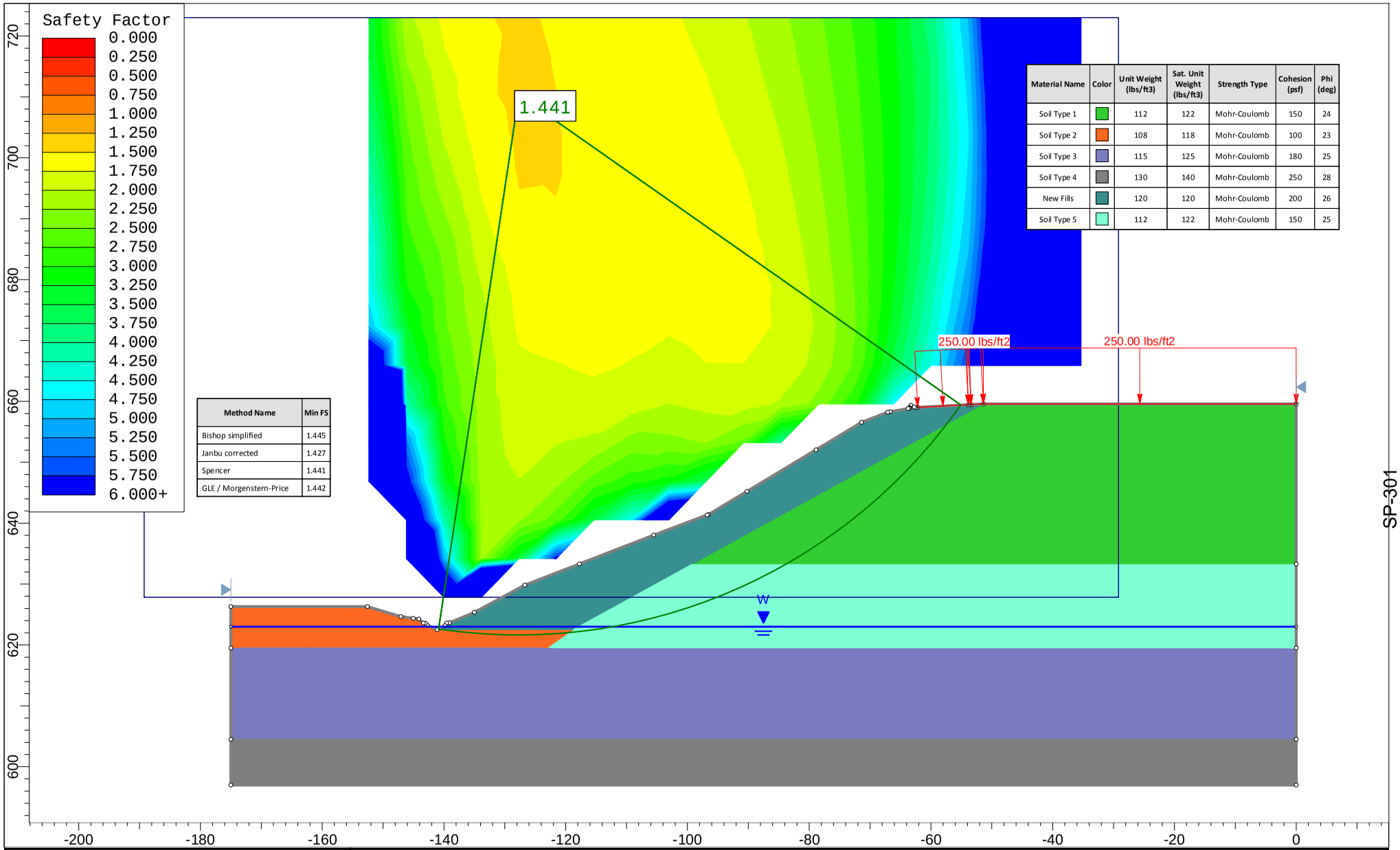
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		110	120	Mohr-Coulomb	2250	0
Soil Type 2		108	118	Mohr-Coulomb	1400	0
Soil Type 3		112	122	Mohr-Coulomb	2500	0
Soil Type 4		112	122	Mohr-Coulomb	2900	0
Soil Type 5		130	140	Mohr-Coulomb	6850	0
New Fills		120	120	Mohr-Coulomb	2000	0

