CTL Engineering, Inc.
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AN EMPLOYEE-OWNED COMPANY

Consulting Engineer – Testing – Inspection Services – Analytical Laboratories Established 1927

October 31, 2025

Environmental Design Group
450 Grant Street
Akron, Ohio 44311

Attention: Kyle T. Lukes, PLA, ASLA
Project Manager

Reference: Geotechnical Engineering Report
PID 117785
COL-EL Riverfront Trail – Retaining Wall Phase 1.1
River Road – Broadway Street
East Liverpool, Columbiana County, Ohio

CTL Project No. 25050019CLE

Mr. Lukes:

CTL Engineering, Inc. has completed the Geotechnical Engineering Report for Phase 1.1 of the above referenced project. Enclosed is the digital (PDF) copy of the report.

Thank you for the opportunity to work with you on this project. If you have any questions or need further information, please feel free to contact our office.

Respectfully Submitted
CTL ENGINEERING, INC.

H. Matthew Kairouz, P.E.
Project Manager

GEOTECHNICAL ENGINEERING REPORT

COL-EL RIVERFRONT TRAIL – RETAINING WALL PHASE 1.1
PID 117785
RIVER ROAD – BROADWAY STREET
EAST LIVERPOOL, COLUMBIANA COUNTY, OHIO

CTL PROJECT NO. 25050019CLE

PREPARED FOR

ENVIRONMENTAL DESIGN GROUP
450 GRANT STREET
AKRON, OHIO 44311

PREPARED BY

CTL ENGINEERING, INC.
3085 INTERSTATE PARKWAY
BRUNSWICK, OHIO 44212
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October 31, 2025

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I. PROJECT DESCRIPTION

The COL-EL Riverfront Trail project consists of installing a gravity retaining wall along the north side of River Road/Broadway Street below US 30 Embankment in East Liverpool, Columbian County, Ohio. The proposed wall is anticipated to be located between Stations STA 3+50 to STA 6+50.

This Geotechnical Engineering Report provides exploration findings slope stability analyses, and soil data for the design of the gravity wall.

II. GEOLOGY AND OBSERVATIONS OF THE PROJECT

A. Geology

According to the Ohio Department of Natural Resources' Division of Geological Survey, the project site is located within Cenozoic Colluvium of Holocence age. The surficial units consisted of Alluvium (Holocene), which includes a wide variety of textures from silt to clay to boulders commonly includes organic material. The Alluvium soils underlain by Silt (predominantly Wisconsinan) commonly contains thin sand partings and may contain localized clay, sand, or gravel layers. Clay content commonly increases with depth. The bedrock geology of the project site is Pennsylvanian-age, Allegheny, and Pottsville groups undivided Shale interbedded with minor sandstone and siltstone.

According to Ohio Department of Natural Resources - Division of Mineral Resources website (www.ohiodnr.com/mineral), there are no mines listed in the immediate vicinity of the project area.

B. Site Conditions

The project site is located within commercial/industrial setting. The residential areas are located to the north side of the project while Ohio River is located to the south side of the project site. River Road/Broadway Street are a 2-lane, asphalt surface covered roadways, exhibiting isolated areas of fatigue cracking. The highway embankment north of Broadway St and River Road is covered with tall grasses. Embankment bulges and scarps were not observed at the time of the site visit.

III. EXPLORATION

C. Historical Exploration:

Our review of Historic information indicated the availability of data at the project site. Two historical soil borings were used to interpolate the bed rock elevation. The two historical soil borings were drilled within the south embankment of US 30 and its information as follows:

Table 1: Historic Soil Borings

Boring No	Boring Renumber	Depth (ft)	Elevation (ft)	Station	Offset (ft)
C-1	C-001-00-72	42	707	999+73	42 RT
C-2	C-002-00-72	40	707	1001+05	45 RT

D. Present Exploration:

Between June 5 and 9, 2025 CTL Engineering advanced three (3) soil borings as follows:

Table 2: Current Soil Borings

Boring No	Depth (ft)	Elevation (ft)	Station	Offset (ft)	Latitude	Longitude
B-001-00-25	60	734	5+50	100 Rt	40.615953	-80.576039
B-002-00-25	27	696	5+60	15 Lt	40.615631	-80.576119
B-003-00-25	30	692	4+70	15 Lt	40.615678	-80.575719

CTL Engineering in collaboration with Environmental Design Group, selected the boring locations as shown approximately on the enclosed Boring Location Plan provided in Appendix A.

The drillers obtained split spoon soil samples at 2.5-foot interval in the upper 20 feet, and at 5-foot interval thereafter. The Split Spoon Samples were obtained in accordance with Standard Penetration (SPT) procedure. The SPT consists of driving a 2.0-inch outside diameter (OD) split-spoon sampler 18 inches into the soil with an automatic 140-pound hammer with 30- inch drops. The SPT hammer used for this project were calibrated in November 8, 2024., its energy ratio was 80.7 percent in obtaining industry standard N-values (N_{60}-values). One Shelby Tube (ST) samples was collected at boring location B-003 at depth of approximately 3-5 feet.
The drilling crew visually classified the soil samples then secured them in glass jars and delivered them to accredited CTL laboratory for further testing and analysis. A CTL geologist reclassified the soil and rock samples and performed laboratory testing on representative samples under the direction of the Geotechnical Engineer. The laboratory testing included hand penetrometer, moisture content, grain size distribution, Atterberg limits, and Consolidated Undrained Triaxial Test. Appendix

A, B, and C include boring location plan, test boring records, and laboratory test results respectively.

IV. EXPLORATION FINDINGS

A. Subsurface Conditions:

The surface at all boring locations was covered with 5 to 6 inches of asphalt underlain by 6 to 7 inches of gravel base.

Fill material was observed at B-01-0-25 and B-02-0-25 extending to depths of approximately 38 and 2 feet below existing grade, respectively. The fill material in the upper 5 feet consisted of dense gravel and stone fragments with sand (A-1-b) or coarse and fine sand (A-3a). The fill from 5 to 38 feet consisted medium dense to dense sandy silt (A-4a), gravel and stone fragments with sand (A-1-b), gravel and stone fragments (A-1-a), and/or gravel and stone fragments with sand and silt (A-2-4).

The natural soil consisted of medium dense sandy silt (A-4a), loose to medium dense fine sand, medium dense to very dense gravel and stone fragments (A-1-a), medium dense silt (A-4b), and/or medium dense to dense gravel and stone fragments with sand (A-1-b).

The standard penetration test (SPT, N_{60}) values and moisture content in the upper 10 feet ranged from 8 to 44 blows per foot (bpf) and from 7 to 23 percent, respectively. The SPT and moisture content below 10 feet ranged from 16 to over 50 blows per foot (bpf) and from 1 to 20 percent respectively. Based on the historic borings C-1 and C-2, gray sandstone was encountered at elevations of approximately 667.5 and 675 feet respectively. The results of soil laboratory tests are summarized in Tables 3 and 4 below.

Table 3: Laboratory Test Results (Soil Indices).

Borehole No.	Sample ID	Depth (ft)	% Gravel	% Sand	% Silt	% Clay	L.L.	P.L.	P.I.
B-001	SS-2	3.5	59	24	14	3	NP	NP	NP
	SS-4	8.5	28	33	34	5	NP	NP	NP
	SS-7	16	58	19	21	2	NP	NP	NP
	SS-9	23.5	78	9	12	1	NP	NP	NP
	SS-11	33.5	55	18	23	4	NP	NP	NP
	SS-13	43.5	0	60	38	2	NP	NP	NP
	SS-15	53.5	16	79	5		NP	NP	NP
	SS-16	58.5	57	41	2		NP	NP	NP
B-002	SS-2	3.5	4	94	2		NP	NP	NP
	SS-4	8.5	29	71	0		NP	NP	NP
B-002	SS-8	18.5	65	34	1		NP	NP	NP

Borehole No.	Sample ID	Depth (ft)	% Gravel	% Sand	% Silt	% Clay	L.L.	P.L.	P.I.
B-003	SS-1	1	0	45	43	3	NP	NP	NP
	SS-5	11	64	36	0		NP	NP	NP
	SS-7	16	11	39	43	7	NP	NP	NP
	SS-10	28.5	48	51	1		NP	NP	NP

LL = Liquid Limit PI = Plasticity Index PL = Plastic Limit

Table 4: Soil Strength Properties

Boring ID	Sample ID	Sample Depth (ft)	MC (%)	γ_m (pcf)	CU Triaxial			
					C' (psf)	φ' (°)	C (psf)	φ (°)
B-003	ST-2	3 – 5	17	113	95	32	320	24

γ_m = Dry Unit Weight
MC = Moisture Content
C' = Cohesion (Effective Stress) C = Cohesion (Total Stress)
φ' = Friction Angle (Effective Stress) φ Friction Angle (Total Stress)

B. Groundwater:

Groundwater was encountered during drilling and at completion of the borings. Depths and elevations of the observed groundwater levels in each test boring location are provided in Table 5. It should be noted that fluctuations in groundwater levels should be expected over time due to variations in precipitation, surrounding groundwater use, and the time of year, the measurements are determined. Static groundwater levels can only be determined through observations made in cased holes over relatively long periods.

Table 5 Groundwater Levels

Boring	Ground Surface Elev. (ft)	Observed Ground Water Level (ft)				Caved
		During Drilling		At completion		
		Depth (ft)	Elev. (ft)	Depth (ft)	Elev. (ft)	Depth (ft)
B-001	734	58	676	58	676	42.4
B-002	696	27	669	27	669	13.7
B-003	692	23	669	27	665	16.3

C. Slope Stability

One representative slope section identified as STA 5+50 was considered for the slope stability analysis of the embankment at the three stages of construction. This section is included in Appendix D as part of the stability analysis. The slope stability analysis was performed using a 2-dimentional limiting equilibrium software program. The program is developed by RocScience as Slide 2018. The slope section was provided by Environmental Design Group via email on June 18, 2025. The subsurface

information used in our analyses were based on the recent test soil borings, historic soil boring (rock information), and laboratory test results.

The minimum factor of safeties obtained for the section at Station 5+50 are summarized in Table 6. The summaries of the stability analyses including slope stability methods, soil layers and parameters are included in Appendix D.

Table 6: Summary Results of Slope Stability Analyses

Stage	Average Minimum FOS		Required FOS
	Total Stress	Effective Stress	
Existing Conditions	1.9	1.9	≥ 1.3
Temporary Excavation (1.5H:1V)	1.3	1.1*	≥ 1.3
Upon Wall Completion	1.8	1.8	≥ 1.3

* Low Margin of Safety

The results of the slope stability analyses indicated that the excavation of the slope cannot remain stable for an extended period, however is expected to remain stable for a short time. CTL recommends that the excavation and wall construction be done in practical sections that can be backfilled within 1 to 2 days pending on weather conditions. Otherwise, if the excavation for the wall has to remain open for an extended period, then the excavations shall be retained using temporary sheet piles. A steeper than 1.5H:1V excavation may be considered with sheet pile support.

For this project, the required minimum FOS is 1.3 for the proposed retaining wall. The slope stability analyses indicated that the minimum FOS's were all well over 1.3 for both the long and short-term stability.

C. Retaining Wall/Sheet Piles

Structural elements subjected to lateral loads may be designed using the parameters listed in Table 7 below. These parameters are based on Rankine Theory and the assumption of a level backfill surface and no excessive hydrostatic pressure. The soil parameters should be adjusted based on final sloped backfill.

Table 7– Lateral Soil Parameters (Retaining Wall - Rankine)

Parameter	Backfill (Granular)
Moist Unit Weight, pcf	130
Angle of Internal Friction, Degrees	32
Soil Cohesion (c), psf	Ignore
Soil/Concrete Friction, Degrees	21
At Rest Earth Pressure Coefficient, K_o	0.47
Active Earth Pressure Coefficient, K_a	0.31
Passive Earth Pressure Coefficient, K_p*	3.25
Factored Bearing Resistance (q_r, psf)	3,750

** Passive resistance should be ignored in the upper 3.5 feet.*

Lateral pressure arising from surcharge loading should be added to the above soil earth pressures to determine the total lateral pressures that the walls must resist. In addition, transient loads imposed on the walls by construction equipment during backfilling should be taken into consideration during design and construction. Excessively heavy grading and construction equipment (that could impose temporary excessive pressures or long-term excessive pressures against the constructed walls) should not be allowed within five (5) feet (horizontally) of the walls.

Excavation (permanent or temporary) should be either shored or sloped for stability purposes. Temporary retaining walls (shoring) should be designed utilizing the relevant soil parameters shown in the Table 7 above.

It is recommended those walls which are restrained from rotating be designed based on at-rest earth pressure conditions, and those walls which are allowed to rotate be designed based on the active earth pressure conditions.

V. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL Engineering should be notified so that our recommendations can modified, if required.

VI. TESTING AND OBSERVATION

During the design process, it is recommended that CTL Engineering work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL Engineering is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on this project. If CTL Engineering is not retained for these services,

CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.

VII. CLOSING

This report has been prepared for the exclusive use by the client for use only on this project. Our services have been performed in accordance with generally accepted Geotechnical Engineering principles and practices. No warranty is either expressed or implied.

CTL Engineering's assignment does not include, nor does this geotechnical report address the environmental aspects of this particular site.
Specific design and construction recommendations have been provided in this report. Therefore, the report should be used in its entirety.

Respectfully Submitted,

CTL ENGINEERING, INC.

Lubna Ishag
Staff Geotechnical Engineer

Matthew Kairouz, P.E.
Project Engineer

APPENDIX A

- **BORING LOCATION PLAN**
- **SOIL PROFILE**

	SOIL BORING LOCATION MAP			
	Date 7/18/2025	Environmental Design Group COL-EL Riverfront Trail – Retaining Wall Phase 1.1 PID 117785 River Road – Broadway Street, East Liverpool, Columbiana County, Ohio		
CTL ENGINEERING, INC. GEOTECHNICAL ENGINEERS TESTING * INSPECTION LABORATORY SERVICES	**Scale** None			
	Drawn By MK	**Reviewed By**	**Page** 1 of 1	**Project No.** 24050019CLE

CTL Engineering, Inc.
3085 Interstate PKWY
Brunswick, OH 44212
Telephone: 330-220-8900

SUBSURFACE DIAGRAM

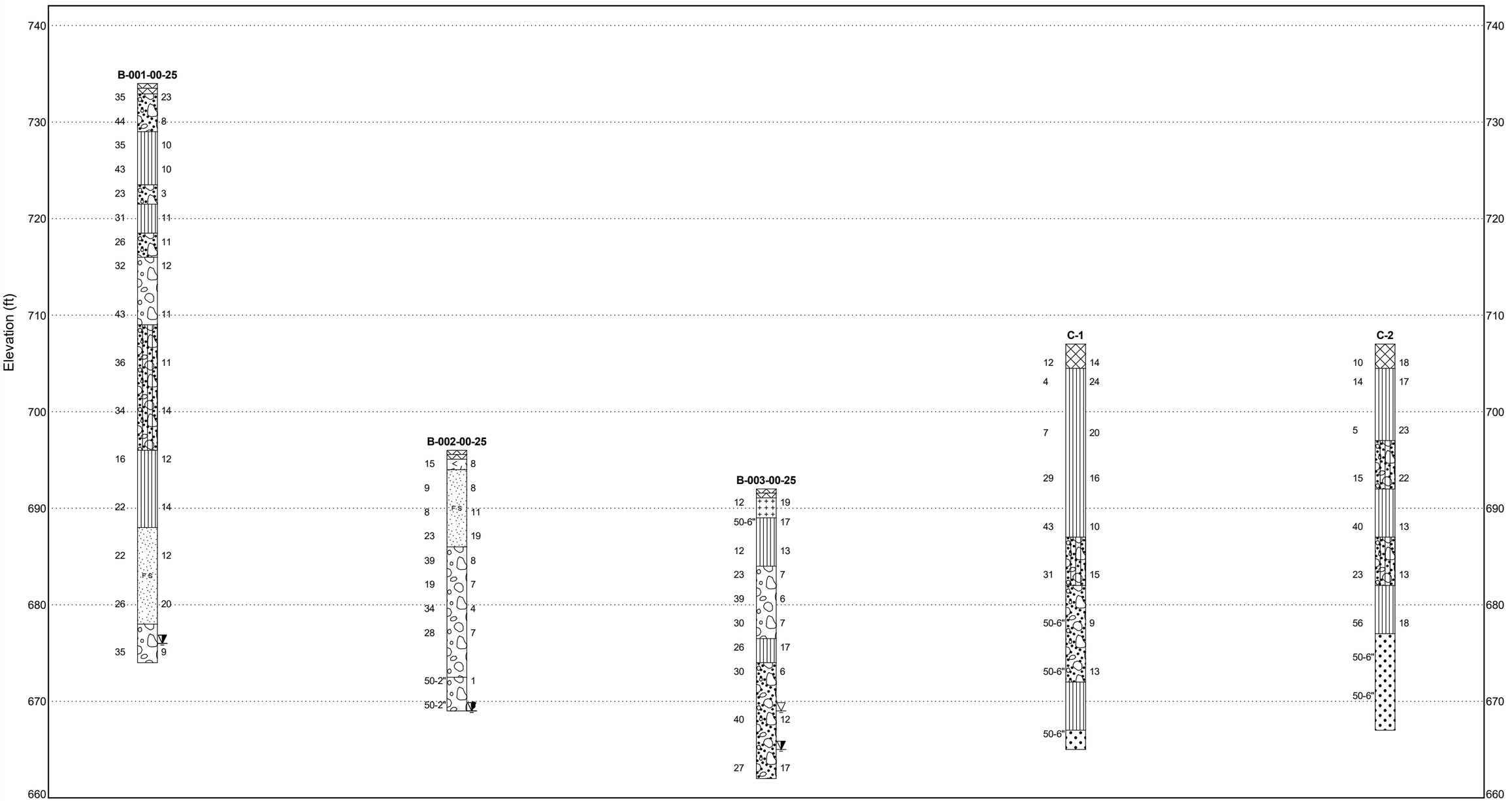
CLIENT Environmental Design Group

PROJECT NUMBER PID 117785

PROJECT NAME COL-EL Riverfront Trail – RET. Wall Phase 1.1

PROJECT LOCATION River Rd. – Broadway St., East Liverpool, OH

- Ohio DOT: Pavement or Aggregate base
- Ohio DOT: A-1-a, gravel and/or stone fragments
- Ohio DOT: Uncontrolled Fill
- Ohio DOT: A-1-b, gravel and/or stone fragments
- Ohio DOT: A-2-4, gravel and/or stone fragments with sand and silt
- Ohio DOT: A-4b, silt
- Ohio DOT: A-4a, sandy silt
- Ohio DOT: A-3, fine sand
- Ohio DOT: Sandstone



APPENDIX B

- **TEST BORING RECORDS**

CLASSIFICATION OF SOILS

Ohio Department of Transportation

(The classification of a soil is found by proceeding from top to bottom of the chart. The first classification that the test data fits is the correct classification.)

SYMBOL	DESCRIPTION	Classification AASHTO	Classification OHIO	LL_0/LL x 100*	% Pass #40	% Pass #200	Liquid Limit (LL)	Plastic Index (PI)	Group Index Max.	REMARKS
	Gravel and/or Stone Fragments	A-1-a			30 Max.	15 Max.		6 Max.	0	Min. of 50% combined gravel, cobble and boulder sizes
	Gravel and/or Stone Fragments with Sand	A-1-b			50 Max.	25 Max.		6 Max.	0	
F.S.	Fine Sand	A-3			51 Min.	10 Max.	NON-PLASTIC		0	
	Coarse and Fine Sand	--	A-3a			35 Max.		6 Max.	0	Min. of 50% combined coarse and fine sand sizes
	Gravel and/or Stone Fragments with Sand and Silt	A-2-4				35 Max.	40 Max.	10 Max.	0	
		A-2-5					41 Min.			
	Gravel and/or Stone Fragments with Sand, Silt and Clay	A-2-6				35 Max.	40 Max.	11 Min.	4	
		A-2-7					41 Min.			
	Sandy Silt	A-4	A-4a	75 Min.		36 Min.	40 Max.	10 Max.	8	Less than 50% silt sizes
	Silt	A-4	A-4b	75 Min.		50 Min.	40 Max.	10 Max.	8	50% or more silt sizes
	Elastic Silt and Clay	A-5		75 Min.		36 Min.	41 Min.	10 Max.	12	
	Silt and Clay	A-6	A-6a	75 Min.		36 Min.	40 Max.	11 - 15	10	
	Silty Clay	A-6	A-6b	75 Min.		36 Min.	40 Max.	16 Min.	16	
	Elastic Clay	A-7-5		75 Min.		36 Min.	41 Min.	≤LL-30	20	
	Clay	A-7-6		75 Min.		36 Min.	41 Min.	>LL-30	20	
	Organic Silt	A-8	A-8a	74 Max.		36 Min.				W/o organics would classify as A-4a or A-4b
	Organic Clay	A-8	A-8b	74 Max.		36 Min.				W/o organics would classify as A-5, A-6a, A-6b, A-7-5 or A-7-6

MATERIAL CLASSIFIED BY VISUAL INSPECTION

Sod and Topsoil

Pavement or Base

Uncontrolled Fill (Describe)

Bouldery Zone

P Peat

* Only perform the oven-dried liquid limit test and this calculation if organic material is present in the sample.

Figure 600-1. ODOT Soil Classification Chart

APPENDIX A.1 - ODOT Quick Reference for Visual Description of Soils

1) STRENGTH OF SOIL:

Non-Cohesive (granular) Soils - Compactness	
Description	**Blows Per Ft.**
Very Loose	≤ 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

2) COLOR :

If a color is a uniform color throughout, the term is single, modified by an adjective such as light or dark. If the predominate color is shaded by a secondary color, the secondary color procedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled"

3) PRIMARY COMPONENT

Use **DESCRIPTION** from ODOT Soil Classification Chart on Back

Cohesive (fine grained) Soils - Consistency

Description	Qu (TSF)	Blows Per Ft.	Hand Manipulation
Very Soft	<0.25	<2	Easily penetrates 2" by fist
Soft	0.25-0.5	2 - 4	Easily penetrates 2" by thumb
Medium Stiff	0.5-1.0	5 - 8	Penetrates by thumb with moderate effort
Stiff	1.0-2.0	9 - 15	Readily indents by thumb, but not penetrate
Very Stiff	2.0-4.0	16 - 30	Readily indents by thumbnail
Hard	>4.0	>30	Indent with difficulty by thumbnail

4) COMPONENT MODIFIERS:

Description	Percentage By Weight
Trace	0% - 10%
Little	10% - 20%
Some	20% - 35%
"And"	35% -50%

5) Soil Organic Content

Description	% by Weight
Slightly Organic	2% - 4%
Moderately Organic	4% - 10%
Highly Organic	> 10%

6) Relative Visual Moisture

Description	Criteria	
	Cohesive Soil	**Non-cohesive Soils**
Dry	Powdery; Cannot be rolled; Water content well below the plastic limit	No moisture present
Damp	Leaves very little moisture when pressed between fingers; Crumbles at or before rolled to $^1/_8$"; Water content below plastic limit	Internal moisture, but no to little surface moisture
Moist	Leaves small amounts of moisture when pressed between fingers; Rolled to $^1/_8$" or smaller before crumbling; Water content above plastic limit to -3% of the liquid limit	Free water on surface, moist (shiny) appearance
Wet	Very mushy; Rolled multiple times to $^1/_8$" or smaller before crumbles; Near or above the liquid limit	Voids filled with free water, can be poured from split spoon.