Method Name	Min FS
Bishop simplified	4.313
Janbu corrected	4.453
Spencer	4.312
GLE / Morgenstern-Price	4.313

SP-300

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 575+81		
Drawn By	ZM	Scale	1:260
Company	NEAS Inc.		
Date	02/24/21	File Name	OTIC Genoa Stabilized Slope WB STA. 575+81_B6&B7_Total.slim



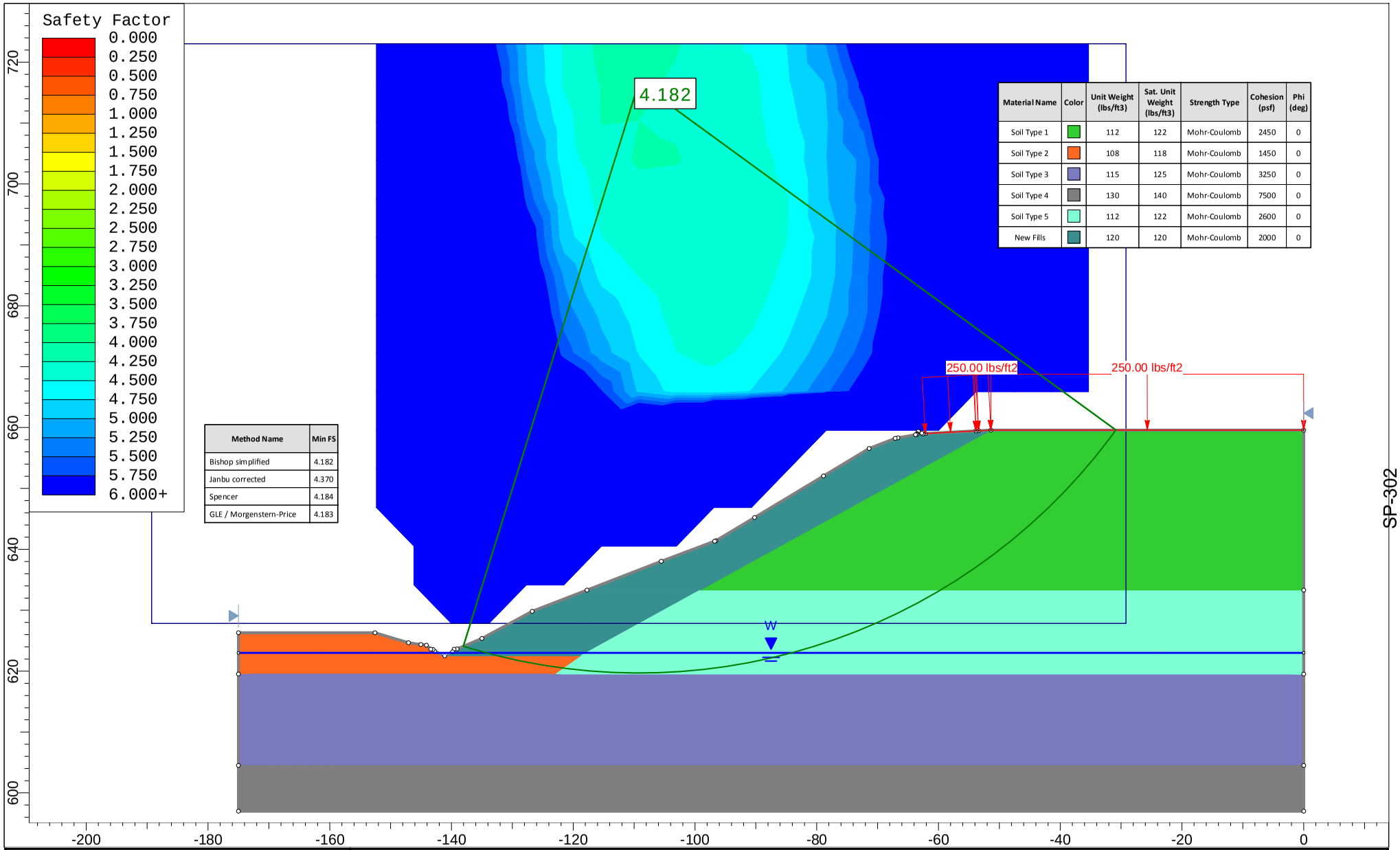
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	150	24
Soil Type 2		108	118	Mohr-Coulomb	100	23
Soil Type 3		115	125	Mohr-Coulomb	180	25
Soil Type 4		130	140	Mohr-Coulomb	250	28
New Fills		120	120	Mohr-Coulomb	200	26
Soil Type 5		112	122	Mohr-Coulomb	150	25