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/17/25 15:26 - O:\PROJECT\2025\CLE-05\250500019CLE_ENVIRONMENTAL DESIGN GROUP_COL- EL RIVERFRONT TRAIL - RET.

PROJECT: RIVERFRONT, RET. WALL PH 1.1	DRILLING FIRM / OPERATOR: CTL / JAMES	DRILL RIG: CTL D-70	STATION / OFFSET: 5+50, 100.0 RT	EXPLORATION ID B-001-00-25
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: CTL / JAMES	HAMMER: CME AUTOMATIC	ALIGNMENT: BROADWAY ST.	
PID: 117785 BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/8/24	ELEVATION: 734.0 (MSL) EOB: 60.0 ft.	PAGE 1 OF 2
START: 6/9/25 END: 6/9/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.7	COORD: 40.615953000, -80.576039000	

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)	ABAN-DONED
ASPHALT (6")	734.0																	
GRAVEL BASE (7")	733.5																	
DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, FILL, DAMP	732.9	1	7 12 14	35	72	SS-1	-	-	-	-	-	-	-	-	-	23	A-1-b (V)	
		2																
		3																
		4	12 16 17	44	83	SS-2	-	59	17	7	14	3	NP	NP	NP	8	A-1-b (0)	
	729.0	5																
DENSE, BROWN, **SANDY SILT**, SOME GRAVEL, TRACE CLAY, FILL, DAMP		6																
		7	9 12 14	35	89	SS-3	-	-	-	-	-	-	-	-	-	10	A-4a (V)	
		8																
		9	8 13 19	43	100	SS-4	-	28	9	24	34	5	NP	NP	NP	10	A-4a (1)	
	723.5	10																
MEDIUM DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, SOME SILT, FILL, MOIST		11																
	721.5	12	14 8 9	23	67	SS-5	-	-	-	-	-	-	-	-	-	3	A-1-b (V)	
DENSE, BROWN, **SANDY SILT**, LITTLE GRAVEL, FILL, MOIST		13																
		14	12 11 12	31	83	SS-6	-	-	-	-	-	-	-	-	-	11	A-4a (V)	
	718.5	15																
MEDIUM DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, SOME SILT, TRACE CLAY, FILL, MOIST		16																
	716.0	17	9 12 7	26	83	SS-7	-	58	14	5	21	2	NP	NP	NP	11	A-1-b (0)	
DENSE, GREY, **GRAVEL AND STONE FRAGMENTS**, LITTLE SAND, SILT, TRACE CLAY, FILL, DAMP		18																
		19	8 12 12	32	89	SS-8	-	-	-	-	-	-	-	-	-	12	A-1-a (V)	
		20																
		21																
		22																
		23																
		24	12 15 17	43	78	SS-9	-	78	6	3	12	1	NP	NP	NP	11	A-1-a (0)	
	709.0	25																
DENSE, GREY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, SOME WOOD, TRACE CLAY, FILL, DAMP		26																
		27																
		28																
		29	9 11 16	36	78	SS-10	-	-	-	-	-	-	-	-	-	11	A-2-4 (V)	

PID: 117785	BR ID:	PROJECT: RIVERFRONT, RET. WALL PH 1.1	STATION / OFFSET: 5+50, 100.0 RT	START: 6/9/25	END: 6/9/25	PG 2 OF 2	B-001-00-25

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)	ABAN-DONED
DENSE, GREY, **GRAVEL AND STONE FRAGMENTS WITH SAND AND SILT**, SOME WOOD, TRACE CLAY, FILL, DAMP *(continued)*	704.0	31 32 33 34 35 36 37 38	10 10 15	34	89	SS-11	-	55	10	8	23	4	NP	NP	NP	14	A-2-4 (0)	
MEDIUM DENSE, BROWN, **SANDY SILT**, TRACE CLAY, DAMP	696.0	39 40 41 42 43	6 5 7	16	72	SS-12	-	-	-	-	-	-	-	-	-	12	A-4a (V)	
MEDIUM DENSE, BROWN, **FINE SAND**, LITTLE GRAVEL, TRACE SILT, CLAY, WET	688.0	44 45 46 47 48 49 50 51 52 53 54 55	6 8 8	22	83	SS-13	-	0	2	58	38	2	NP	NP	NP	14	A-4a (1)	
			5 6 10	22	78	SS-14	-	-	-	-	-	-	-	-	-	12	A-3 (V)	
			6 7 12	26	72	SS-15	-	16	10	69	- 5 -		NP	NP	NP	20	A-3 (0)	
DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS**, AND SAND, TRACE CLAY, SILT, DAMP	678.0	56 57 58 59 60	7 12 14	35	78	SS-16	-	57	19	22	- 2 -		NP	NP	NP	9	A-1-a (0)	
	674.0	EOB																

NOTES: CAVED @42.4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/17/25 15:26 - O:\PROJECT\2025\CLE-05\250500019CLE_ENVIRONMENTAL DESIGN GROUP_COL- EL RIVERFRONT TRAIL - RET.

PROJECT: RIVERFRONT, RET. WALL PH 1.1	DRILLING FIRM / OPERATOR: CTL / JAMES	DRILL RIG: CTL D-70	STATION / OFFSET: 5+60, 15.0 LT	EXPLORATION ID B-002-00-25
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: CTL / JAMES	HAMMER: CME AUTOMATIC	ALIGNMENT: BROADWAY ST.	
PID: 117785 BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/8/24	ELEVATION: 696.0 (MSL) EOB: 27.0 ft.	PAGE 1 OF 1
START: 6/5/25 END: 6/5/25	SAMPLING METHOD: SPT	ENERGY RATIO (%): 80.7	COORD: 40.615631000, -80.576119000	

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)	ABAN-DONED
ASPHALT (5")	696.0																	
	695.6																	
GRAVEL BASE (6")	695.1																	
MEDIUM DENSE, BROWN, **COARSE AND FINE SAND**, SOME GRAVEL, FILL, MOIST	694.0	1	9 5 6	15	78	SS-1	-	-	-	-	-	-	-	-	-	8	A-3a (V)	
LOOSE TO MEDIUM DENSE, BROWN, **FINE SAND**, TRACE GRAVEL, SILT, CLAY, DAMP		2																
		3																
		4	3 3 4	9	72	SS-2	-	4	10	84	- 2 -		NP	NP	NP	8	A-3 (0)	
		5																
F. S.		6																
		7	3 3 3	8	78	SS-3	-	-	-	-	-	-	-	-	-	11	A-3 (V)	
		8																
@8.5' some gravel		9	4 7 10	23	83	SS-4	-	29	10	61	- 0 -		NP	NP	NP	19	A-3 (0)	
	686.0	10																
MEDIUM DENSE TO DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS**, SOME SAND, DAMP		11																
		12	9 12 17	39	72	SS-5	-	-	-	-	-	-	-	-	-	8	A-1-a (V)	
		13																
		14	12 6 8	19	61	SS-6	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
		15																
		16																
		17	9 12 13	34	72	SS-7	-	-	-	-	-	-	-	-	-	4	A-1-a (V)	
		18																
		19	12 12 9	28	56	SS-8	-	65	17	17	- 1 -		NP	NP	NP	7	A-1-a (0)	
		20																
		21																
		22																
	672.5	23																
VERY DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS**, SOME LIMESTONE, MOIST		24	50/2"	-	100	SS-9	-	-	-	-	-	-	-	-	-	1	A-1-a (V)	
		25																
		26	50/2"	-	100	SS-10	-	-	-	-	-	-	-	-	-	6	A-1-a (V)	
	669.0	EOB 27																

Auger Refusal @26.0'

NOTES: CAVED @13.7', AUGER REFUSAL @26.0'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

STANDARD ODOT SOIL BORING LOG (8.5 X 11) - OH DOT.GDT - 7/17/25 15:26 - O:\PROJECT\2025\CLE-05\250500019CLE_ENVIRONMENTAL DESIGN GROUP_COL- EL RIVERFRONT TRAIL - RET.

PROJECT: RIVERFRONT, RET. WALL PH 1.1	DRILLING FIRM / OPERATOR: CTL / JAMES	DRILL RIG: CTL D-70	STATION / OFFSET: 4+70, 15.0 LT	EXPLORATION ID B-003-00-25
TYPE: STRUCTURE FOUNDATION	SAMPLING FIRM / LOGGER: CTL / JAMES	HAMMER: CME AUTOMATIC	ALIGNMENT: BROADWAY ST.	
PID: 117785 BR ID:	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/8/24	ELEVATION: 692.0 (MSL) EOB: 30.0 ft.	PAGE 1 OF 1
START: 6/6/25 END: 6/6/25	SAMPLING METHOD: SPT / ST	ENERGY RATIO (%): 80.7	COORD: 40.615678000, -80.575719000	

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)	ABAN-DONED
ASPHALT (5")	692.0																	
GRAVEL BASE (6")	691.6																	
MEDIUM DENSE, BROWN, **SILT**, AND SAND, TRACE CLAY, WET	691.1		5 5 4	12	89	SS-1	-	0	2	43	52	3	NP	NP	NP	19	A-4b (4)	
MEDIUM DENSE, BROWN, **SANDY SILT**, LITTLE GRAVEL, TRACE CLAY, DAMP	689.0				100	ST-2	-	-	-	-	-	-	-	-	-	17	A-4a (V)	
	684.0		4 3 6	12	100	SS-3	-	16	10	28	43	3	NP	NP	NP	13	A-4a (2)	
MEDIUM DENSE TO DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS**, AND SAND, DAMP			4 6 11	23	72	SS-4	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
			9 11 18	39	78	SS-5	-	64	18	18	-	0 -	NP	NP	NP	6	A-1-a (0)	
	676.5		6 9 13	30	72	SS-6	-	-	-	-	-	-	-	-	-	7	A-1-a (V)	
MEDIUM DENSE, BROWN, **SANDY SILT**, LITTLE GRAVEL, TRACE CLAY, MOIST	674.0		6 9 10	26	17	SS-7	-	11	8	31	43	7	NP	NP	NP	17	A-4a (3)	
MEDIUM DENSE TO DENSE, BROWN, **GRAVEL AND STONE FRAGMENTS WITH SAND**, WET			7 10 12	30	78	SS-8	-	-	-	-	-	-	-	-	-	6	A-1-b (V)	
		W	7 12 18	40	67	SS-9	-	-	-	-	-	-	-	-	-	12	A-1-b (V)	
	662.0	EOB	8 8 12	27	83	SS-10	-	48	41	10	-	1 -	NP	NP	NP	17	A-1-b (0)	

NOTES: CAVED @16.3'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: NOT RECORDED

C-001-00-72

Date Started 7-20-72 Sampler Type SS Dia 1 3/8"
Date Completed 7-20-72 Casing Length 39.5' Dia 3 1/2"
Boring No C-1 Station & Offset 999+73, 42' RT. (RET. WALL) Surface Elev 707.0'

Elev	Depth	Std. Pen (N)	Rec ft.	Loss ft.	Description	Sample No	Physical Characteristics: % Agg	% CS	% FS	% Silt	% Clay	LL	PI	WC	SHTL Class.
707.0	0				BRICKS										
	2														
704.5	4	7/5			BROWN SANDY SILT	1	-	-	-	-	-	-	-	14	VISUAL
702.0	6	2/2			BROWN SANDY SILT	2	8	5	42	33	12	NP	NP	24	A-4a
	8														
697.0	10	3/4			BROWN SANDY SILT	3	0	1	50	38	11	NP	NP	20	A-4a
	12														
	14														
692.0	16	10/19			BROWN GRAVELLY SANDY SILT	4	21	6	33	31	9	NP	NP	16	A-4a
	18														
687.0	20	20/23			BROWN SILTY GRAVELLY SAND	5	24	24	21	22	9	NP	NP	10	A-2-4
	22														
	24														
682.0	26	15/16			BROWN SILTY GRAVELLY SAND	6	24	30	22	17	7	NP	NP	15	A-1-b
	28														
677.0	30	50 (0.4')			BROWN SILTY SANDY GRAVEL WITH COBBLES	7	43	12	20	19	6	NP	NP	9	A-1-b
	32														
	34														
672.0	36	50/			BROWN SILTY SANDY GRAVEL	8	34	7	20	30	9	20	4	13	A-4a
	38														
667.5					TOP OF ROCK										
667.0	40				SANDSTONE										
665.0	42		1.2	0.8	SANDSTONE, GRAY, FIRM, FINE-GRAINED, CROSS-BEDDED, MICACEOUS-IN-PART, BROKEN AND JOINTED. CORE LOSS 40%.										

BOTTOM OF BORING

C-002-00-72

Date Started 7-19-72 | Sampler Type SS | Dia 1 3/8" | Water Elev
Date Completed 7-19-72 | Casing Length 30' | Dia 3 1/2"
Boring No C-2 | Station & Offset 1001+05, 45' RT. (RET. WALL) | Surface Elev 707.0'

Elev	Depth	Std. Pen. (N)	Rec ft.	Loss ft.	Description	Sample No	Physical Characteristics: % Agg	% C S	% F S	% Silt	% Clay	L L	P I	W C	SHTL Class.
707.0	0				BRICKS										
	2														
704.5	4	4/6			BROWN SANDY SILT	1	7	2	35	39	17	NP	NP	18	A-4a
702.0	6	7/7			BROWN SANDY SILT	2	0	0	44	39	17	NP	NP	17	A-4a
	8														
697.0	10	3/2			BROWN SILTY SAND	3	0	1	66	23	10	NP	NP	23	A-2-4
	12														
692.0	14														
	16	6/9			BROWN SANDY SILT	4	0	1	57	32	10	NP	NP	22	A-4a
	18														
687.0	20														
	22	20/20			BROWN SILTY SANDY GRAVEL	5	43	6	29	16	6	NP	NP	13	A-2-4
	24														
682.0	26	10/13			BROWN SANDY SILT	6	14	8	13	45	20	26	8	13	A-4a
	28														
677.0	30														
675.0	32	19/37			BROWN SANDY SILT TOP OF ROCK	7	13	6	28	34	19	26	9	18	A-4a
	34		1.7	1.3											
	36				SANDSTONE, GRAY, FIRM, FINE-GRAINED, CROSS-BEDDED, MICACEOUS-IN-PART, BROKEN AND JOINTED. CORE LOSS 34%.											
	38		3.6	1.4											
667.0	40				BOTTOM OF BORING										

APPENDIX C

- **LABORATORY TEST RESULTS**

CONSOLIDATED UNDRAINED TRIAXIAL TEST ON COHESIVE SOILS
AASHTO T 297 & ASTM D4767

CTL ENGINEERING, INC.
2860 Fisher Road Columbus, Ohio 43204

Client: Environmental Design Group

Project: COL- EL Riverfront Trail-
Retaining Wall Phase 1.1

Project No. 25050019CLE

Sample ID: B-03, ST-1, 3.0'-5.0'

Lab Code No. 25050752COL
Reviewed by: SM

Sample Type	Undisturbed		
Date Set-up:	6/18/2025	6/18/2025	6/18/2025
Date Sheared:	6/26/2025	6/26/2025	6/26/2025
Avg. Sample Height (in.):	5.6660	5.6953	5.7290
Avg. Sample Diameter (in.):	2.8500	2.8500	2.8500
Height-to-diameter ratio:	1.99	2.00	2.01
Wet Density (pcf):	127.2	128.7	139.6
Dry Density (pcf):	106.9	110.6	121.3
Void Ratio:	0.576	0.523	0.389
Specific Gravity (assumed):	2.7	2.7	2.7
Moisture Content (%):	19.0	16.3	15.1
Cross Sectional Area (ft^2):	0.044	0.044	0.044
Volume (ft^3):	0.02	0.02	0.02
Confining Pressure (psf):	576	1152	1728
Rate of Axial Strain (%/min):	0.2118	0.2107	0.2095
Compressive Strength (psf):	1806	2602	6608
Minor Principal Stress at Failure (psf):	576	1152	1728
Major Principal Stress at Failure (psf):	2382	3754	8336
Failure Criterian (%):	Point of Obliquity		
β:	0.95	0.95	0.95
Specimen Saturation:	Wet Method		

POST SHEAR
576 psf

POST SHEAR
1152 psf

POST SHEAR
1728 psf

Grading (ASTM D422)

% Agg:	NA
% Sand.:	NA
% Silt:	NA
% Clay:	NA

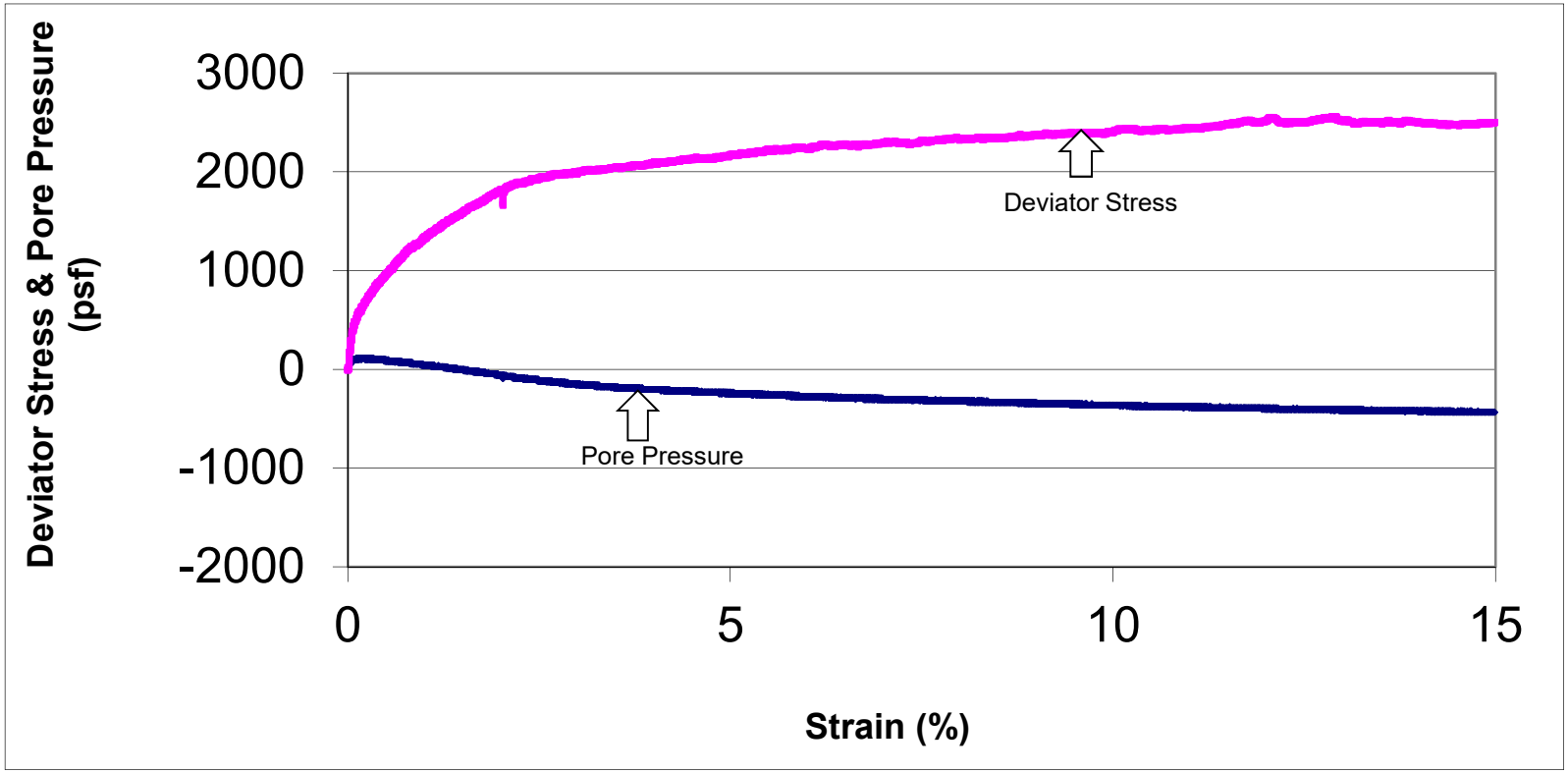
Atterberg Limits (ASTM D 4318)

L.L.:	NA
P.L.:	NA
P.I.:	NA

Visual Classification: Brown, Sandy Silt (A-4a)

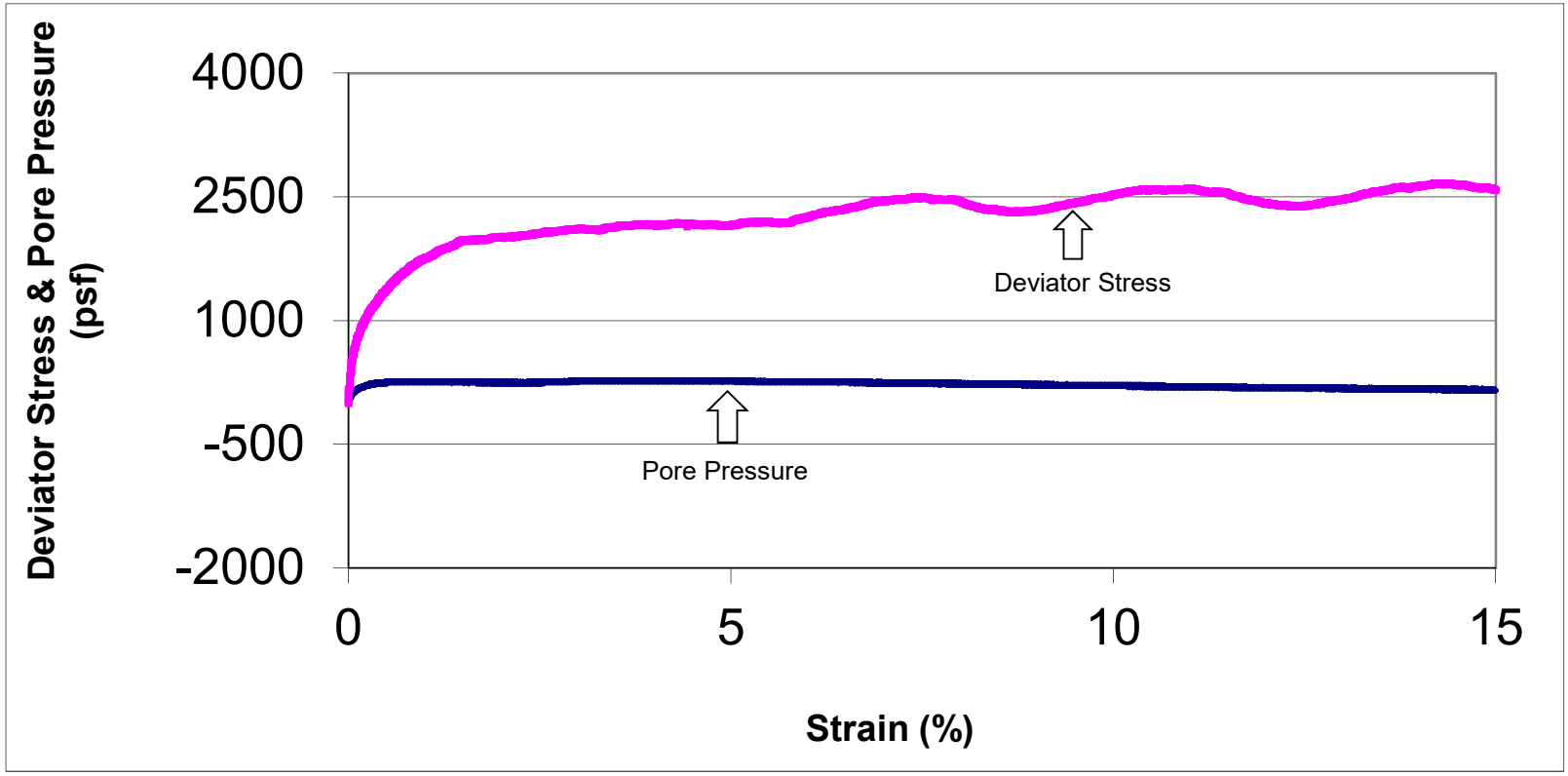
Deviator Stress & Pore Pressure vs. Strain