Method Name	Min FS
Bishop simplified	1.445
Janbu corrected	1.427
Spencer	1.441
GLE / Morgenstern-Price	1.442

SP-301

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 578+75		
Drawn By	ZM	*Scale* 1:260	*Company* NEAS Inc.
Date	02/24/21		*File Name* OTIC Genoa Stabilized Slope WB STA. 578+75_B8&B9_Effective.slim



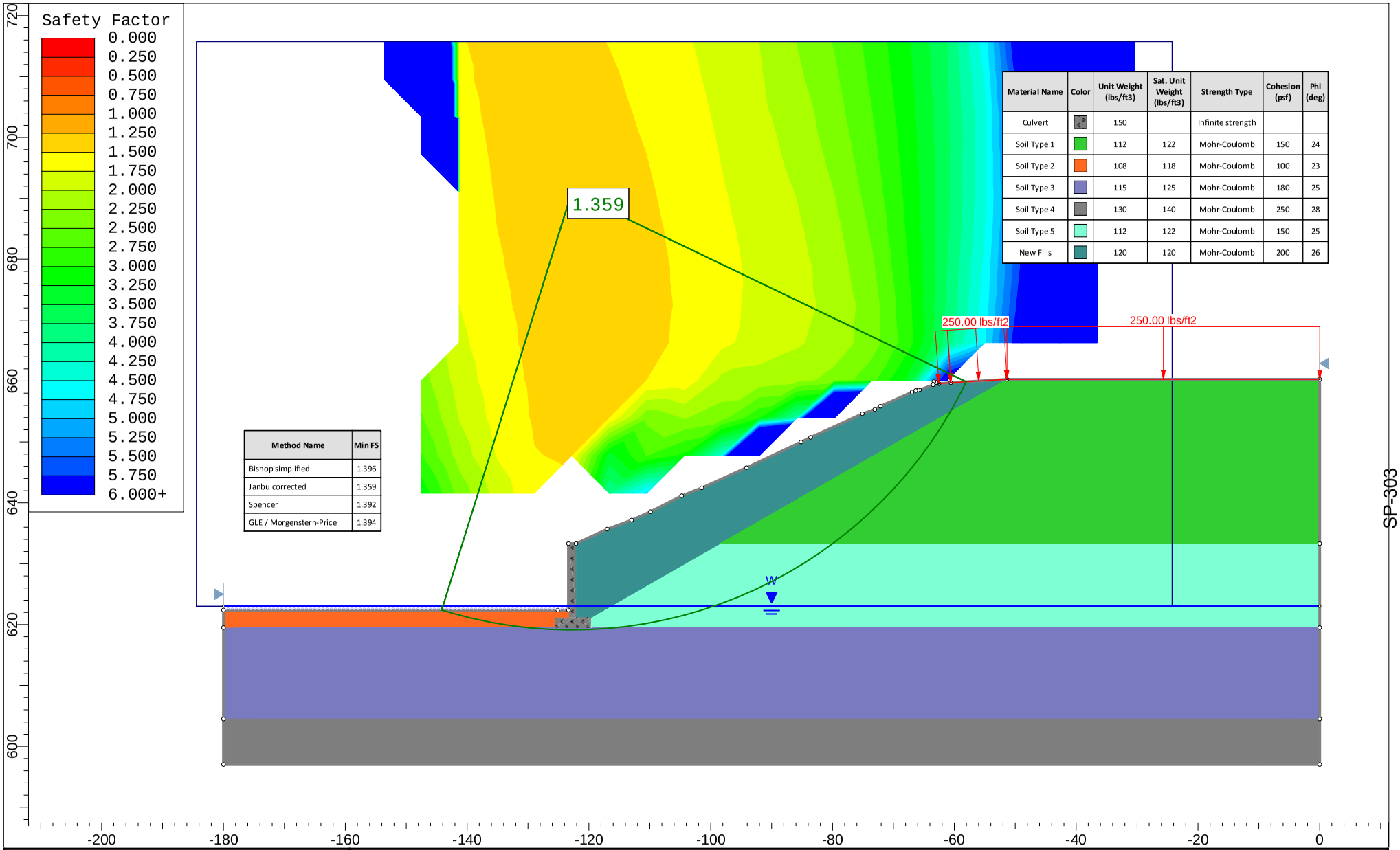
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soil Type 1		112	122	Mohr-Coulomb	2450	0
Soil Type 2		108	118	Mohr-Coulomb	1450	0
Soil Type 3		115	125	Mohr-Coulomb	3250	0
Soil Type 4		130	140	Mohr-Coulomb	7500	0
Soil Type 5		112	122	Mohr-Coulomb	2600	0
New Fills		120	120	Mohr-Coulomb	2000	0