CLIENT:	Environmental Design Group	Sample ID:	B-03, ST-1, 3.0'-5.0'
PROJECT:	COL- EL Riverfront Trail-	Confining Pressure (psf):	576
LOCATION:	0		
PROJECT #:	25050019CLE		



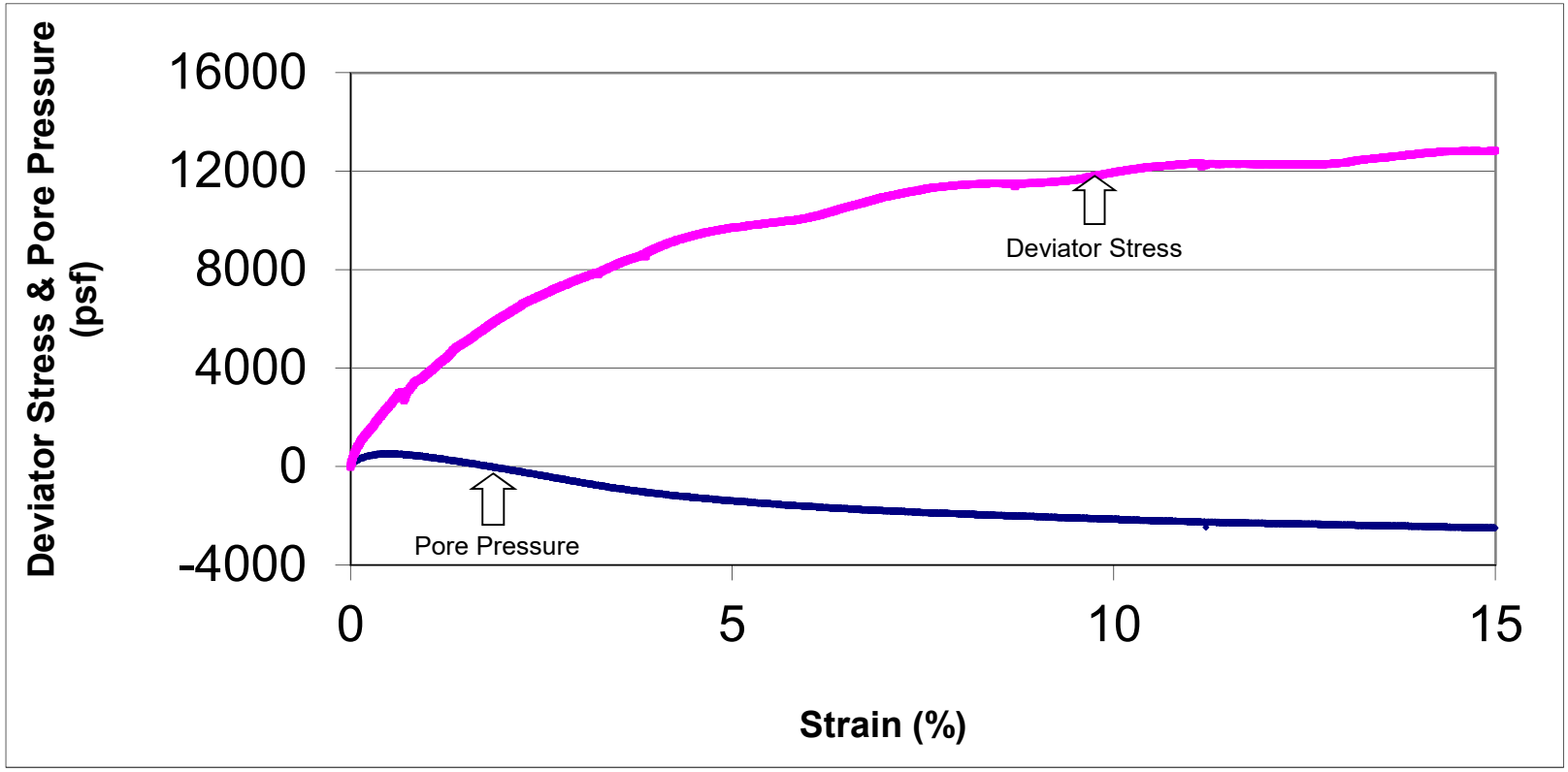
Deviator Stress & Pore Pressure vs. Strain

CLIENT:	Environmental Design Group	Sample ID:	B-03, ST-1, 3.0'-5.0'
PROJECT:	COL- EL Riverfront Trail-	Confining Pressure (psf):	1152
LOCATION:	0.00		
PROJECT #:	25050019CLE		



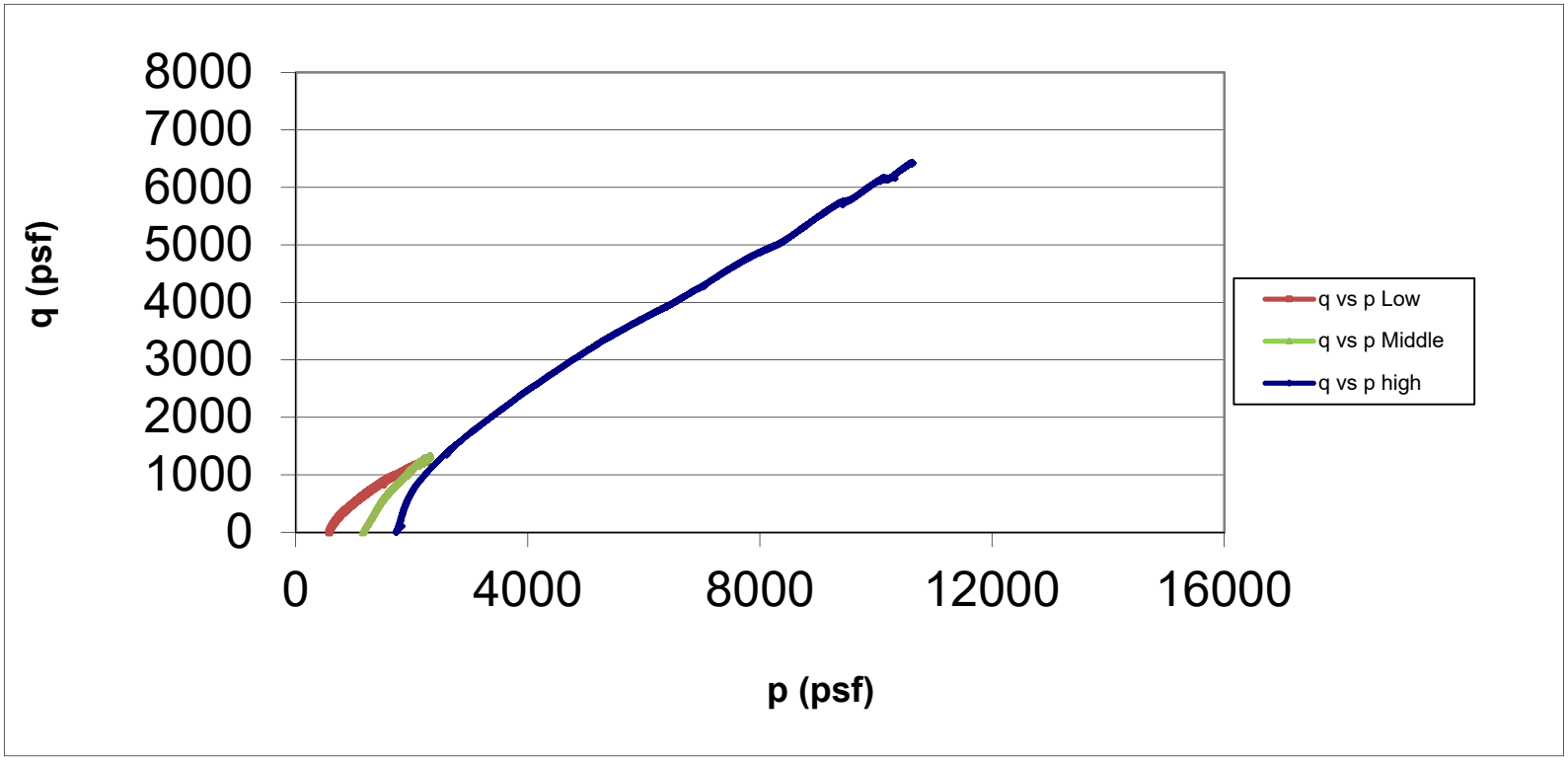
Deviator Stress & Pore Pressure vs. Strain

CLIENT:	Environmental Design Group	Sample ID:	B-03, ST-1, 3.0'-5.0'
PROJECT:	COL- EL Riverfront Trail-	Confining Pressure (psf):	1728
LOCATION:	0		
PROJECT #:	25050019CLE		



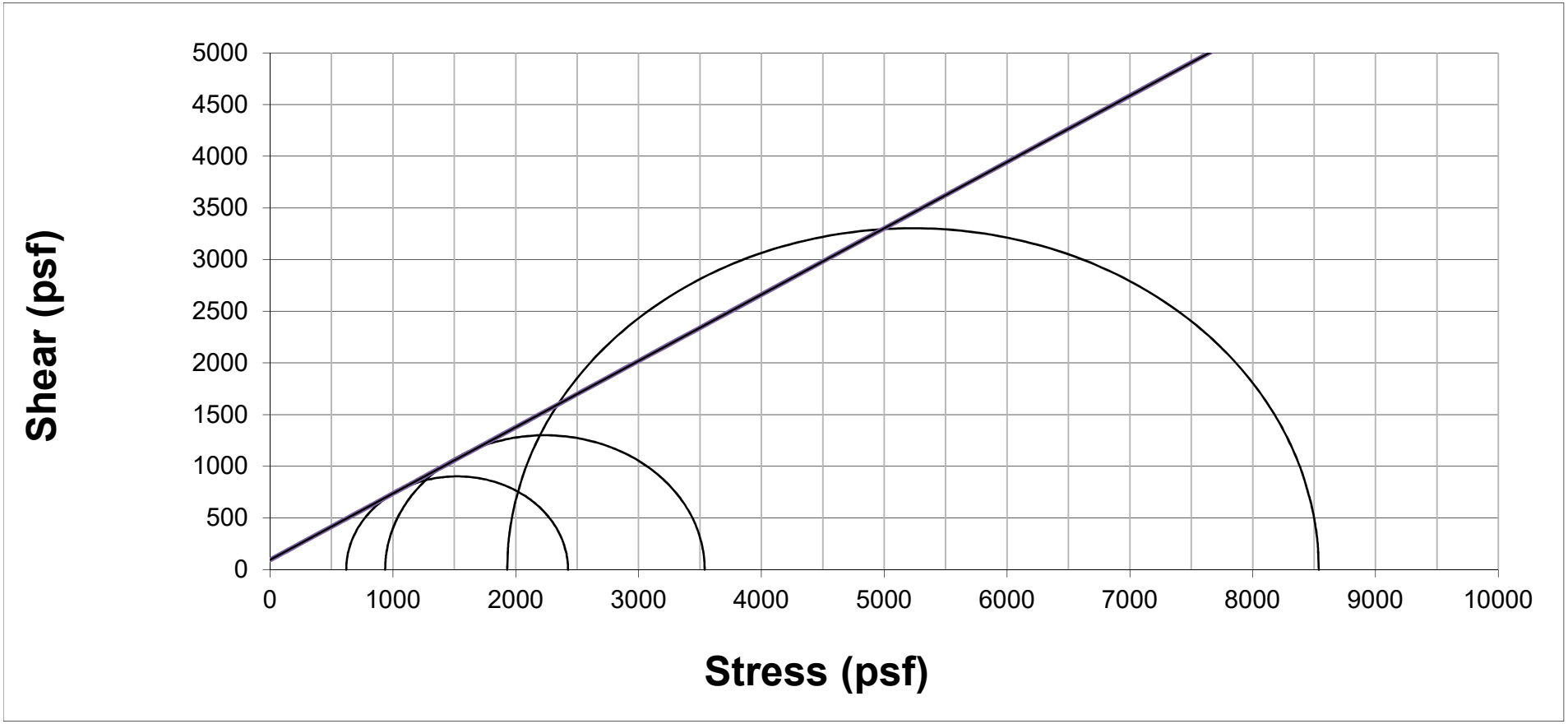
q vs. p

CLIENT:	Environmental Design Group	Sample ID:	B-03, ST-1, 3.0'-5.0'		
PROJECT:	COL- EL Riverfront Trail-				
LOCATION:	0	Confining Pressure (psf):	Low	Middle	High
PROJECT #:	25050019CLE		576	1152	1728



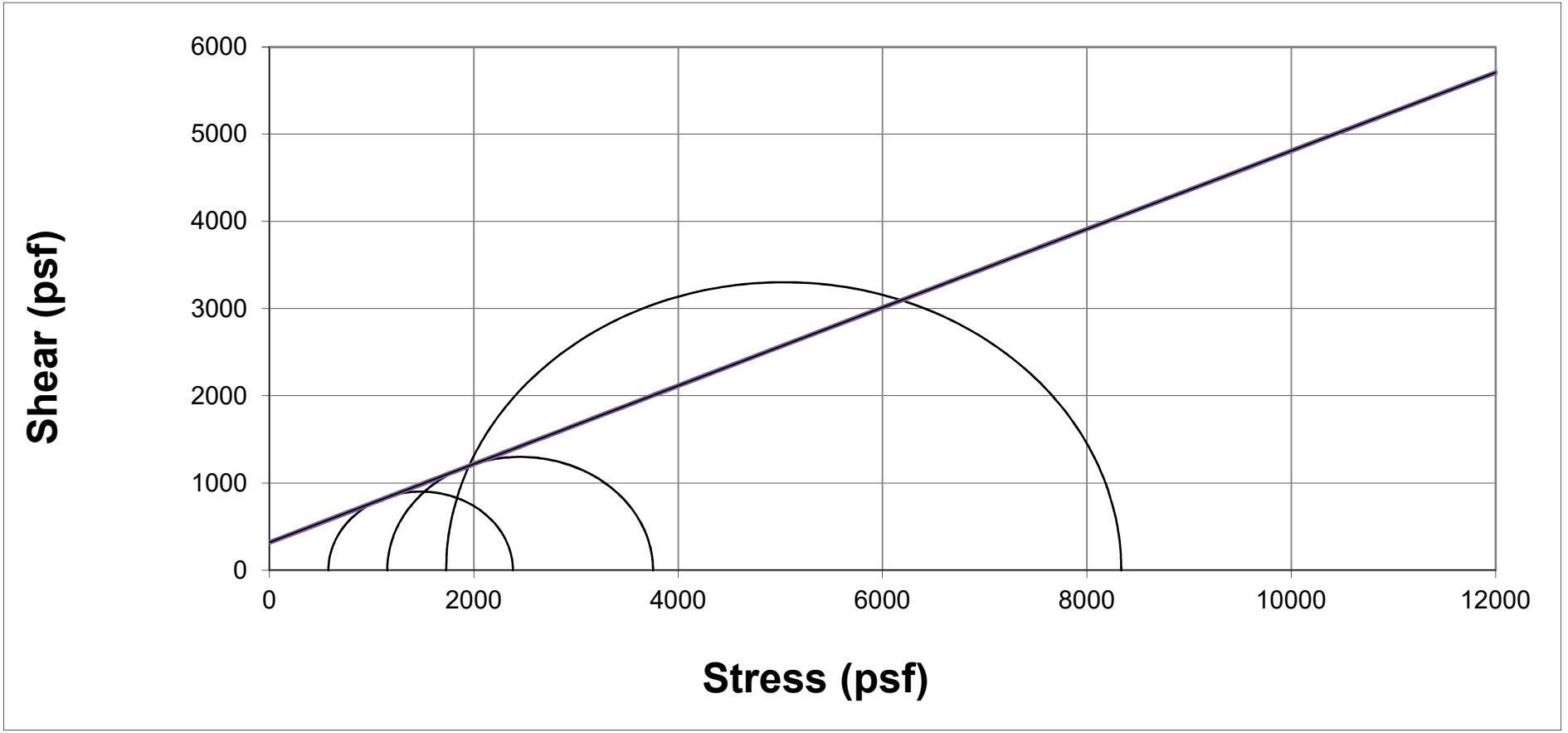
Mohr Circle Effective Stress

CLIENT:	Environmental Design Group	Sample ID: B-03, ST-1, 3.0'-5.0'			
PROJECT:	COL- EL Riverfront Trail-				
LOCATION:	0.00	Confining Pressure (psf):	576	1152	1728
PROJECT #:	25050019CLE	Cohesion(psf):	95		
		Angle of Friction(°):	32		



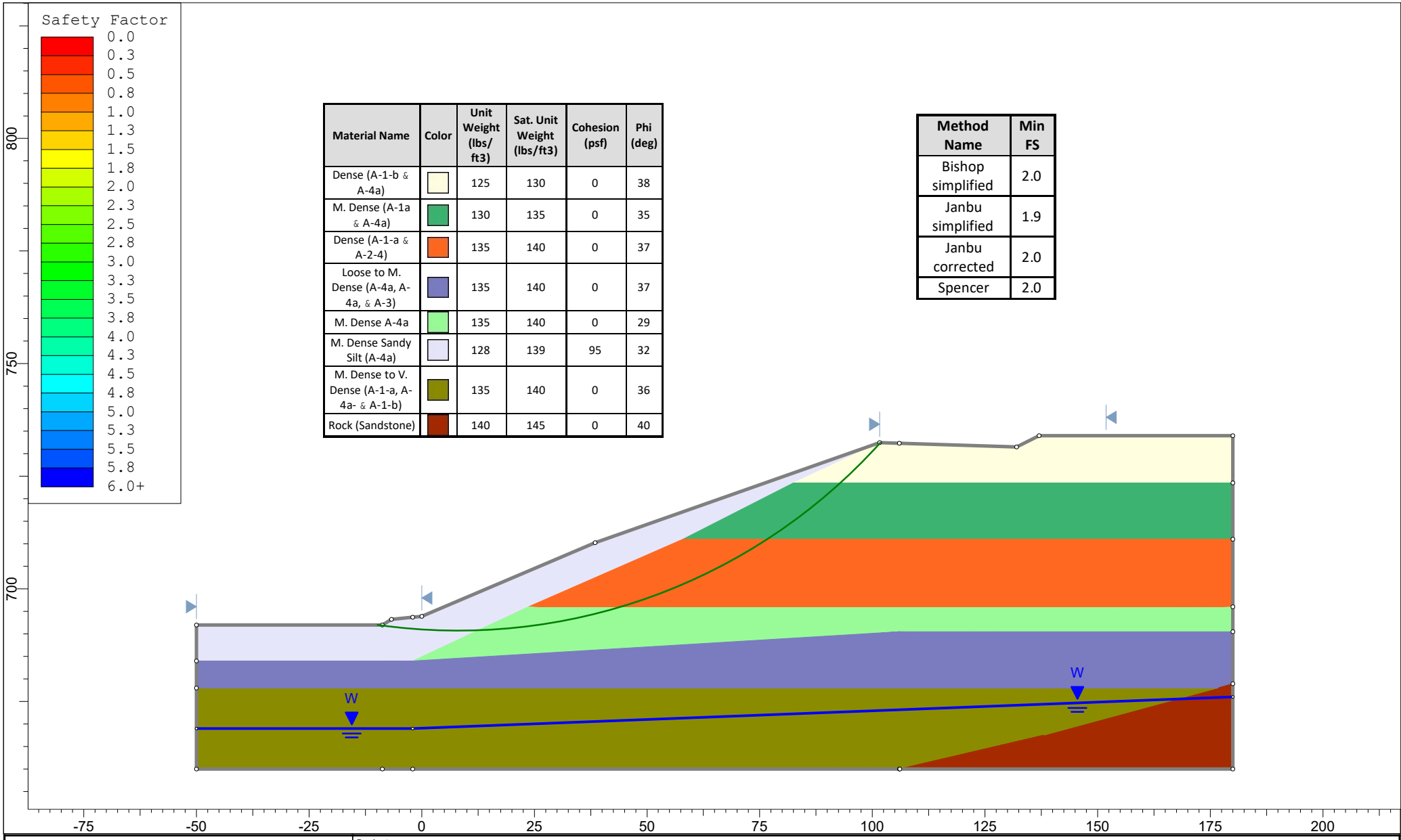
Mohr Circle Total Stress

CLIENT:	Environmental Design Group	Sample ID:	B-03, ST-1, 3.0'-5.0'		
PROJECT:	COL- EL Riverfront Trail-				
LOCATION:	0.00	Confining Pressure (psf):	576	1152	1728
PROJECT #:	25050019CLE	Cohesion(psf):	320		
		Angle of Friction(°):	24		