Method Name	Min FS
Bishop simplified	4.182
Janbu corrected	4.370
Spencer	4.184
GLE / Morgenstern-Price	4.183

SP-302

SLIDEINTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 578+75		
Drawn By	ZM	Scale	1:260
Company	NEAS Inc.		
Date	02/24/21	File Name	OTIC Genoa Stabilized Slope WB STA. 578+75_B8&B9_Total.slim



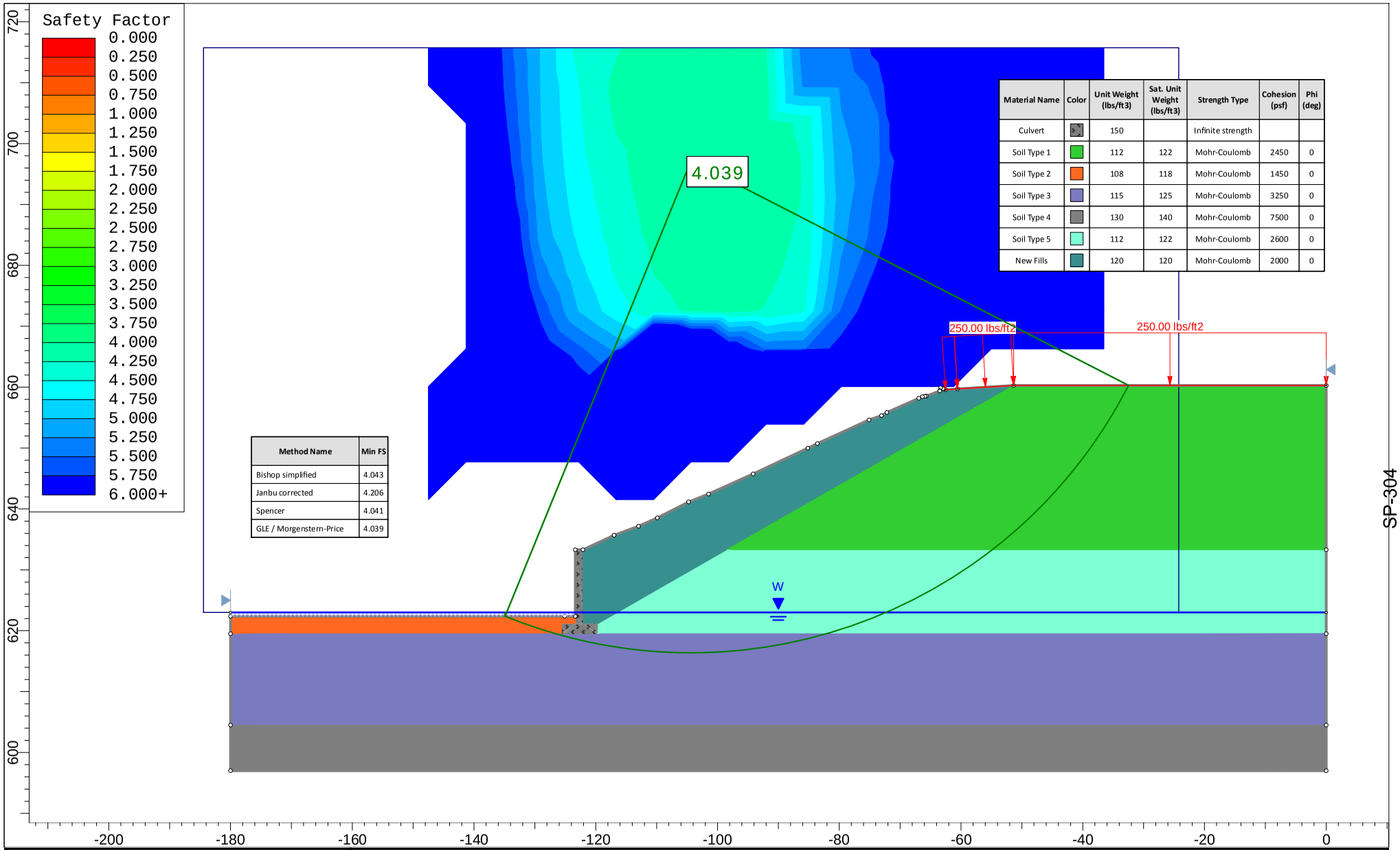
Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	150	24
Soil Type 2		108	118	Mohr-Coulomb	100	23
Soil Type 3		115	125	Mohr-Coulomb	180	25
Soil Type 4		130	140	Mohr-Coulomb	250	28
Soil Type 5		112	122	Mohr-Coulomb	150	25
New Fills		120	120	Mohr-Coulomb	200	26

Method Name	Min FS
Bishop simplified	1.396
Janbu corrected	1.359
Spencer	1.392
GLE / Morgenstern-Price	1.394

SP-303

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 580+75		
Drawn By ZM	*Scale* 1:260	*Company*	NEAS Inc.
Date 02/24/21		*File Name*	OTIC Genoa Stabilized Slope WB Culvert STA. 580+20.54, B8&B9, Effective slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Culvert		150		Infinite strength		
Soil Type 1		112	122	Mohr-Coulomb	2450	0
Soil Type 2		108	118	Mohr-Coulomb	1450	0
Soil Type 3		115	125	Mohr-Coulomb	3250	0
Soil Type 4		130	140	Mohr-Coulomb	7500	0
Soil Type 5		112	122	Mohr-Coulomb	2600	0
New Fills		120	120	Mohr-Coulomb	2000	0

Method Name	Min FS
Bishop simplified	4.043
Janbu corrected	4.206
Spencer	4.041
GLE / Morgenstern-Price	4.039

SP-304

SLIDE INTERPRET 7.038

Project	OTIC GES 99-20-04		
Analysis Description	Westbound STA. 580+75		
Drawn By ZM	*Scale* 1:260	*Company*	NEAS Inc.
Date 02/24/21		*File Name*	OTIC Genoa Stabilized Slope WB Culvert STA. 580+20.54_B8&B9_Total.slim