APPENDIX D

- **SLPOE STABILITY PRINTOUTS**



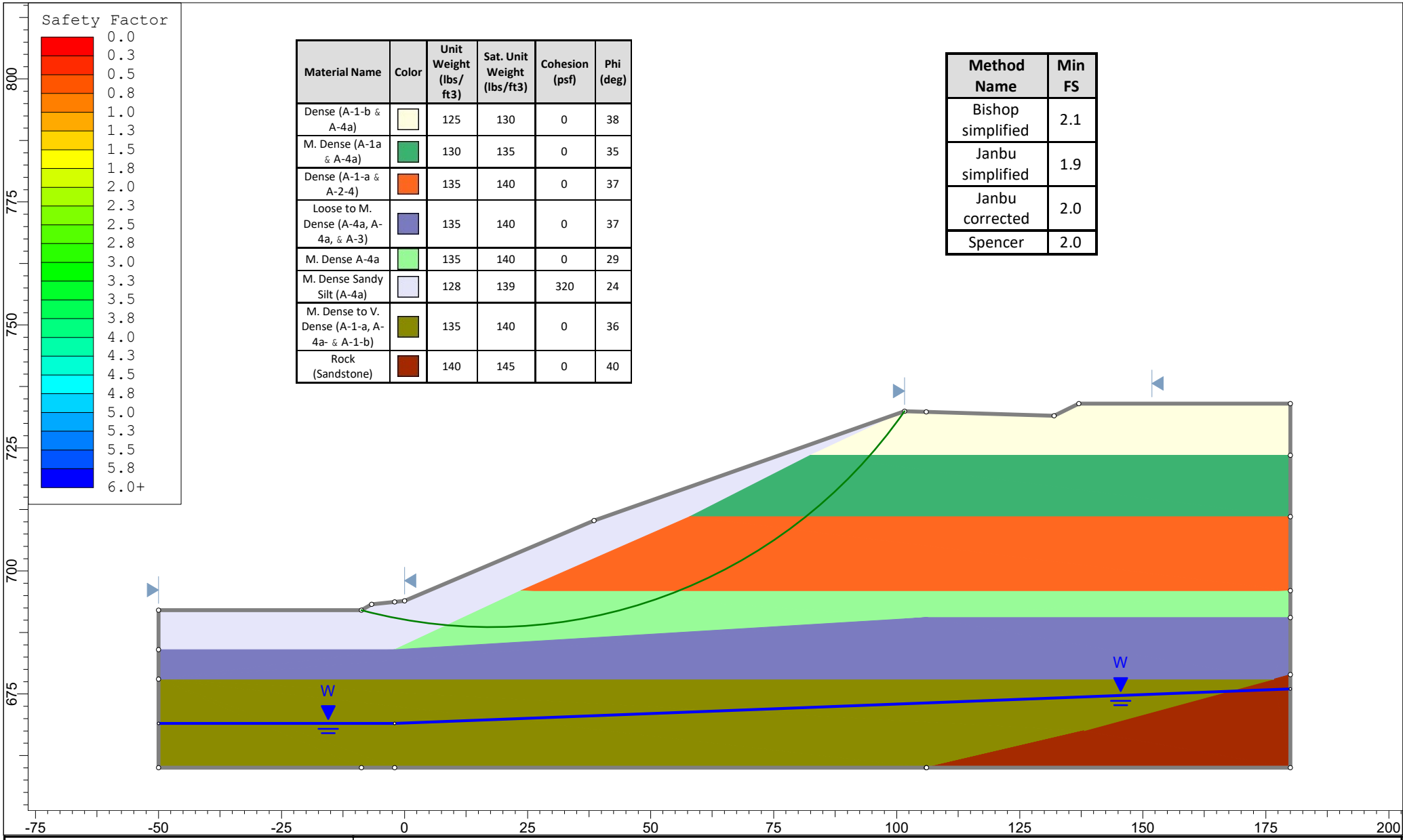
Material Name	Color	Unit Weight (lbs/ ft3)	Sat. Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Dense (A-1-b & A-4a)		125	130	0	38
M. Dense (A-1a & A-4a)		130	135	0	35
Dense (A-1-a & A-2-4)		135	140	0	37
Loose to M. Dense (A-4a, A-4a, & A-3)		135	140	0	37
M. Dense A-4a		135	140	0	29
M. Dense Sandy Silt (A-4a)		128	139	95	32
M. Dense to V. Dense (A-1-a, A-4a- & A-1-b)		135	140	0	36
Rock (Sandstone)		140	145	0	40

Method Name	Min FS
Bishop simplified	2.0
Janbu simplified	1.9
Janbu corrected	2.0
Spencer	2.0

rocscience

SLIDEINTERPRET 9.025

Project	COL-EL Riverfront Trail – Retaining Wall Phase 1.1		
Group	Section for Wall (STA 5+50)	*Scenario*	Existing Condition (Effective Stress)
Drawn By	LI	*Company*	CTL Engineering
Date	7/3/2025	*File Name*	STA 5+50.slmd



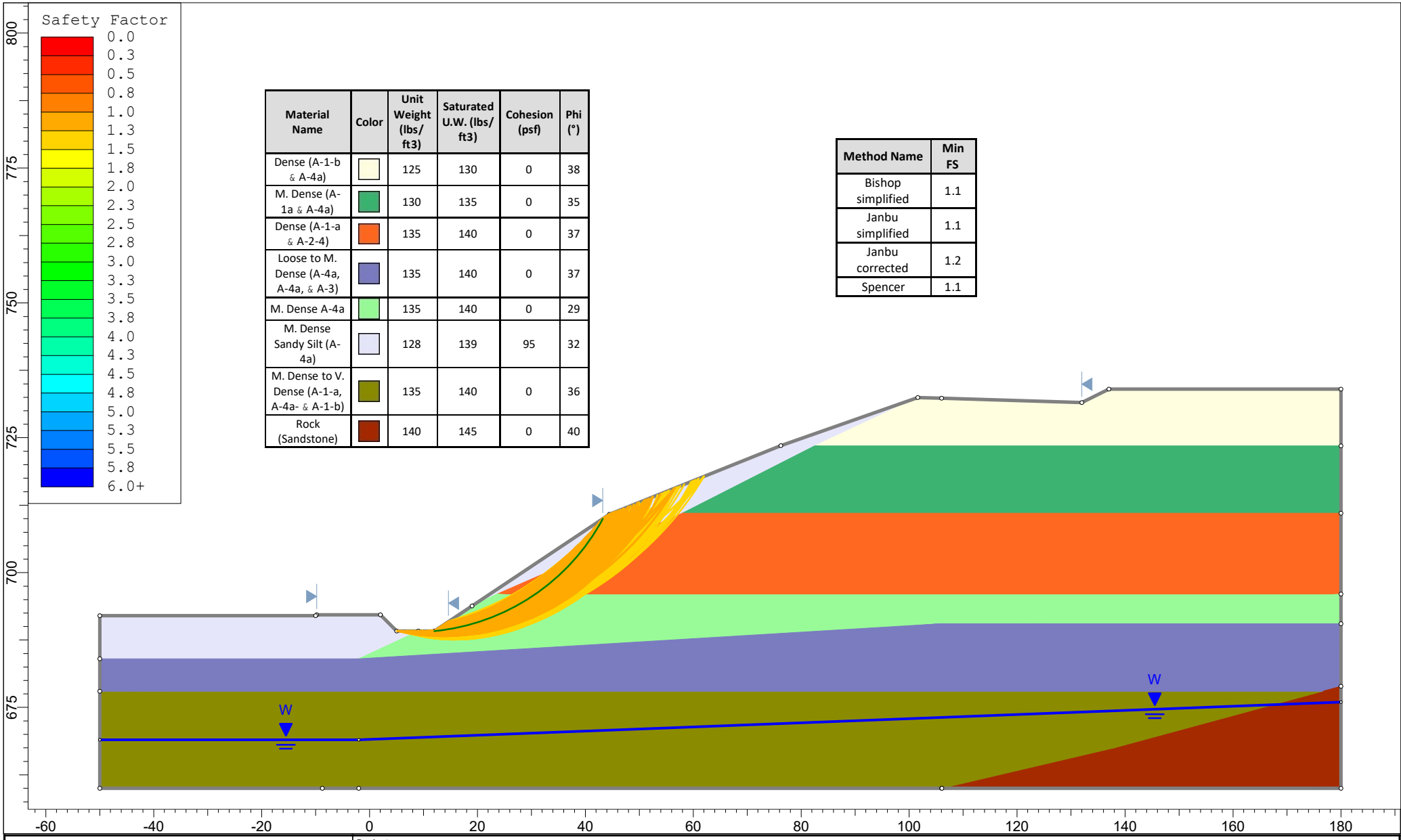
Material Name	Color	Unit Weight (lbs/ ft3)	Sat. Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Dense (A-1-b & A-4a)		125	130	0	38
M. Dense (A-1a & A-4a)		130	135	0	35
Dense (A-1-a & A-2-4)		135	140	0	37
Loose to M. Dense (A-4a, A-4a, & A-3)		135	140	0	37
M. Dense A-4a		135	140	0	29
M. Dense Sandy Silt (A-4a)		128	139	320	24
M. Dense to V. Dense (A-1-a, A-4a- & A-1-b)		135	140	0	36
Rock (Sandstone)		140	145	0	40

Method Name	Min FS
Bishop simplified	2.1
Janbu simplified	1.9
Janbu corrected	2.0
Spencer	2.0

rocscience

SLIDEINTERPRET 9.025

Project	COL-EL Riverfront Trail – Retaining Wall Phase 1.1		
Group	Section for Wall (STA 5+50)	*Scenario*	Existing Condition (Total Stress)
Drawn By	LI	*Company*	CTL Engineering
Date	7/3/2025	*File Name*	STA 5+50.slmd



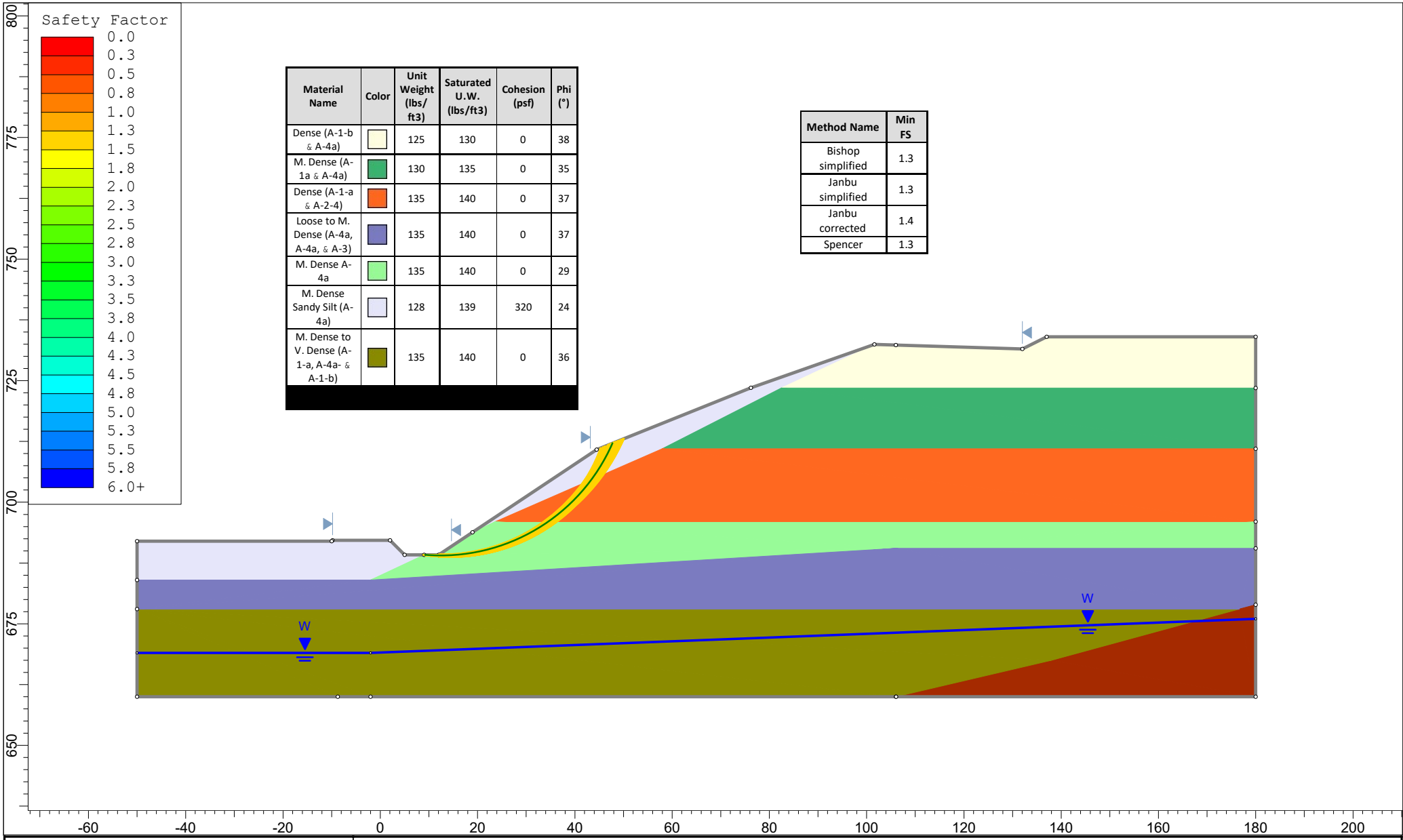
Material Name	Color	Unit Weight (lbs/ ft3)	Saturated U.W. (lbs/ ft3)	Cohesion (psf)	Phi (°)
Dense (A-1-b & A-4a)		125	130	0	38
M. Dense (A-1a & A-4a)		130	135	0	35
Dense (A-1-a & A-2-4)		135	140	0	37
Loose to M. Dense (A-4a, A-4a, & A-3)		135	140	0	37
M. Dense A-4a		135	140	0	29
M. Dense Sandy Silt (A-4a)		128	139	95	32
M. Dense to V. Dense (A-1-a, A-4a- & A-1-b)		135	140	0	36
Rock (Sandstone)		140	145	0	40