APPENDIX E

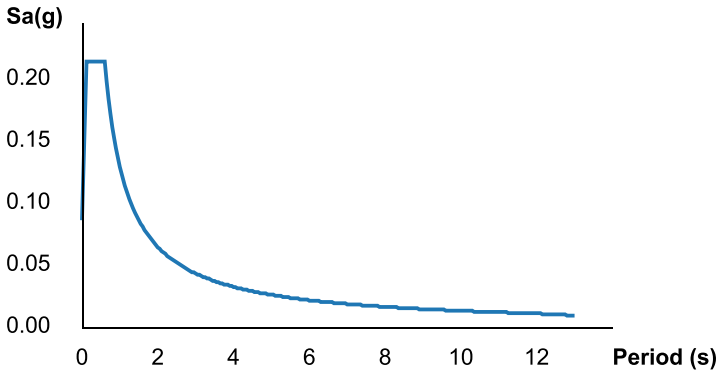
SEISMIC DESIGN PARATERS

Hazards by Location

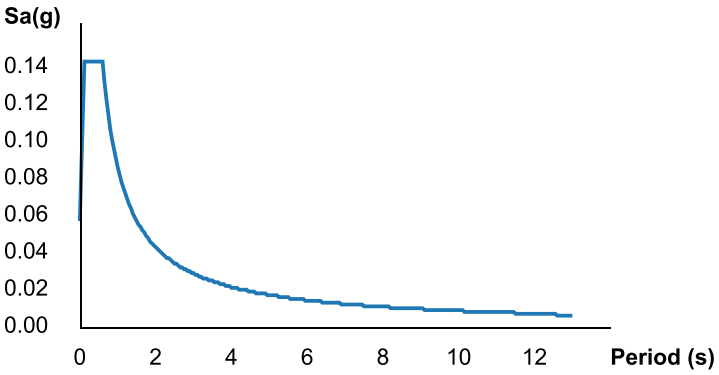
Search Information

Coordinates:	41.511464 , -83.422943
Elevation:	652 ft
Timestamp:	2021-03-08T20:08:25.762Z
Hazard Type:	Seismic
Reference Document:	ASCE7-16
Risk Category:	II
Site Class:	D-default

MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	0.134	MCE_R ground motion (period=0.2s)
S_1	0.054	MCE_R ground motion (period=1.0s)
S_{MS}	0.214	Site-modified spectral acceleration value
S_{M1}	0.129	Site-modified spectral acceleration value
S_{DS}	0.143	Numeric seismic design value at 0.2s SA
S_{D1}	0.086	Numeric seismic design value at 1.0s SA

Additional Information

Name	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2s
F_v	2.4	Site amplification factor at 1.0s
CR_S	0.95	Coefficient of risk (0.2s)

CR_1	0.907	Coefficient of risk (1.0s)
PGA	0.07	MCE_G peak ground acceleration
F_{PGA}	1.6	Site amplification factor at PGA
PGA_M	0.112	Site modified peak ground acceleration
T_L	12	Long-period transition period (s)
SsRT	0.134	Probabilistic risk-targeted ground motion (0.2s)
SsUH	0.141	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
SsD	1.5	Factored deterministic acceleration value (0.2s)
S1RT	0.054	Probabilistic risk-targeted ground motion (1.0s)
S1UH	0.059	Factored uniform-hazard spectral acceleration (2% probability of exceedance in 50 years)
S1D	0.6	Factored deterministic acceleration value (1.0s)
PGAd	0.5	Factored deterministic acceleration value (PGA)

The results indicated here DO NOT reflect any state or local amendments to the values or any delineation lines made during the building code adoption process. Users should confirm any output obtained from this tool with the local Authority Having Jurisdiction before proceeding with design.

Disclaimer

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