Method Name	Min FS
Bishop simplified	1.1
Janbu simplified	1.1
Janbu corrected	1.2
Spencer	1.1

rocscience

SLIDEINTERPRET 9.039

Project	COL-EL Riverfront Trail – Retaining Wall Phase 1.1		
Group	Section for Wall (STA 5+50)	*Scenario*	Excavation Stage (Effective Stress)
Drawn By	LI	*Company*	CTL Engineering
Date	10/16/2025	*File Name*	STA 5+50 - Excavation Stage.slmd



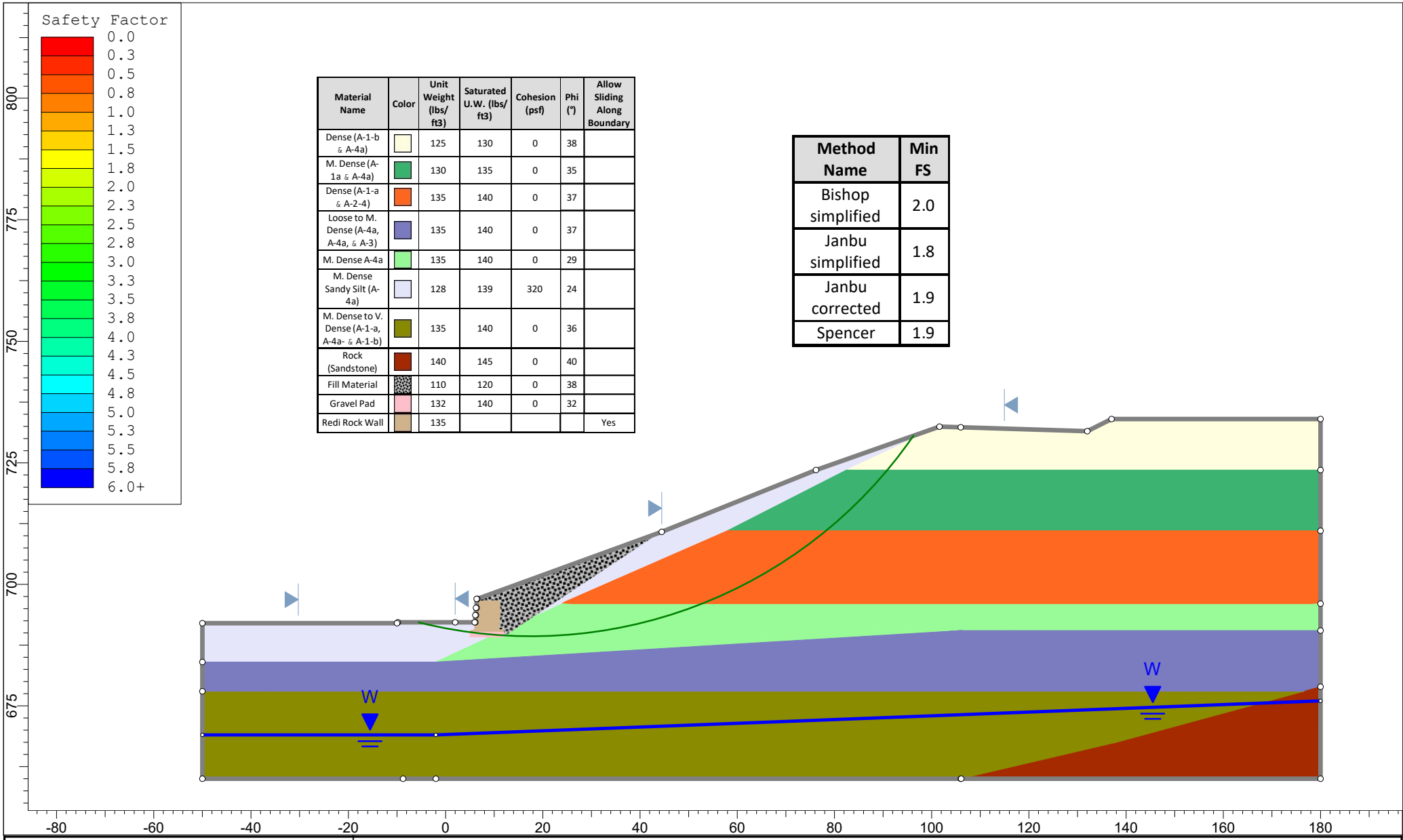
Material Name	Color	Unit Weight (lbs/ ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)
Dense (A-1-b & A-4a)		125	130	0	38
M. Dense (A-1a & A-4a)		130	135	0	35
Dense (A-1-a & A-2-4)		135	140	0	37
Loose to M. Dense (A-4a, A-4a, & A-3)		135	140	0	37
M. Dense A-4a		135	140	0	29
M. Dense Sandy Silt (A-4a)		128	139	320	24
M. Dense to V. Dense (A-1-a, A-4a- & A-1-b)		135	140	0	36

Method Name	Min FS
Bishop simplified	1.3
Janbu simplified	1.3
Janbu corrected	1.4
Spencer	1.3

rocscience

SLIDEINTERPRET 9.039

Project	COL-EL Riverfront Trail – Retaining Wall Phase 1.1		
Group	Section for Wall (STA 5+50)	*Scenario*	Excavation Stage (Total Stress)
Drawn By	LI	*Company*	CTL Engineering
Date	10/16/2025	*File Name*	STA 5+50 - Excavation Stage.slmd



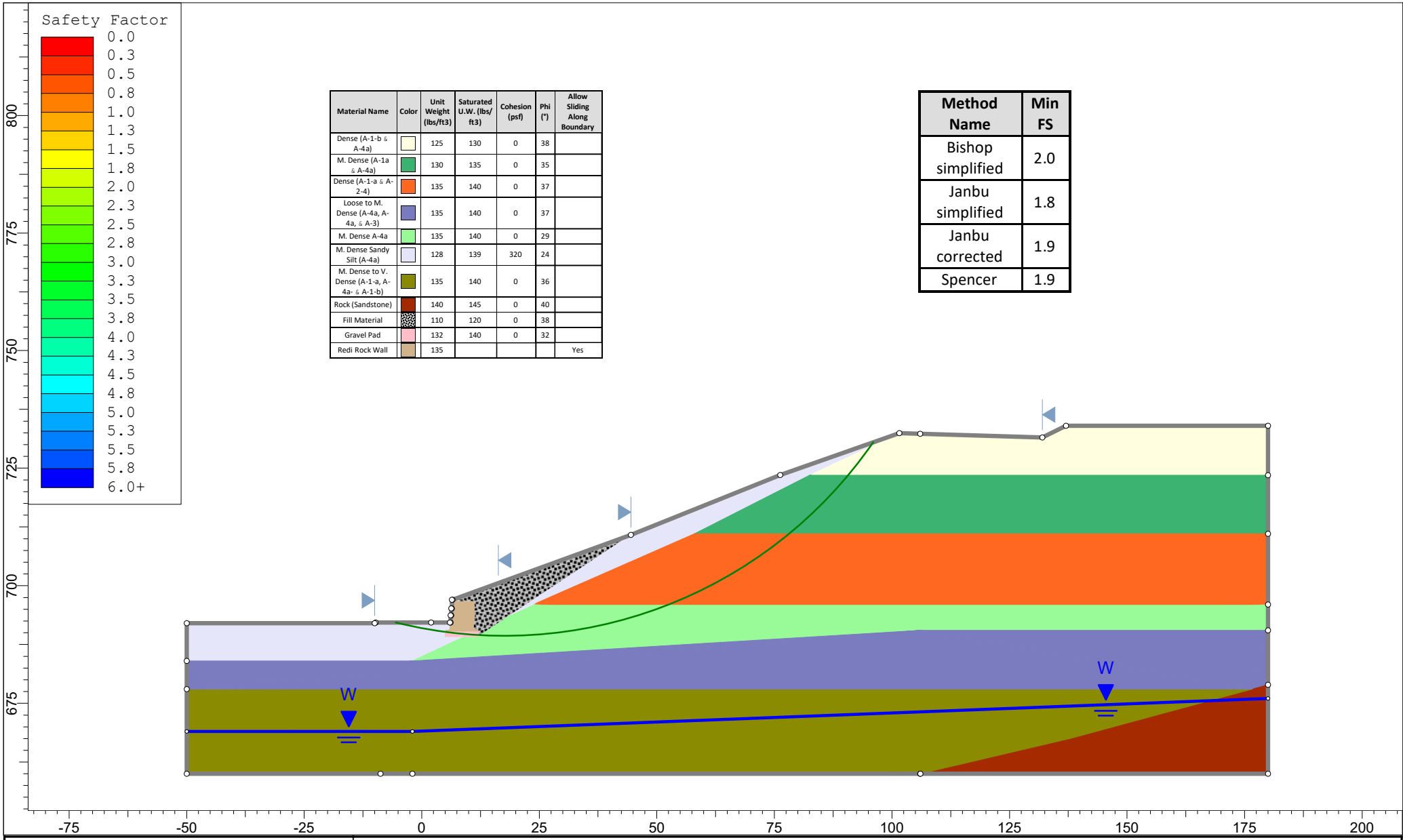
Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)	Allow Sliding Along Boundary
Dense (A-1-b & A-4a)		125	130	0	38	
M. Dense (A-1a & A-4a)		130	135	0	35	
Dense (A-1-a & A-2-4)		135	140	0	37	
Loose to M. Dense (A-4a, A-4a, & A-3)		135	140	0	37	
M. Dense A-4a		135	140	0	29	
M. Dense Sandy Silt (A-4a)		128	139	320	24	
M. Dense to V. Dense (A-1-a, A-4a- & A-1-b)		135	140	0	36	
Rock (Sandstone)		140	145	0	40	
Fill Material		110	120	0	38	
Gravel Pad		132	140	0	32	
Redi Rock Wall		135				Yes

Method Name	Min FS
Bishop simplified	2.0
Janbu simplified	1.8
Janbu corrected	1.9
Spencer	1.9

rocscience

SLIDEINTERPRET 9.039

Project	COL-EL Riverfront Trail – Retaining Wall Phase 1.1		
Group	Section for Wall (STA 5+50)	*Scenario*	Construction Stage (Total Stress)
Drawn By	LI	*Company*	CTL Engineering
Date	10/16/2025	*File Name*	STA 5+50 - Proposed Wall.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Saturated U.W. (lbs/ft3)	Cohesion (psf)	Phi (°)	Allow Sliding Along Boundary
Dense (A-1-b & A-4a)		125	130	0	38	
M. Dense (A-1a & A-4a)		130	135	0	35	
Dense (A-1-a & A-2-4)		135	140	0	37	
Loose to M. Dense (A-4a, A-4a, & A-3)		135	140	0	37	
M. Dense A-4a		135	140	0	29	
M. Dense Sandy Silt (A-4a)		128	139	320	24	
M. Dense to V. Dense (A-1-a, A-4a- & A-1-b)		135	140	0	36	
Rock (Sandstone)		140	145	0	40	
Fill Material		110	120	0	38	
Gravel Pad		132	140	0	32	
Redi Rock Wall		135				Yes

Method Name	Min FS
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SLIDEINTERPRET 9.039

Project	COL-EL Riverfront Trail – Retaining Wall Phase 1.1		
Group	Section for Wall (STA 5+50)	*Scenario*	Construction Stage (Total Stress)
Drawn By	LI	*Company*	CTL Engineering
Date	10/16/2025	*File Name*	STA 5+50 - Proposed Wall.slmd